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## **Abstract**

Many technologies have been created in order to simplify our everyday life and technology in the kitchen is not an exception. Indeed, evolution in the dimension of technology is keeping growing up from the first micro wave to the recent induction cooking hobs. The precision cooking method is also part of these new technologies but have not been adopted by many households yet. In this paper, consumer perception has been investigated to identify the hindrances to acceptance of *precision cooking* technique in households.

These brakes have been investigating through implementing a consumer survey in the United States. An online questionnaire has been answered by 280 north-American people for one month including hypothesis testing.

Three groups of people have been identified during the research: “Don’t know *precision cooking* method”, “Know the *precision cooking* method” and “Use the *precision cooking* method”. As a general opinion people who have already experience a food product cooked using this specific method was positive.

The group of people not familiar with the technique have a bigger interest than the one who know it already. However, both groups perceive the precision cooking method or so called “sous-vide” technique, as complexed and time consuming.

These two dimensions being the major factors they look at while purchasing a new kitchen appliance before looking at the price. The resistance to change and the nutrition aspect are the major brakes tested in the survey not to use the precision cooking method at home. These results may help professionals in this cooking method such as immersion circulator producers to communicate effectively on this new cooking method and as a result attract new users.

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## **Foreword**

The subject of the thesis is in regard to the social sciences applied to the food environment. More precisely, this thesis is evaluating the brakes to acceptance of using the precision cooking method in households.

I would like to thank all the people who contributed in some way to the work described in the thesis. First and foremost, I thank my academic advisor, Professor Consuelo Iborra, for helping and supporting me along this work. She contributed to engaging me new ideas and demanding high quality of work.

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## **Introduction**

The process of heating allows humans to discover new flavors. For example, the *Maillard* chemical reaction between sugar and protein creates specific colors and flavors. (McGee, 1984)

Thanks to the engineers and scientists, technology in the kitchen has progressed which helped the chefs to create new combination of flavors.

Every single one from pressure cooker to steamer oven was accepted by the households even though it was inaccessible at the beginning as the micro wave or cooking robots for example.

In this fast-moving world, time is our enemy. We spend more and more time at work rather than being households. This is the reason why the introduction of *precision cooking* could be a real advantage for these hard workers who still want to eat good food. This technique has already been adopted by professionals but not yet accepted by households who seem to be more skeptical about it

This new cooking method is already available with new appliances adapted for the domestic kitchens in the United States. Unfortunately, bad perception and preconceived ideas have been created around this state of the art technique. A study identifying the brakes to this acceptance could help the industry to increase the level of acceptance of the *precision cooking* method in the United States.

So as to gather their perception on this method, an online survey has been answered by 280 north-American households. Seven hypotheses have been tested in this one with open and closed questions to pinpoint the essential hindrances to use the *precision cooking* method at home.

“Human subjectivity or perception determines the consumers’ preference, attitudes, and choice” (Verbeke, 2002). It is therefore significant to identify these hindrances improving as a result the implementation of the *precision cooking* method in north-American domestic kitchens.



## A. PRECISION COOKING

Cooking is the transfer of energy from a heat source to the food. It is when applying heat, the structure of molecules such as the shape of proteins, fats and carbohydrates will be altered. These chemical reactions will alter the texture and the taste of the ingredient (Lopez-Alt, 2015). The right modification of some biochemical components of foods will result in an organoleptic enhancement of the product. Similarly, acids in marinade, salt or concentrated sugars for example experience the same effect on food.

For centuries, the human being is seeking for new cooking techniques in order to increase the meal experience, considering the sensory and the nutritional features. These innovations in the kitchen are usually related with technological discoveries, the technique *sous-vide* is not an exception.

## 1. Origin of *sous-vide*

*Sous-vide* technique emerged in the 1970s in the kitchen of the well-known French chef Troisgros (Hesser, 2005). He realized that cooking his foie gras was a major product loss, about 50 percent of its original weight. Georges Pralus, another chef, got the idea to wrap the foie gras into plastic films before cooking it at a lower temperature. The conclusion was astounding; only 5 percent of loss from its original weight (Hesser, 2005). However, the results were completely satisfactory as from a multi-laminate plastic pouch invented by Ready® was used (Light & Walker, 1990).

During the same decades, Dr. Goussault, both economist and scientist, was working on the same technique but on the industrial level. He discovered that cooking at a lower temperature with an extended time, could lead to a better level of tenderness of the meat (Keller, 2008).

Vacuum-packing, or *sous-vide* practice in French has long been established on the industrial level. This one was especially used to seal and pasteurize the food in order to obtain a longer shelf-life. For example, sausages and hams were pasteurized in a vacuum pack for preservation in Europe (Goussault, 1993). Indeed, one of the advantage of cooking *sous-vide* is the preservation of the food. Comparing *sous-vide* dishes, it was observed that the sensory shelf life could be extended with correct storage refrigeration (1,5°C/34,7°F) (Armstrong & McIlveen, 2000; Schellekens & Martens, 1992).

Temperature, technique and taste were reborn.

In 1979, Georges Pralus decided to open his culinary school in which he could teach the chefs this state of the art technique (Hesser, 2005). At the same time Dr. Goussault got hired by

SNCF® (France's national state-owned railway company) with Joël Robuchon (Renown French chef) to work on the on-board food of the speeding long distance trains. Dr. Goussault began to study the core temperature, meaning the temperature inside the food, before and after heated through carryover. Together Dr. Goussault and Joël Robuchon, developed the menu in 1980 (Hesser, 2005).

From that project, both Dr. Goussault and Georges Pralus continued teaching Michelin star chefs all around the world this new technique in Europe (Arnold, 2006).

In 1989, Dr. Goussault created a process line for high quality *sous-vide* products with the company Cuisine Solutions, on an industrial scale. From then, this company is master in *sous-vide* product in the United States and France for the retail and foodservice market.

## **2. *Sous-vide* definition**

In other words, the principle of *sous-vide* technique is very simple: It is a process by which ingredients are sealed in a pouch under vacuum, and subsequently cooked in a water bath at a series of precisely defined temperatures to reach a desired result.

The key terms of this definition is described below:

### 2.1. “water bath”

It was discovered that the water is the best heat transfer fluid and coolant as well as the most regulated. Indeed, the air is far less dense than water. Given the same mass and temperature, water will contain about four times as much energy as air. There is more energy in the water than air with the same volume and same temperature. (Lopez-Alt, 2015). Therefore, the water is a better heat conductor than air.

### 2.2. “sealed in a pouch under vacuum”

To avoid water to “wash” the product by reducing its color or decreasing aromatic substances, it is crucial that the product is protected by a thin coating adhering perfectly to its surface like a new skin. For example with a red cabbage test, “In *sous-vide* treatment, time and temperature conditions significantly influenced the firmness and the color of cooked red cabbage” (Iborra-Bernad, Philippon, García-Segovia, & Martínez-Monzó, 2013).

