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REVIEW ARTICLE

Evaluation of Sous-Vide Technology in Gastronomy

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ABSTRACT: Sous vide is cooked under control by applying a certain temperature (65-96 °C) / time after vacuuming in the package of the food which is formed alone or with other auxiliary products (sauce-spices) and stored under cold conditions (1-4 °C) by rapidly reducing the temperature after heat application This process is also known as lapping, vacuum cooking, vacuum packed cooking with vacuum pack or baking-cooling with vacuum packaged. In the products prepared by this technology, the blocking effect provided by oxidative and aerobic bacteria development through vacuum packaging combines with microbial protection effect provided by pasteurization; Thanks to the applied cold chain, a long and safe shelf life is provided and consumed. Food can be made reliable by pasteurizing at low temperatures, and even safely consumed without cracking and crunchy foods. In addition to all these advantages, sous vide technology also has some disadvantages. When the investigations are examined, it has been concluded that the research on sous vide technology's reliability in terms of health should be intensified.
Keywords: sous vide, gastronomy, food.

INTRODUCTION

Sous-Vide Technology

The eating habits of the society have changed with the importance of time, and the individuals have been directed to feed with the foods prepared more easily and quickly. On the one hand, as the consumption habits change, the increasing awareness of the consumers with the developing technology has prompted the desire to consume the food products which are prepared quickly and easily by the people but the food items are not lost and the compounds which are not harmful to health by advanced processes are consumed. To meet consumer expectations, sous vide is a technology that finds application in both home and catering sector (Creed, 1998; Nyati, 2000). The Sous vide method has been reported to provide reliable, durable and quality products that are served to this purpose by providing heat treatment applied to the vacuum packaged product and thus enabling the food to be preserved for a long time without losing its freshness and being easily heated and consumed if desired by the consumer (Ghazala, 1998). Sous-vide technology is a result of consumer demand for fresh and good quality food (Garcia-Linares, Gonzales-Fandos, Garcia-Fernandes, & Garcia-Arias, 2004).

Sous vide packaged foods are defined as baking under control by applying raw food or raw material (olive oil, salt, spices, sauce, etc.) to the raw food in a package and vacuuming after applying certain temperature/time (González-Fandos, García-Linares, Villarino-Rodríguez, García-Arias, & García-Fernández, 2004). The French word "sous vide" is used in the sense of "under vacuum" and is defined as a cooking technique applied to raw or half-cooked food (Schellekens, 1996). Sous vide is described as one of the subcategories of low-oxygen packaging technology in a separate chapter from the vacuum packaging technique. Because the vacuum packaging process is only one of the production steps of the sous vide technology. Therefore, sous vide is defined as vacuum cooking technique, unlike vacuum packaging. According to Sous vide history, it is known that this technique has been preferred to other cooking methods by the chefs since the 1970's due to their different advantages. As food's advantages over storage time and increased sensory quality began to come to the forefront, it began to be shown as one of the alternative cooking techniques planned for use in mass consumption places after 2000's (Creed, 1998; Nyati, 2000; Picouet, Cofan-Carbo, Vilaseca, Ballbè, & Castells, 2011).

Vacuum-packaging techniques used in vacuum packed cooking methods, heat application and cold storage of cooked foods delay the oxidation of muscle pigments and lipids while slowly progressing microbiological deterioration. This method prolongs the shelf life compared to the products prepared by the traditional "cooked cold" method (Pedro Díaz, Nieto, Bañón, & Garrido, 2009).

Basically, the products processed by this method are cooked in a relatively long time at a temperature of from about 65° C to about 96° C and after the application of heat, the temperature is rapidly reduced and stored under cold conditions (1-4° C). These products, which are prepared by vacuum-packed cooking and stored in the cold, can remain intact for 6-42 days (González-Fandos *et al*., 2004). With the application of more intense temperature (95-100 ° C for 60-90 minutes) applied in America, this period is over 90 days (Thippareddi, Subbiah, Korasapati, & Sanchez-Plata, 2009). Although it is extremely difficult to clearly determine the shelf life, it has been reported that this training period varied between 5-45 days for fish and shellfish prepared by vacuum packaged cooking (Pedro Díaz *et al*., 2009). Vegetable, meat and fish products prepared with this technique are primarily found in industrial markets and in markets increasingly prevalent (Ohlsson & Bengtsson, 2002).

