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Sous-vide: A Modern Cook-Chill Technique in Seafood Packaging

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Abstract

From heat treatment to vacuum packaging, the *Sous-vide* method provides good taste, aroma, texture, and nutritionally valuable food products under controlled temperature with an increase in shelflife compared to conventional cooking methods. In addition to essential vitamins and minerals, seafood is a rich source of PUFA (Polyunsaturated Fatty Acids). With this cooking technique, the nutrient quality of such foods can be almost fully retained and it can meet the consumers' preference for healthy and safe foods. Therefore, the application of such technology is increased day by day mainly in the catering industry. This article mainly highlights the above emerging technology and discussed its merits and demerits in seafood packaging.

Introduction

There is a growing demand all over the world by consumers for high-quality convenience foods particularly ready-to-eat or ready-to-serve food products having a long shelf life. Besides that, the awareness of protein-rich easily digestible healthy foods containing essential amino acids, unsaturated fatty acids, minerals, and vitamins has been gradually accelerated. Among several foods, seafood is of great interest to people today because of its high nutritional content & health benefits as well. Because of perishable in nature, seafood is deteriorated physically, chemically, and microbiologically (Ikbal *et al.*, 2020). Thus, various cooling methods are adopted in addition to the use of various additives and/or different packaging mediums to foodstuffs to preserve them from deterioration and made them available for a long duration. But the use of additives is not enough to reduce the growth of microorganisms and sometimes consumers prefer chemical or additive-free foods although it is safe for consumption. Such factors lead to the development of so many technologies for preserving seafood to enhance these qualities and to ensure longer shelf life. The *Sous-vide* cooking method in combination with controlled chilled storage can be used successfully to extend seafood shelf-life. *Sous-vide* is a process whereby foods are vacuum packaged and then cooked, chilled, and stored in refrigerated conditions which enhances the sensory and nutritional properties of cooked foods, as well as improve the taste, tenderness, and juiciness, and making sure of the use of fewer taste enhancers, less color-loss, nutrients-loss, and aroma-loss (Creed, 2001). Therefore, it is nowadays used in the home, molecular gastronomy, catering as well as in various seafood industries, also known as vacuum cooking technology or lapping. *Sous-vide* is in a food category commonly referred to as new-generation refrigerated foods.

What is 'Sous-vide'?

The *Sous-vide* (In french, means 'under empty'/'under vacuum') is a professional method of cooking in which food is vacuum-sealed in a plastic pouch and then placed in a water bath or steam environment for longer than normal cooking times (usually 1-7 hrs.) at an accurately regulated temperature much lower than normally used for cooking (generally around 50-95 °C) and rapidly chilled and then reheated for serving after a period of chilled storage. It is also known as pouch cooking/vacuum cooking or low-temperature long time (LTLT) cooking method (Aviles *et al.*, 2020). The technology intends to cook the item evenly, ensuring that the inside is properly cooked without overcooking the outside, and to retain moisture. *Sous-vide* is an extended shelf-life cook-chill system, basically comprising of two types: a) Short-life cook-chill system, b) Extended shelf life cook-chill system.

Extended Shelf Life Cook-Chill System

Foodstuffs undergo a cooking process equivalent to 90 °C for 10 minutes which carry a 6-log reduction of non-proteolytic *Clostridium botulinum* (type E) and have a refrigerated shelf life of more than 10 days.

Short-Life Cook-Chill System

Foodstuffs undergo a cooking process equivalent to 70 °C for 2 minutes and provide a 6-log reduction in *Listeria monocytogenes* and have a refrigerated shelf life of not more than 10 days at ≤ 5 °C from production to consumption.

The lipid oxidation and muscle pigmentation are reduced due to cooking and vacuum packaging used in *Sous-vide* technology. At the same time, the microbiological spoilage of cooked foods is heavily retarded during refrigerated storage. Therefore, the shelf-life of the perishable commodity is extended compared with food prepared by traditional methods (*i.e.*, cooking-cooling). The shelf life of various seafood has been reported to differ between 5 and 45 days according to their microbiological aspects.

Historical Timeline of Sous-vide

- In 1799, Sir Benjamin Thompson discovered *Sous-vide*.
- In 1960, the development of stable, high-temperature, food-safe plastic films and made *Sous-vide* cooking possible. American and French engineers started using *Sous-vide*.
- In 1970, George Pralus introduced *Sous-vide* to reduce the shrinkage of Foie Gras.
- Bruno Goussault researched different temperatures for *Sous-vide*.
- *Sous-vide* packaging is first used technically in France, Belgium, America, Canada, and Singapore.
- In the 21st Century, used around the world in various companies and restaurants.

Major Difference between the Sous-vide Process with that of Conventional Cooking Method

- *Sous-vide* provides vacuum packaging of the food.
- One of the main reasons people are willing to hold *Sous-vide* is its simplicity.
- One of the most noticeable benefits of *Sous-vide* cooking over traditional methods is the tenderness that it brings to the foodstuffs.
- *Sous-vide* yields far less shrinkage than cooked meat. In general, during cooking in traditional methods, most portions of meat and fish will shrink by about 25% of their original size, when this number can fall by up to 40% in *Sous-vide* cooking.
- In *Sous-vide* cooking, a humid atmosphere is created by closed, vacuum-sealed bags. This can retain all the moisture and aromas which are usually lost during cooking, and effectively steaming the contents. This added juiciness makes the food come out with much more intense flavors and texture.