Traditionally, chefs were used to cook in bladders, parchments, pies or in covered terrines. Nowadays, complex plastics have replaced these old practices. Considering the air as a brake to heat transmission, it is important to remove the air using a vacuum pump. So called “*sous-vide*”, translated in English as vacuum-packing.

Nowadays, professionals in *sous-vide* are using a specific type of bag temperature-resistant and do not affect the product inside in regard to the Food Security Administration (FDA).

### 2.3. “series of precisely defined temperatures to reach a desired result”

As it is mentioned before, the sealed and vacuumed bag is immersed in a controlled temperature water bath for a certain period of time.

The water’s temperature is easy to regulate for *precision cooking* (Truchelut, 2012). For this reason, above being a great heat conductor the water temperature can also be very accurate.

In order to have a consistency and perfection in the results, the precise temperature technique is very important for sanitary and organoleptic reasons.

However, “*Sous-vide* products can be cooked with two different techniques, you can use either the water bath with an immersion heater, or the steam oven” Dr. Goussault says.

### 3. “Precision cooking” term

This *sous-vide* technique is also called “*Precision cooking*” defined as: “Cooking food packed a plastic bag under vacuum, this one is immersed in water bath at a precise temperature during a precise cooking time” (Keller, 2008).

In this thesis, the term “*precision cooking*” will be, from now, used throughout the text because this technique is the one which seems the easiest to transmit in households according the points exposed in the next sections... In the *precision cooking*, every ingredient has its accurate cooking time and temperature which will easily transposed in the educational channel of cooking “*sous-vide*”.

However, the term *sous-vide* is a more familiar term used for the *precision cooking* in households.

## B. CONTEXT

### 1. Educational channels

#### 1.1. Culinary schools

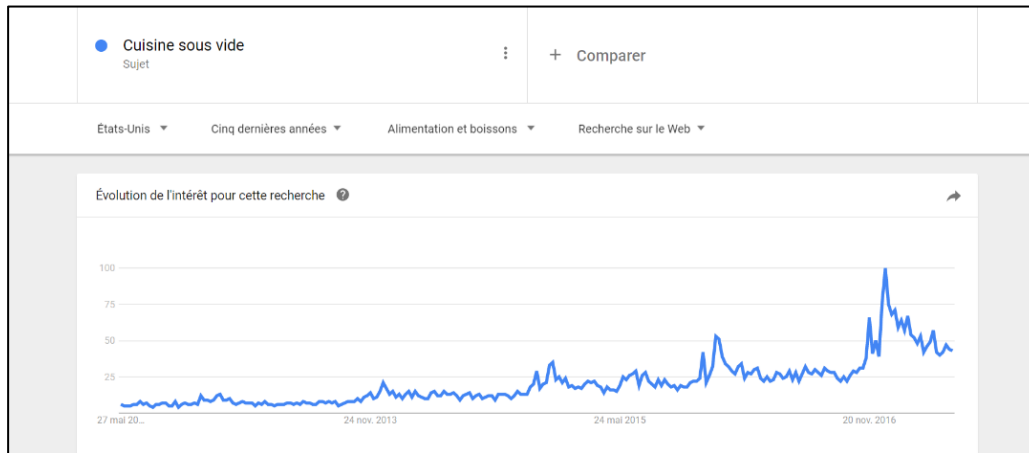
Lessons about this new cooking technique are usually part of exclusive classes as in CREA (Culinary Research and Education Academy) for example.

Indeed, the *precision cooking* technique is not a usual course in the program of the culinary schools in the United States yet.

CREA provides off-site trainings at the chef's restaurant or on-site in the research center in Washington DC. They also have recently launched online courses dedicated to professionals.

Students of culinary schools usually learn the traditional French techniques such as in the Culinary Institute of America. They only might get insight from the *precision cooking* method during their first internship or work in a professional kitchen.

Unfortunately, it is not obvious yet to integrate this cooking method in the educational program but it may be important that students get knowledge from this technique in the following years since this one is gaining popularity in the United States. The research on the internet for this cooking technique has increased of 35% from 2012 and of 23% from 2015 (see Graph 1). Most importantly, the future students should learn the science behind *precision cooking* which is as well essential if they are willing to become a great chef.



**Figure 1.** Google trends, term “Cuisine sous-vide” searched online in the United States consulted on the 06-06-2017.

## 1.2. MOOC (Massive Open Online Course)

In this more and more connected world, a popular study program is gaining popularity: Online courses. This new setup was born in England 170 years ago when the teachers were sending the lessons and students the assignments by mail (Moe, 2015). Nowadays, they are usually in a video format of 10 minutes average in which one instructor or more are teaching the subject of the courses.

This modern version of the traditional classes is more and more common. Some platforms have then been created such as Coursera® which is one of the famous ones.

Basically, the courses are about economics, politics, finance and so on.

It is a possibility that online courses will replace the traditional ones but it is an interesting channel of education to tap into in the next years since people have more and more busy life. This way, students can manage their schedule more independently.



Culinary is a more particular and unusual subject not easy to find in these kind platforms except in regard to the nutritional aspect. However, the University of Hong Kong has recently launched an online course on the science of gastronomy. This one explains the fundamentals of science of cooking from the composition of basic food to the perfect temperature of cooking for this one. Similarly, Harvard University has also launched an online course on basic principles in physics and engineering applied on cooking.

Other online courses in a video format are accessible on blogs or websites such as ChefSteps®, Anova®, Sansaire® which is more dedicated for enthusiasts while CREA or Escoffier are more dedicated to professionals.

However, the amateurs can access these videos as well but materials and vocabulary used in these ones are more adapted for a professional audience.

### 1.3. Books

Thomas Keller is a famous chef who made a very elegant cooking book with stunning pictures which is key to understand the beauty of cooking *sous-vide* or *precision cooking*. He is one of the first chef to introduce the *precision cooking* technique into his kitchen and was then a pioneer regarding this method in the United States.

Moreover, the book so called “Sous-vide at Home “is one the rare cookbooks dedicated to this state of the art technique, compiling the basics of *precision cooking* technique. It is the most recent one, written by Lisa Q. Fetterman and Meesha Halm. (Fetterman, Halm, & Peabody, 2016)

### 1.4. Website

One major website dedicated to *precision cooking* technique is ChefSteps®. This 4 years old company was born in Seattle and is dedicated to inspiring creation and experimentation for amateurs in the kitchen. Since 2016, this company is more and more dedicated to the *precision cooking* technique by adding recipes and explanation on its website and more recently by implementing the most affordable connected immersion circulator for enthusiasts so called Joule®. Similarly, the company Nomiku® was the first to create an affordable connected immersion circulator in 2012. However, this one has been overtaken by ChefSteps® with Joule® few years later.

In order to create a community around this appliance and technique, Nomiku® company has launched a blog called Eattender® allowing Nomiku® users to share their recipes. To date, there is no existing website exclusively dedicated to *precision cooking*. However, enthusiasts usually prefer to be part of a community such as in blogs.