Sous Vide Technology Process Stages

Cooking with Sous vide technology is separated from cooking in a traditional way. The first is the raw product cooked in a heat-resistant, vacuum-packed plastic bag into which food can be placed; and the second is that the cooking process is carried out at precisely controlled temperatures. Since food is cooked

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in a vacuum package with sous vide technology, which is a kind of pasteurization process, the temperature is uniformly distributed throughout the food during cooking, so that the temperature distribution in the conventional cooking method is not observed in the sous vide cooking of foods (Baldwin, 2012; González-Fandos *et al*., 2004).

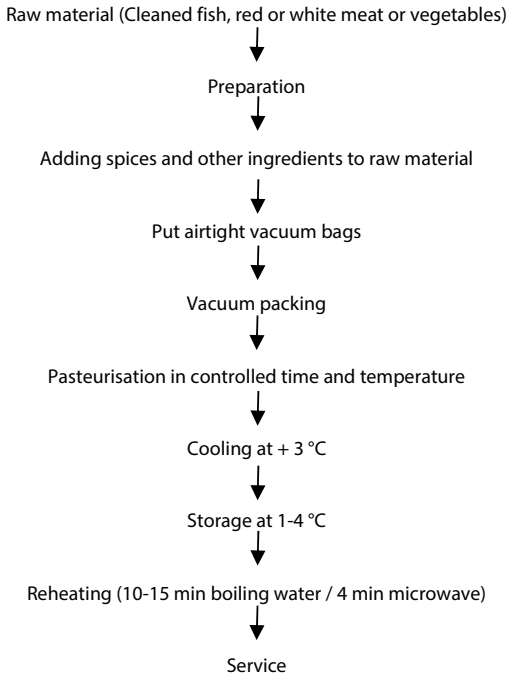

Figure 1. Sous vide technology flow chart

When cooking with Sous vide technology, the food is put into heat-resistant plastic bags and vacuumed to close the mouth. The vacuumed bag is cooked according to the appropriate temperature-time parameters by placing it in the cooking chamber which can control the temperature and water circulation in it. At the end of cooking, the product is removed from the water and served directly or on a grill or pan. There are 2 types of consumption of food cooked with Sous vide technology. The first is vacuum packaging, heating or pasteurization, cook-serve / hold consisting of stages for preparation and service for service, vacuum packaging, pasteurization, rapid cooling, refrigeration or freezer storage, reheating just before consumption, cook-chill / freeze 'consisting of stages of preparation and service for the service. The sous vide process flow diagram is shown in Figure 1 (Baldwin, 2012; González-Fandos *et al*., 2004; Venugopal, 2006).

Advantages and Disadvantages of Sous Vide Technology

Sous-vide method has advantages and disadvantages.

Advantages of Sous vide application

- The ability to apply foodstuffs that are stored cold and susceptible to degradation, such as poultry and fish,
- Preventing the moisture that may be formed in the packaging due to packaging,
- It is ensured that fresh water and volatile aromatic components remain in the product
- It is a method that can be applied in a short time with little work force,
- If the customer is ready for service in a short time and easily when requested,
- It is possible to make the food more attractive by adding various ingredients such as garlic and oil,
- Prevents oxidative reactions leading to bad smell and taste in the food
- If the steps of the process are practical,
- By means of vacuum packaging, it is possible to prevent the activities of aerobic microorganisms,
- Extending the shelf life to produce products in terms of producers and sellers in terms of economic and consumer,
- It is preferred in hospitals, schools, factories and restaurants due to the preservation of nutrient composition of the foods applied and the fast Serviceability,
- Thanks to the fact that it is applicable to fish, poultry as well as many other foods, it is possible to provide a wide range of menu facilities for collective service units such as restaurants, hotels and factories,
- Transfer of heat from the water to the product efficiently, and the product is exposed to a homogenous heat, so that it is at the same temperature from the center to the center, which is very close to the characteristics of the fresh product and provides a more moist and crispy product than the traditional baking.
- It is possible to store rafts for a longer time while saving money from the place and work force,

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- Serving innovations in the catering sector, depending on quality and shelf life,
- The producers in the industry are strengthening the market competition (Baldwin, 2012; Garcia-Linares *et al*., 2004; Schellekens, 1996).