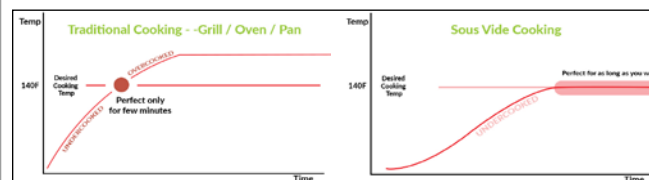


Figure 1: Temperature differences between conventional cooking and *Sous vide*

Principles of Sous-vide

The process is mainly based on 3 principles, *viz.*,

- Use of heat-resistant laminated plastic film for packaging to prevent both contaminations of food and leaking of food constituents.
- Use of vacuum to remove air and to prevent oxidation of food.
- Use of an LTLT (Low-Temperature Long Time) method to pause the breakdown of the food constituents and to enhance proper cooking.

Processing Steps of Sous-vide

- **Raw materials-** Meat or Fish or Vegetable is taken.
- **Preparation-** Washing, peeling, boning, trimming, seasoning, *etc.* are done, and prepare the brine under strict hygienic and quality-control conditions.
- **Packaging-** Put the material into plastic pouches/ bags and hermetically sealed which are impermeable to air. It inhibits oxidation reactions which leads to the deterioration of foods. It serves to pull down the plastic film tightly onto the food

surface, this allows maximum heat transfer into the food through the plastic during cooking. While using this vacuum packaging, the packaging materials should be non-corrosive, non-reactive to the products within it.

- **Pasteurization**- This is done to achieve an internal temperature generally between 65-95 °C. Cooking can be carried out in a water bath, where laminated bags or pouches are immersed in water at a controlled temperature or in an autoclave with an electronic regulator.

- **Rapid chilling**- Packed food is chilled at 1-3 °C as quickly as possible which prevents the growth of any surviving microbes.

- **Storage**- Storage at 0-3 °C is required for a while before reheating and serving. This prevents the growth of *Clostridium Botulinum*.

- **Re-heating and serving**- Reheating of the product is done for about 4-5 min or dipping in boiling water 10-15 min before serving.

Table 1: Recommended cooking times and temperatures for Sous-vide cooking in some seafood (Source: <https://www.vacmasterfresh.com/sous-vide/>).

Seafood	The thickness of the vacuum-sealed pouch (inches)	Cooking temperature (°C)	Cooking time (minimum)	Cooking time (maximum)
Lean fish	0.5	Desired serving temp.	30-40 min	Cooking to maximum times may result in mushy, soft textures
Fatty fish	1	Desired serving temp.	40-50 min	
Lobster	1	60	45 min	
Scallops	1	60	40-60 min	
Shrimp	Large (>1)	60	30 min	

Advantages of Sous-vide Technology

- Reduces the risk of post-process product recontamination. Because of pasteurization and vacuum packaging, most of the pathogenic bacteria (*C. botulinum*, *B.cereus*, *C. perfringens*, *S. aureus*, *Salmonella* sp., *V. parahaemolyticus*) has been reduced in processed products.
- Extended product shelf life (generally up to 21 days) and producing economically high-quality products for consumers.
- Superior retention of aroma, flavor, nutrients & texture. Food cooked in vacuum-sealed pouches doesn't lose its flavor.
- *Sous-vide* prevents the leaching of nutrients and lowers the cooking losses.
- *Sous-vide* treatment may accelerate the bioaccessibility of minerals like Ca, Cu, Fe, K, Mg, etc.
- Due to maintenance of a continuous low temperature with longer times, it reduces the formation of different harmful compounds like Maillard reaction compounds, polyaromatic hydrocarbons, acrylamides, etc.
- As it has offered ready-made (ready-to-eat or ready-to-cook) packages for commercial use, it saves much more time, labor, and space.
- *Sous-vide* technology has comprised several innovations in the catering industry depending upon the quality of products and their shelflife.

Disadvantages of Sous-vide Technology

- Many difficulties like degradation of the vacuum-sealed bag, might also take place during *Sous-vide* cooking. Seafood

contamination can easily occur by migration of plastic-derived compounds into the product during *Sous-vide* cooking.

- Few seafood items like squid, clam, octopus are facing some difficulties during cooking and preparing by *Sous-vide* as they are not always of uniform quality.

- Equipment and material are costly.

- Must be used within a controlled and hygienic environment using high-quality raw material, proper packaging & careful pasteurization, chilling, storage, and reheating, a mistake in any of these steps could lead to the growth of microorganisms.

- Product undercooking or temperature abuse during chilled storage can favour the growth of *Clostridium botulinum* increasing potential hazards due to botulism. The HACCP (hazard analysis critical control point) system is a recommended management tool, can be used to control hazards associated with *Sous-vide* processing.

Some Safety Issues

Women eating food cooked by *Sous-vide* process in pregnancy may expose themselves and/or their unborn children to risk and thus may choose to avoid unpasteurized recipes. *Clostridium botulinum* (type E) bacteria can grow in food in the absence of oxygen and produce the deadly botulinum toxin.

Conclusion

As a highly perishable commodity, more emphasis should be given to extending the shelf life of seafood concerning food safety and consumers' health. *Sous-vide* cooking enables users to cook their food to precise

temperatures reducing the need for constant monitoring of food. Despite having good advantages this process has limited applications as the material cost is high. More scientific researches are needed to optimize the *Sous-vide* technology in seafood products. Future developments aiming to optimize the quality of minimally processed foods such as *Sous-vide* foods will need to use methods that can accommodate more of what consumers experience. Knowing the health benefits of different seafood, the consumption of seafood must be increased. Therefore, such vacuum packaged seafood with superior quality and prolonged shelflife has been gaining public interest.

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