## 2. The science into the kitchen

For years, chefs are challenging themselves to evaluate their cooking results whether it is well done or not. Thanks to their eyes, touch and experience a cook can have an idea on how well a piece of meat is cooked. Indeed, it is always about perception and anxiety; a cook must always anticipate the cooking time and temperature. Only the experience in the industry matters. This is how science can give support to chefs in order to always achieve accurate cooking.

As Escoffier mentioned in 1907, “In a word, cookery, whilst continuing to be art, will become scientific and will have to submit its formulas which very often are still too empirical, to a method which leaves nothing to chance”.

Indeed, a chef has several constraints while cooking: external heat level, cooking time, core temperature of optimal cooking type, texture, taste, ... All of these factors have to be considered during the cooking process of any product in a kitchen. However, everything was about anticipation in the kitchen so far... (Truchelut, 2012)

Some engineers have then found out that water would be the best heat circulator in order to have a controlled and precise temperature, one of the most important cooking parameter (Truchelut, 2012). This way, chefs would be able to decide what temperature he is expecting the product to reach in order to have an optimal taste or tenderness.

However, it is known that water can deteriorate the qualitative aspect of a product from the visual to the organoleptic level. Cooking carrots into hot water results in yellow water, meaning that your carrot has lost some of its color (Chiavaro et al., 2012).

Consequently, scientists have suggested chefs to use thin plastic bags in order to protect their products and at the same time cook at a perfect temperature.

The research of the precise temperature of every ingredient is still carried on so that to lead to cooking perfection in the kitchen.

Baked potatoes and desserts including dairy products are some examples of the many research projects in *precision cooking* technique.

Sciences are now part of the kitchen. Chefs are more and more looking to learn from and work with scientists in order to improve traditional techniques either learning new ones. The landmark of this approach is Harold McGee with his book “On food and cooking” in 1984. He goes over all basic ingredients that can be found in a kitchen and explain its composition and reaction towards cooking. He believes that if a chef understands his food, he will be able then to be very creative. Cooking is based on more than one disciplinary; this is also about chemistry and physics rather than only an art (Brillat-Savarin, 1825).

For example: After years of expertise, it is known that any rare meat must be cooked between 57,7°C (136°F) and 60°C (140°F) due to the slow change of properties of the albumin between 57,7°C (136°F) and 61,6°C (143°F) (Lopez-Alt, 2015).

It is a key for a chef to understand how its products react to acidity, heat and sometimes cold. Ingredients are made of molecules and chefs should understand how these ones: the chemical reactions.

Above all, science has always been important in term of safety and shelf life. “Food-processing methods” for that purpose “started with heating in bottles and cans, as developed by Appert and later on Pasteur to modern sterilization techniques, such as ultra-high temperature and other non-thermal techniques” (van Boekel et al., 2010). This old method, still up to date, has the advantage of destructing the undesired compounds and microorganisms as well as annihilates natural toxins.

In conclusion, part of the passion and creativity of chefs could inspire food scientists and technologists to progressively look for food quality and perception as driving forces for their work, instead of purely rational grounds such as ingredient safety, ease of processing and cost (Vega & Ubbink, 2008). Furthermore, an evolution in technologies will allow new junctures to provide quality and health to the food systems.

### 3. “*Sous-vide*” market

#### 3.1. Appliances

In the recent years, cooking robots have been designed in order to simplify everyday life of busy households such as the Cooking Chef® from Kenwood® company or Thermomix® from Vorwerk® company.

These robots require a plug and a major space in the domestic kitchen with its optional accessories while *precision cooking* technique requires only mandatory accessories.

Indeed, four essential items are necessary for this method: a box to deep the bags in the water, an immersion circulator to heat the water, a vacuum sealer to seal, plus finally specific vacuum bags.

For the professional use, Multivac® is the most famous and important company for vacuum sealer and bags and Polyscience® is the cutting-edge technology in terms of immersion circulator. This last one is most adapted appliance for cooking enthusiasts while for a more important volume of production, heating tanks are used instead.

Joule®, Nomiku®, Sansaire®, Addelice® or Anova® are examples of brands that have worked lastly on the design and shape of these circulators.

However, any of these companies offer a vacuum sealer already available in the market as a food saver promoting the advantage of extending the shelf life of the ingredients. As a matter of fact, a vacuum sealer company called *FoodSaver*® has a great presence in the retail stores of the United States. These vacuum sealers are smaller than the professional ones and therefore are more adapted to the domestic kitchens. The company provides also the adapted vacuum bags.

Regarding the -so called- “*sous-vide* bags”, companies selling an immersion circulator, mentioned in the previous paragraph, offer an alternative to vacuum sealer and bags. They suggest using Ziploc® plastic bags (resistant to heat) and immerse these ones into water in order to remove the air from the bag before closing them. The Ziploc® company mentions on their website that “All Ziploc® brand containers and microwavable Ziploc® brand bags meet the safety requirements of the U.S. Food and Drug Administration (FDA) for temperatures associated with defrosting and reheating food in microwave ovens, as well as room, refrigerator and freezer temperatures.”, meaning these specific bags dedicated to heating are safe. (Ziploc Company, 2016)

Lastly, the *Sous-vide Supreme*® company offers a small version of the professional heating tank. This one offers the advantage of providing a cover which differentiates itself from the immersion circulators.

### 3.2. Food in supermarket

From the Middle Ages, chefs are imaginative in order to extend shelf life of their ingredients such as keeping the meat in fat or salt (Montanari, 1996).

In the 19<sup>th</sup> century, the invention of the sterilization by Nicolas Appert has allowed the production of various vegetables in cans that could be consumed similar to fresh ones. (Montanari, 1996). In

1860, Gail Borden expanded this method of conservation in the United States allowing big companies such as Borden® (Gail®’s company) or Campbell® to grow up (Montanari, 1996).

Nowadays, different storing methods in the supermarket are frozen products, food cans, modified atmosphere products but also recently *sous-vide* ingredients and prepared meals.

#### **4. Eating habits at home**

In the United States, they have a great tendency to eat ready-to-eat meals or snacks out of home. They incorporate food consumption – whether meals, snacks or bites – into a range everyday activities : at work, watching tv, on the phone,... (Surveylab, 2016).

Nevertheless, cooking at home is still part of their domestic life. A consumer study shows that 64% of the north-Americans enjoy making food from scratch (Surveylab, 2016).

Above that, 66% of millennials believe mealtimes are important part family moments and often eat at home with family and friends. Eating a meal with relatives is therefore an essential social activity in the everyday life.

However, it is estimated that 80 to 90% of the food used in home cooking are semi-processed and as a result, makes sense to consider the beneficial effects of processing on safety and quality of food (Jongen & Meulenberg, 2005). This processed food is essentially fresh, which they believe it is important while cooking at home.

Items such as fresh fruits, vegetables, salads or fresh baked bread are the most popular food items in this category (Jongen & Meulenberg, 2005).



## C. STAKES

### 1. Introduction to home cooking: Nutrition and safety

The *precision cooking* technique helps to improve the organoleptic quality of products as well as lengthen their shelf life and finally ensure food safety and stability (Schellekens & Martens, 1992).