The disadvantages and risks that the Sous vide method can bring are;

- The pre-processing time is long.
- The additional cost of operating the equipment and packaging films used in vacuum packaging and pasteurization applications,
- The necessity of making a tight cold chain,
- Microbial growth may be due to the fact that production is done without any additive substance in some products even with the use of the minimum additive material. Some Sous Vide product formulas do not even use salt.
- As a result of shrinking production conditions, the product is contaminated during processing, loss of quality as a result of protection of cold chain and failure to achieve expected the effect on shelf life,
- Failure to provide pasteurization conditions properly if the temperature to be applied is insufficient and the prevention of the toxic effect of *C. botulinum*,
- The conditions of pasteurization to be applied are determined and it is necessary for trained personnel to apply it (Baldwin, 2012; Creed, 1998; Nyati, 2000).

Use of sous vide technology in the field of Gastronomy

Using eight different combinations (between 5 and 12 hours) and temperatures (between 60 and 80° C), the various tissue and physicochemical properties of the iberian pigs, as well as the effect of vacuum packaging, were analyzed compared to boiling for 30 minutes. As a result of these analyzes, the cooking time and temperature affected meat texture considerably. The researchers discovered that the meat cooked with the sous vide technique at 80 °C is similar to the water losses with a 30-minute scrape of the traditional cooked meat. One of the generally reported advantages of cooking meat for sous vide is that it is more juicy and has higher nutritional value due to more concentrated nutrients (Sánchez del Pulgar, Gázquez, & Ruiz-Carrascal, 2012).

In a study where they investigated the effect of storage at different temperatures (4° C and 12° C) on the shelf life of the whiskers cooked in sous vide for 10 minutes at 70° C; the lipid, protein and moisture contents of the fish were statistically different after sous vide cooking, and the same tendency was not observed in the content of ash and carbohydrate. In addition, the TVB-N value of raw fish at 11,64 mg / 100 g decreased to 9,62 mg / 100 value after cooking sous vide. However, the limit value of 30 mg / 100 g was observed at 12° C and 4° C at 18 and 42 days, respectively. The shelf life of the haddock with short shelf life increased at both storage temperatures by 10 minutes sous vide cooking at 70 ° C (Mol, Ozturan, & Cosansu, 2012).

In a study in which the shelf life of traditional and sous vide cooked and differently stored beef was monitored, the shelf life of traditional cooked meat products was found to be 7, 11 and 26 days at 20, 10 and 3° C, respectively. For microbial growth in Sous vide products, products stored at 3 and 10 ° C have more shelf life than 40 days, while products stored at 20°C have microbial growth started on day 9. In terms of sensory quality in traditionally cooked samples, shelf life is 7 and 3 days at 3 and 10° C, respectively, and 12 days in samples cooked with sous vide method. Accordingly, it has been reported that sous vide packaging is an effective method for protecting the product in terms of microbial, physical and sensory degradation at the evaluated storage temperatures (Deok Jang & Sun Lee, 2005).

In a study on beef, the formation of heterocyclic aromatic amine (HCA) was observed in 10 different methods at different temperatures and times of sous vide cooking, boiling and frying. While the amount of HCA in the fry was higher, the lowest HCA value showed 120 min. Sous vide and boiling (<100° C - 42 min) at 75-85° C. The increase in the cooking time without changing the temperature increased the amount of HCA in the sous vide method (Oz & Zikirov, 2015).

The beef was cooked at 75° C and 100° C sous vide method. In comparison with boiling, sous vide preservation, which showed higher vitamin B3 preservation, was better at the 2 temperature value than the sous vide method applied at 75° C in the B12 vitamin storage (Rinaldi *et al*., 2013).

Compared to the traditional anthocyanin content of the red cabbage cooked with traditional sous vide methods, the loss of anthocyanin in the traditional method is found twice as much as the loss in sous vide method (Iborra-Bernad, Tárrega, García-Segovia, & Martínez-Monzó, 2014).