#### 1.1. Nutrition

The obesity rate is more worrisome nowadays than years before and especially in the United States where it has been increasing the recent years. More accurately, “Obesity rate is higher among middle age adults from 40 to 59 years old (40.2%) and older adults aged 60 years old and over (37.0%) than among younger adults aged from 20 years old to 39 years old (32.3%)” stated the Center for Disease Control and Prevention (Le Guern Lytle, 2017).

In addition, more than 15 million of north-American children live in "food-insecure" households — having limited access to adequate food and nutrition due to cost, proximity and/or other resources (Coleman-Jensen, Rabbitt, Gregory & Singh, 2016).

Cooking at home considered as time consuming for families who already have busy days, they are more tended to buy prepared meals or are going to restaurants serving enormous portion of food.

The challenge is to facilitate the main cook of families in order to save time but also to enjoy their meal and most importantly healthy one. Nonetheless, north-American citizens usually use at least one processed food in their home cooking recipe (SurveyLab, 2016).

Implementing the *precision cooking* at home would help them to cook at home without frills. *Precision cooking* is a better nutritional technique than traditional cooking methods such as a steaming or grilling to date (Watier & Belliot, 1991). Indeed, cooking in a plastic bag helps the ingredients to maintain its nutritional values since everything is kept in a sealed bag under vacuum protecting the ingredients. The absence of oxygen and the use of temperatures below 212°F (100°C) help to reduce the oxidation and damages to sensitive compounds such as vitamins (Iborra-Bernad, 2013).

For example, thanks to a simulation retention could be seen of 86% of vitamins C using the *precision cooking* on broccoli compared with the raw product after 5 days in chilled storage. While broccoli boiled or steamed showed retention figures of 9.4 or 7.3% respectively (Creed, 1995).

The slow heat diffusion with water and the thin protection layer are very important to this nutritional benefit. Therefore, application of *precision cooking* technique at home would be beneficial for north-American families who are willing to live healthier a simple way.

Last but not least, a study of Candel (2001) has showed up a type of consumers called the “convenience orientation approach”. “The analyses of this approach suggest that the lack of relation between the meal preparer's working status and convenience food consumption is due to convenience food not offering enough preparation convenience”. On another note, “The household production approach argues that households produce outputs like meals for the family employing a production function in which products and services purchased, the capital stock of the household

and the time used are the major production factors.” Since meal production occurs in a family context, some forms of convenience may mean reduced effort for the main shopper and meal preparatory, whereas other forms of convenience may mean reduced effort for the whole family.

It is a real challenge today for marketers to understand whether home cooks would like to enjoy their time in the kitchen with their family but simultaneously would prefer to spend little time cooking because they still have a busy life. A question may be raised, would the *precision cooking* be a real benefit to their lifestyle?

### 1.2. Texture and taste

On the one hand, the nutrition level using this technique is very good as shown before. On the other hand, at precise temperature the texture is perfectly controlled as well as the taste which is amplified since the aromatic molecules remain in the plastic bag.

As a conclusion, “Comparing cooked samples with similar firmness, *precision cooking* samples preserved better color, taste, aroma and anthocyanin content than traditional cooked samples due to the bag which retained flavor and antioxidant components” (Iborra-Bernad et al., 2013).

### 1.3. Safety

Since the foodstuff is packed before cooking, this *precision cooking* technique minimizes the risk of a possible microbial cross-contamination of the bacteria after the cooking phase (Martínez-Hernández et al., 2013).

In accordance with the FDA (U.S. Food and Drug Administration), “Heat processes for *sous-vide* or cook-chill operations must be designed so that, at a minimum, all vegetative pathogens are destroyed by a pasteurization process and temperature control is verified” (U.S. Department of health and human/ Food and Drug Administration, 2013).

## **2. Time saving**

The *precision cooking* technique does not require to stand by the stove, the oven or in general by the kitchen. Bags can be immersed into the water with high confidence that your food will be precisely cooked, by avoiding overcooking. Indeed, as soon as the core temperature as reached the water temperature, the ingredient will stop cooking. There is of course some post preparation before vacuum packing it but after immersing the bags in the water, home cooks can relax and enjoy their time.

Moreover, if home cooks need to deal with possible allergies, they may cook different recipes at the same time while keeping the similar protein. This will allow for example some guests to eat marinade with nuts and others without.

Additionally, this technique is a real-time saver in regard to maintenance. This water contained in the box can be reused since the bag protects the water from the ingredients. Therefore, there is little cleanup involved with *precision cooking* unless to sear the product before or after the cooking phase on a pan for example.

### 3. Anxiety free

Anxiety is a common feeling that everybody experiences occasionally and some people frequently. People may feel nervous in job interviews or in a casual conversation with strangers. Who has never experienced these “butterflies” (Leary & Kowalski, 1997) ?

This feeling may also appear while cooking. Indeed, households may encounter anxiety while cooking for example a piece of meat. As chefs have experience in cooking meat, households have little or barely no experience. It is therefore obvious they may experience anxiety when cooking for themselves or their relatives.

*Precision cooking* technique is about the right temperature and the right cooking time in order to guarantee the perfect cooking. As the household decides on the temperature and time to get the desired cooking, the sureness that the food is well done is therefore guaranteed with the *precision cooking* method.

The provenance, advantages and materials of the precision cooking technique have been detailed in the previous paragraphs. From now, a research has been conducted to identify the brakes to the acceptance of this cooking method.

In the following sections, the methodology of the study will be explained and in addition, the analysis and its results will be presented.

## D. METHOD

### 1. Design

Households' perception of *precision cooking* technique is investigated in a study compiling qualitative and quantitative research techniques. Across this research, the term “*sous-vide*” is used through the data collection since this one is the most common expression and as a consequence is more visual for the respondents.

In order to elaborate the survey, a focus group is organized to get insight from the *precision cooking* technique perception. This one is composed of 15 people who are all food enthusiasts and are aged from 27 to 65 years old.

The discussion was semi-structured and subjects debated on the innovation in the kitchen and in addition to that the knowledge of the food techniques and its perception.

With the help of this focus group, households' attributes of *precision cooking* method are identified.

Consequently, based on the outcomes of the qualitative research, a questionnaire has been constructed (see Appendix A).

This questionnaire aims to identify the brakes towards the usage of the *precision cooking* technique in the domestic kitchen. So that to identify these one(s), several hypotheses have been raised and are described in the next section.

### 1.1. Questionnaire

The questionnaire is built in three different parts to test the behavior of households towards the perception of the *precision cooking* technique (see Appendix A).

#### **1st part**

First, their consumer profile such as age or gender and information in regard to food was identified. For example, they were asked how many hours were spent per week cooking at home on a one-choice answer between “0 to 3 hours” to “More than 14 hours”. (see Table 1)

#### **2nd part**

Second, the brakes towards the *precision cooking* technique were tested in relation to the use of this one at home (Hypotheses explained in the next paragraph).

In this part, respondents were asked to indicate to which extent they agree with statements such as “Warm plastic in contact with food is dangerous”, or “Cooking at low temperature is unsafe”. Several factors were investigated along this part of the survey such as the resistance to change, the sustainability or the space management. The questions inserted in the survey were selected from the focus group.

### **3rd part**

In the latter, the households' knowledge of the *precision cooking* technique and its perception were tested. For example, the respondents were asked to check the material they believe is necessary in order to use the *precision cooking* method. Open questions were also investigated such as “Why don't you cook sous-vide at home?” to get the conscious insight from their perception of the *precision cooking* method.

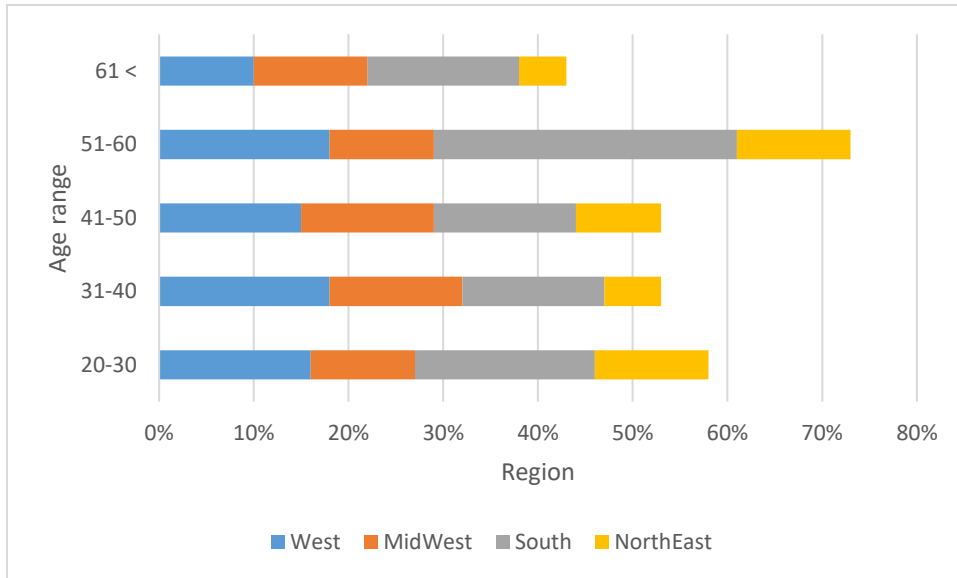
#### **1.2. Sample**

The survey was put online among 280 citizens of the United States. The respondents were selected from food enthusiast associations or groups, culture-related associations and their relatives. The respondent selection was not based on probability sampling method. Accordingly, the generalization of the results to the overall population is possible. In addition, the respondents are part from the four different regions of the United States; West, Midwest, South and Northeast according to the Census bureau (see Table 1). The characteristics of the sample constitute in an extensive range of households in relation to socio-demographics. The different age range is balance across the 280 respondents in which the range from 51 to 60 years old is the most important (see Figure 2).



**Table 1***Socio-demographic characteristics of the sample (n and percentage of respondents, n = 280)*

		n	%
<u>Genre</u>	Female	220	79%
	Male	59	21%
<u>Age</u>	Mean (S.D.)	2.96 (1.38)	
	20-30 years old	58	21%
	31-40 years old	53	19%
	41-50 years old	53	19%
	51-60 years old	72	26%
	61 years old and above	43	15%
<u>Home situation</u>	I live alone	40	14%
	I live with a significant other	100	36%
	I live with my family	122	44%
	I live with my roommates	17	6%
<u>Occupation</u>	Student	14	5%
	Employee for wages	172	61%
	Self-employed	39	14%
	Out of work and looking for work	8	3%
	Out of work but not currently looking for work	16	6%
	Military	0	0%
	Retired	29	10%
	Unable to work	2	1%
<u>U.S. Region</u>	West	77	28%
	Midwest	62	22%
	South	97	35%
	Northeast	44	16%



**Figure 2.** Respondents ranged per age and region (n = 280)

There is a high percentage of people between 51 and 60 years old and more importantly in the South. The range 51 to 60 years is followed by the range 20 to 30 years old which is a major proportion in the South as well.

### 1.3. Data analysis method

In order to be visually simpler, the analysis of the data will be conducted per hypothesis. In the next section, each hypothesis is defined and analyzed. At the end of this analysis, a small conclusion of this hypothesis will be made.

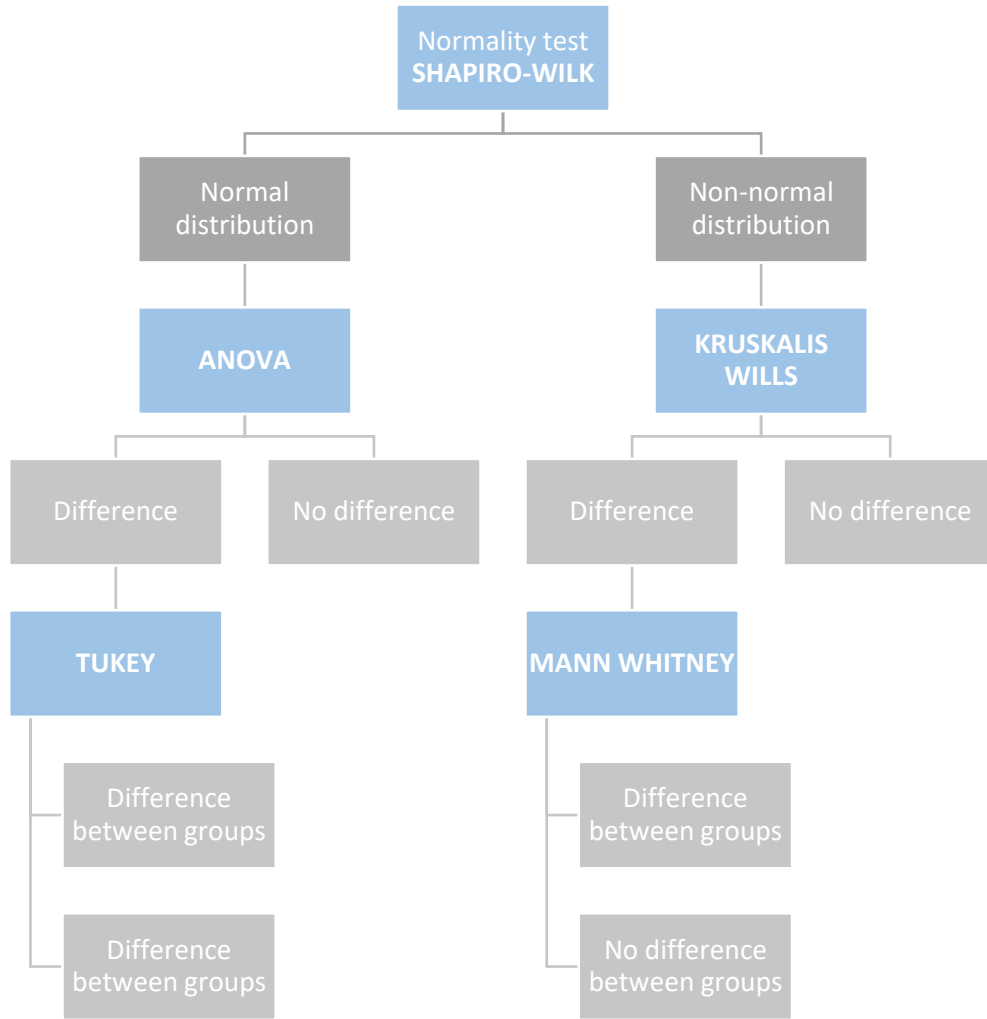
As a result, each of the 7 hypotheses will be presented as such:

- Definition: Context of the hypothesis
- Hypothesis: Hypothesis precised
- Analysis: Test of the hypothesis
- Conclusion: Conclusion of the test; Is the hypothesis rejected or not ?