In a study of the degradation of cooked salmon stored under Sous Vide cooling, it was packaged, cooked at 80 °C / 45 minutes baking time, quickly cooled at 3° C and cooled 2° for 0, 5 or 10 weeks for catering use It's stored in C. sous vide processing prevented the growth of aerobic and anaerobic psychrotrophs, lactic acid bacteria, molds and yeasts and *Enterobacteriaceae*. PH, water activity, TBARS, CIELab colors. Sensory impairment suggests that microbiological quality alone may exceed the shelf life of sous-vide-cooked salmon before microbiological and physical-chemical degradation (P. Díaz, Garrido, & Bañón, 2011).

Sous-vide cooking enhances the total phenolic content and the antioxidant activity of the hodan when the sod-vide processing of borage (*Borago officinalis L.*) is evaluated for its organoleptic and health-related properties. Sous-vide cooked borage is brighter, more green and richer than antioxidants without boiling. The quality of the sous-vide source is maintained for 14 days (P> 0.05) except color (Alcusón, Remón, & Salvador, 2017).

Microbiological and sensory qualities of different storage periods were investigated by cooking lamb meat with sous vide technique at 70° C for 12 hours. It was determined that psychrophile, lactic acid bacteria and *Enterobacteriaceae* were inactivated in the lamb that was cooked at the temperature stated in the study (Pedro Díaz, Nieto, Garrido, & Bañón, 2008).

Antimicrobial effect of rosemary and thyme essential oils on *Listeria monocytogenes* was investigated in rosemary vine storage during storage, the *L. monocytogenes* population increased during storage at 8° C and was similar in control and thyme samples. On the contrary, rosemary showed an antimicrobial effect until day 14, which reduced the growth of *L. monocytogenes* (Gouveia, Alves, Silva, & Saraiva, 2016).

The levels of lipid and protein oxidation in lambs were investigated by Sous Vide method at 60, 70 and 80° C for 6, 12 and 24 hours. In the study, while the number of conjugated dienes increased in the samples cooked at higher temperature and time, the decrease in TBA and hexanal amounts were detected and an increase in total protein carbonyls was determined at all cooking temperatures-time, and all these changes in lipids and proteins affected the meat texture and sensory quality (Roldan, Antequera, Armenteros, & Ruiz, 2014).

In a comparison of antioxidative properties of raw vegetables and thermally processed ones using conventional and sous-vide methods, Antioxidative properties for raw vegetables were obtained with the range of 7.47-235 (µM Trolox / 100 g of vegetables) and 2.66-103 (µM Fe2 + 100 g of vegetables), for

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vegetables after the conventional cooking process 6.15-657 (µM Trolox / 100 g of vegetables) and 3.03-99.9 (µM Fe2 + / 100 g of vegetables), for vegetables after the sous-vide process 4.45-648 (µM Trolox / 100 g of vegetables) and 3.06-99.9 (µM Fe2 + / 100 g of vegetables). vegetables such as red onion, shallots, broccoli, tomato, parsley root and cauliflower were found to have a higher antioxidative potential after cooking using the sous vide method than on conventional method (Kosewski *et al*., 2018).

In a study, Sous Vide and High Pressure Processing (HPP) can be combined to produce safe and potentially acceptable meat products. The basic qualities of dried beef (color, moisture content and expressible moisture) were not significantly affected by HPP. Sous vide cooking high pressure processed steak did not change the quality of the steaks, except for the heaviest processed samples (Sun, Sullivan, Stratton, Bower, & Cavender, 2017).

They reported that different levels of heterocyclic aromatic amine (HCA) were formed in meat samples cooked using different cooking methods (frying pan, deep frying, grill, oven). They found that the highest total amount of HCA in the study (112ng / g) was found in chicken breast meat cooked on the barbecue. In addition, the total HCA content was 27,40 ng / g in the fried chicken breast, 21,30 ng / g in the deep fried chicken breast, and 4 ng / g in chicken breast. In the study, it was also found that the total HCA contents of duck breast meat cooked in a pan, deep fat, barbecue and stove were 53.30ng / g, 14ng / g, 32ng / g, 7ng / g respectively (Liao, Wang, Xu, & Zhou, 2010).