In the Analysis part, it has been decided to test each hypothesis comparing the three different groups defined as “Not knowing the sous-vide” (Group = 0), “Knowing the sous-vide” (Group = 1), “Using the sous-vide” (Group = 2) from the question 32 (“Have you ever heard of sous-vide technique?”).

For each hypothesis, results of a specific question were tested comparing these three groups. The question has been chosen in term of level of significance for representing the hypothesis the best.

The analysis will be as such:



## **E. HYPOTHESES AND DATA ANALYSIS**

### **1. Sustainability**

#### **1.1. Definition**

This is a major and universal discussion nowadays: the ecology.

Discussions around recycling of materials such as plastic are still on going around the world. These debates are aiming to sensible the population to the sustainability of our common earth.

In regard to the plastic usage in the United States, measures to ban “the use of plastic bags have met with official resistance. With its powerful lobby, the plastic industry argues that jobs will disappear. The industry employs some 2 million workers.” (Le Guern Lytle, 2017).

To be more accurate, “Americans alone throw out at least 100 billion bags a year, the equivalent of throwing away 12 million gallons of oil, which seems an intolerable waste” (Le Guern Lytle, 2017).

The reason why the plastic is a major ecological discussion is that this material does not biodegrade as other materials do. Even though some improvements in the plastic fabrication has been done in order to for this one to decompose more rapidly (Le Guern Lytle, 2017).

It is for all these reasons, a hypothesis that the usage of plastic in this cooking method may be an issue for households in term of sustainability is suggested.

### 1.2. Hypothesis

The hypothesis is that, households are sensible to the plastic consumption in the United States and as a result, the usage of plastic for this specific cooking method could be a brake to use *precision cooking* technique at home for sustainability reasons

#### Questions related to the hypothesis:

- I never use plastic bags in the grocery store. (Agreement scale)
- I buy local products for sustainability purpose. (Agreement scale)
- I care about the amount of garbage made at home. (Agreement scale)

#### Question analyzed in the next paragraph:

Question 17: “I never use plastic bags in the grocery store” (Agreement scale from 1 to 6)

### 1.3. Analysis

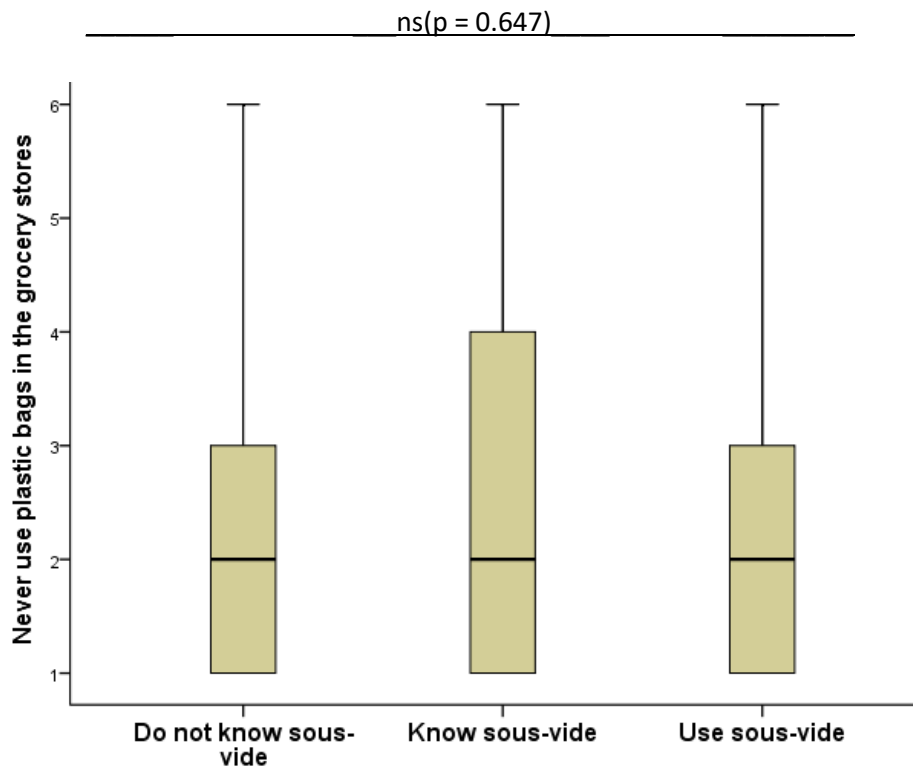
**Table 2**

*Statistics of the Shapiro-Wilk test of agreement scale on the sentence “I never use plastic bags in the grocery stores” across the 3 groups (n = 280)*

Q32		Shapiro-Wilk		
		Statistic	df	Sig.
Q17	Do not know sous-vide	.802	151	.000
	Know sous-vide	.835	108	.000
	Use sous-vide	.751	21	.000

The result of the test is significant, rejecting the null hypothesis and rejecting the assumption of normality for the distribution ( $p < 0.001$ )

For more details, distribution histograms (see Appendix B1).



**Figure 3.** Box plots (horizontal line: median, box: interquartile range, vertical bar: range, circle: outlier) of agreement scale according the sentence “I never use plastic bags in the grocery stores” per group. ns= non significance ( $p > 0.05$ ). \* indicates significant differences between groups ( $p < 0.05$ ).

The Kruskal Wallis test shows there is no difference between the three groups ( $p > 0.05$ ) (see Figure 3).

#### 1.4. Conclusion

The three different groups have the same position in regard to the sustainability. They are tended not to be concerned about it since they pretend to always use plastic bags at the grocery store.

The hypothesis that, people do not use *precision cooking* method at home because they believe that using plastic is not sustainable, is not valid.

The sustainability aspect does not refrain households to adopt the *precision cooking* technique at home.

## 2. Safety: Cooking at low temperature

### 2.1. Definition

Food safety is a very big subject and mostly in an industrial level since it is the unique stuff which is introduced in our body. This can be a reason why home cooks may have an apprehension on the low temperature cooking practice.

The Food and Drug Administration (FDA) is establishing rules in order to avoid any contamination hazard. In addition to this federal agency, the USDA (United States Department of Agriculture) is also a major actor in food safety in the United States.