Processing of the Sous vide chicken sausages was optimized in vacuum packing conditions and compared to the 30 minute (SV30), 60 minute (SV60) and 120 minutes (SV120) cooked at 100 cooks and aerobically cooked at 100° C for 30 minutes. At the end of the study, sous vide processing found that the chicken sausages with improved product quality and shelf life at 4 ± 1 horse lower lipid oxidation and microbial growth (Naveena *et al*., 2017).

Changes in the chemical, physical, microbiological and sensory properties of processed mussels cooked with sous vide compared to conventionally cooked mussels (90° C - 10 min) were monitored during refrigerated storage (3.0 ± 1° C). sous vide with salty water or salt water for 10 minutes at 85 °C and chill method to maintain mussels quality and extend shelf life to 21 storage days. In addition, with the addition of saline, a shelf-life extension of up to 30 days was possible compared to mussels exposed to conventional cooking. They have come to the conclusion that Sous-vide technology is promising to improve the shelf life and quality (Bongiorno *et al*., 2018).

In one study, they found that it is possible to increase the shelf life by exposing the applied saline slices to high-pressure application, a technique well known for decontamination of ready-to-eat food (Picouet *et al*., 2011).

In the study, the total and durable starch contents of three potato varieties (Agria, Agata and Carrera) of the sous vide cooking process evaluated the effect of color and shear strength. Potato slices were also cooked with three common treatments (boiling, frying and microwave oven) to evaluate the differences between the methods. According to the results, in-package sterilization has come to the conclusion that it can be considered to be applied in the food industry as a technology that has a similar effect to traditional cooking processes used in potato products (Muñoz, Achaerandio, Yang, & Pujolà, 2017).

In studying the quality of asparagus prepared from traditional and sous-vide cooking methods, Microwave oven caused the highest weight loss, dry weight and Total Color Difference. Steaming caused both chlorophyll and neoxanthin content to decrease the most. The whole cooked asparagus was generally considered acceptable by the panelists. Sous vide- microwaving found that they were better preserved or increased the quality of spears (Gonnella, Durante, Caretto, D'Imperio, & Renna, 2018).

Escherichia coli O157: H7 showed that bacteria can be destroyed at a certain temperature and time when the pH of the inoculated sous vine calf is adjusted to 4.5 or 5.5 with lactic or acetic acid (Juneja & Novak, 2003).

In the study, the cheese was injected into brine containing whey and sodium chloride and sous vide was cooked. The total weight loss of the injection and the muscle strength of the beef steak were significantly reduced (Szerman *et al*., 2007).

Despite the vacuum packaging, a large number of *Bacillus* species have been isolated from cooked cod filets packed with cold stored (5° C) vacuum packs. However, it has been determined that cooling under control of *B. cereus* is effective, except for a few psychrotrophic strains (Huss, Ababouch, & Gram, 2004).

After making cakes from Lethrinus lethrinus bacon, the microbiological properties of the products stored at 3° C were studied after baking with vacuum packed, traditional "cook-chill" and vacuum packed cookery methods. When the product was deteriorated by sensory scores at sixteenth week, it was determined that the total number of bacteria was traditionally packed in a vacuum and 5 log CFU / g was found in products that had been cooked and cooled and 3 log CFU / g in vacuum packaged products. (Shakila, Raj, & Felix, 2012).

CONCLUSIONS AND DISCUSSION

Sous vide manufacturing technique has become one of the cooking techniques that have been started to be preferred in the gastronomy sector due to many advantages such as extending shelf life, preserving sensory quality and microbiological quality. Although food cooked with sous vide technology is regarded as safe, it should be checked that the internal temperature in storage is safe and reliable for botulism. Because vacuum packaging provides a suitable environment for the growth of *Clostridium botulinum type E* with the ability to grow and toxin at low temperatures and if proper storage conditions are not provided, *Clostridium botulinum* spores that remain alive during cooking may develop and become poisoned. Pathogens such as *Listeria monocytogenes, enterotoxigenic Escherichia coli* and sporadic *Bacillus cereus*, which develop at low temperatures, may develop during cold storage if they remain viable during production. It has come to the conclusion that the reliability of scientific works should be strengthened.

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CONFLICTS OF INTEREST

"The authors declare no conflict of interest".