In *precision cooking* method, it is important that the minimum core temperature controls are in place, or the formation of *C. botulinum* toxin may occur (U.S. Department of health and human/ Food and Drug Administration, 2013).

Heat processes for *precision cooking* or cook-chill operations must be designed so that, at a minimum, all vegetative pathogens are destroyed by a pasteurization (U.S. Department of health and human/ Food and Drug Administration, 2013).

Last but not least, fragile people such as pregnant women or old people may also have concerns on *precision cooking* method and its low temperature cooking aspect since they are more sensitive to pathogen bacteria present in food. From this point of view, unnecessary risks do not have to be taken.



## 2.2. Hypothesis

The hypothesis is that, households do not want to use the *precision cooking* technique at home because it is a low temperature cooking process and therefore they may have a preconceived idea that this one is unsafe.

### Questions related to the hypothesis:

- Fully cooked meat/fish is safer for our health (Agreement scale)
- Cooking at low temperature is unsafe (Agreement scale)
- Food must always be cooked above 100°C (212°F) (Agreement scale)

### Question analyzed in the next paragraph:

Question 16: “Cooking at low temperature is unsafe” (Agreement scale from 1 to 6)

## 2.3. Analysis

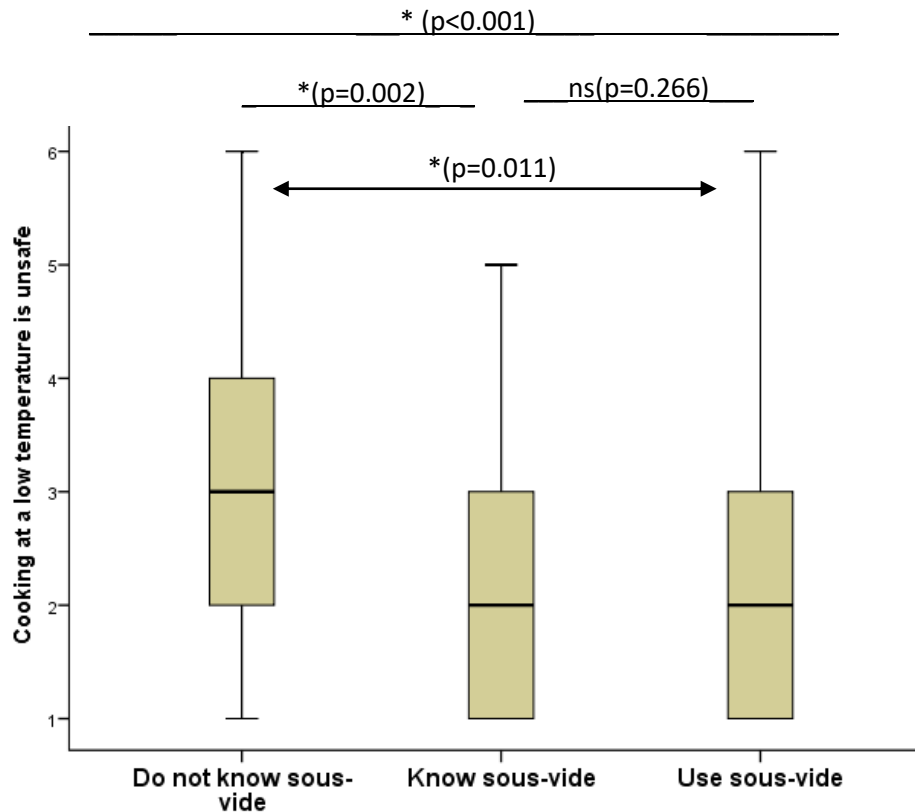
**Table 3**

*Statistics of Shapiro-Wilk test of agreement scale on the sentence “Cooking at low temperature is unsafe” across the 3 groups (n =280)*

		Shapiro-Wilk		
Q32		Statistic	df	Sig.
Q16	Do not know sous-vide	.920	151	.000
	Know sous-vide	.870	108	.000
	Use sous-vide	.759	21	.000

The result of the test is significant, rejecting the null hypothesis and rejecting the assumption of normality for the distribution ( $p < 0.001$ ).

For more details, distribution histograms (see Appendix B2).



**Figure 4.** Box plots (horizontal line: median, box: interquartile range, vertical bar: range, circle: outlier) of agreement scale according the sentence “Cooking at low temperature is unsafe” per group. ns= non significance ( $p > 0.05$ ). \* indicates significant differences between groups ( $p < 0.05$ ).

The Mann Whitney test shows there is a difference between the groups “Do not know the sous-vide” to “Know sous-vide” and “Use sous-vide” ( $p > 0.05$ ) (see Figure 4).

#### 2.4. Conclusion

The people not knowing the *precision cooking* method believe more the low temperature cooking methods are unsafe than the people knowing or not this technique.

In general, they seem to have accepted cooking methods using low temperature across the three groups. Moreover, 85.7% of them already have adopted the slow cooker at home which includes also a low temperature cooking phase.

The hypothesis that, people do not use precision cooking at home because they believe that cooking at a low temperature is unsafe, is not valid because the people knowing sous-vide has the same opinion than users.

### **3. Safety: use of the plastic bag**

#### **3.1. Definition**

One of the main concern about *precision cooking* is the use of plastic during the cooking phase.

This one is indeed in contact with the ingredient inside the bag. But is that a real problem for safety reasons? Is it safe that this one has a direct contact with the ingredient that currently have biochemical transformations ongoing?

Home cooks may have concerns of using plastic as a cooking tool since this one used to have lots of chemical compounds such as polymers and additives. These chemical compounds have a bad reputation due to the use of the term “chemical”, an undesirable expression in the current food industry. Currently, the latest food-safe plastic bags are made of polyethylene, free of plasticizers and finally estrogen-like compounds.

Above that, these ones do not contain any bisphenol A which is currently leading to a safety question (Aungst, 2014). While Canada and the European Union have banned BPA from plastic bottles (Barroso, 2011), studies in the United States on the use of plastic bags are still ongoing in order to ensure food safety.

### 3.2. Hypothesis

An investigation is put in place whether cooking in a plastic bag is a brake to using the *precision cooking* technique at home in terms of food safety.

#### **Questions related to the hypothesis:**

- Cooking in the microwave is safe (Agreement scale)
- Warm plastic in contact with food is dangerous. (Agreement scale)
- Glass packaging is safer than plastic or metal. (Agreement scale)

#### **Question analyzed in the next paragraph:**

Question 10 : “Warm plastic in contact with food is dangerous” (Agreement scale from 1 to 6)

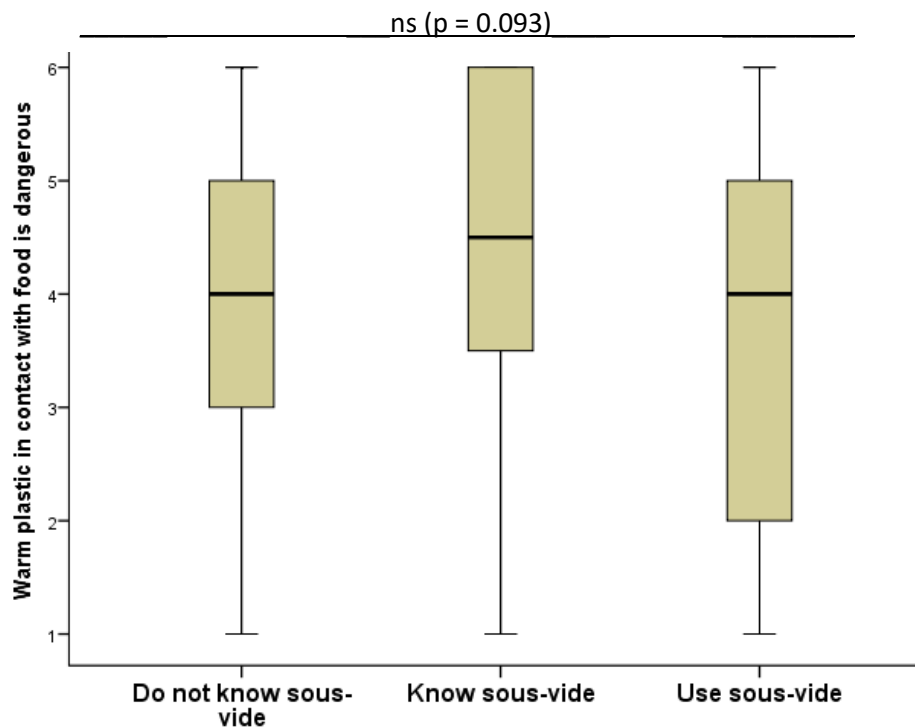
### 3.3. Analysis

**Table 4**

*Statistics of Shapiro-Wilk test of agreement scale on the sentence “Warm plastic in contact with food is dangerous” across the 3 groups (n = 280)*

Q10	Q32	Shapiro-Wilk		
		Statistic	df	Sig.
	Do not know sous-vide	.912	151	.000
	Know sous-vide	.898	108	.000
	Use sous-vide	.917	21	.074

The result of the test is not significant, the null hypothesis is not rejected and the sample comes from a population which has a normal distribution ( $p > 0.05$ ). For more details, distribution histograms (see Appendix B3).



**Figure 5.** Box plots (horizontal line: median, box: interquartile range, vertical bar: range, circle: outlier) of agreement scale according the sentence “Warm plastic in contact with food is dangerous” per group. ns= non-significance ( $p > 0.05$ ). \* indicates significant differences between groups ( $p < 0.05$ ).

The Kruskal Wallis test shows there is no difference between the three groups ( $p > 0.05$ ) (see Figure 5).

### 3.4. Conclusion

From people not knowing the technique to the people using this one at home, they all seem to have a general negative perception about warm plastic on food. However, it did not refrain the group 2 to use the *precision cooking* method at home.

The hypothesis that, households do not adopt the *precision cooking* technique at home because they have a bad opinion on warm plastic in contact with food for safety reasons, is not valid.

#### 4. Return on Investment: the cost

##### 4.1. Definition

As many new kitchen appliances, there is a certain financial investment. Sometimes, high and sometimes low. The *precision cooking* technique requires four different accessories: an immersion circulator or a water oven, a vacuum sealer and its vacuum bags.

Housemakers also go for cheap options; buying an immersion circulator instead of the water oven or, some cooks suggest using Ziploc® bags instead of special vacuum bags and vacuum sealer which is a bigger expense.

The expense for the *precision cooking* method is detailed here under:

- **Immersion circulator:**

The minimum price in the north-American market for an immersion circulator is the Anova® immersion pod at 129\$ (+/- 114.50€) and the maximum is the Polyscience® at 599.99\$ (+/- 597€).

The immersion circulator is necessary in order to heat the water at a precise temperature to perform a precise cooking phase.

In average, the minimum cost is about 281.68\$ (+/- 250€), the investment depending mostly on the expertise of the circulator. Polyscience® is a pod adapted for professional kitchen while Anova® or Joule® brands are more adapted for home makers.

- **Water oven:**

Another option to an immersion circulator, but with a higher expense is the water oven working similarly to a fryer but with water instead of oil.

The water oven is a major expense compared to the immersion pod with a minimum price of 179.99\$ (+/- 159.74€) by the company Hamilton Beach®, while the maximum is around 599\$ (+/- 531€) by Mellow® company.

The average price of the water oven on the north-American market is to a certain extent 354.83\$ (+/- 315€).

- **Plastic bags:**

Vacuum plastic bags are sold in rolls or in piles with a minimum of 0.18\$ (+/- 0.16€) per bag (VacMaster®) and the greatest price being 0.45\$ (+/- 0.40€) per bag (FoodSaver®) for home makers. Professional vacuum bags are more expensive and are usually thinner. However as mentioned above, some professionals also suggest using Ziploc® bags in order to reduce the cost of this *precision cooking* technique.

- **Vacuum sealer**

One of the major characteristics of the *precision cooking* technique is that it requires the use of a vacuum sealer in order to be able to cook ingredients under vacuum.

The vacuum sealer cost has a big divergence between the minimum and maximum price. The minimum being 29.99\$ (+/- 26.60€) by the Butefo® company and the maximum price is at around 848.89\$ (+/-753€) by the VacMaster® company available also for households.



Of course, the cost is more important if the house makers are willing to employ professional vacuum sealers with usually a bigger size and potency.

- **Energy consumption:**

The greatest consumption of energy for this cooking method is the electricity intake of the immersion circulator or water oven. The *precision cooking* technique requires low temperature and as a result longer cooking time than the traditional cooking methods. Therefore, water ovens and immersion circulators are turned on for a long time.

Although, the *precision cooking* technique requires a water bath, this one is kept clear while cooking the foodstuff since this one is protected by the plastic bags. Water is then not a big investment using this state of the art method.

As a conclusion, the most important cost of this *precision cooking* technique is the electricity consumption during the cooking phase.

In order to evaluate the energy consumption, some users have used a kWh meter during a cooking phase. It has revealed that, about 9 hours cooking time at 140°F (60°C) consumes about 2 kWh. Considering the average price per kWh in the United States in march 2017 which is 0.129\$ (+/- 0.11€), the energy cost would be 0.258\$ (+/- 0.23€) (U.S. Energy Information Administration, 2017).

As a result, to cook a meat during 8 hours at 140°F (60°C) using the *precision cooking* method. The minimum total cost would be:

- The plastic bag (One time usage): 0.18\$ (+/- 0.16€)
- The energy consumption (One time usage): +/- 0.25\$ (+/- 0.23€)
- Water (Reusable several times): 0.004\$ (< 0.01€) for 2.64 gallons (10 liters)
- TOTAL COST = 0.43\$ (+/- 0.38€)

The following list is an initial investment:

- Vacuum sealer: 29.99\$ (+/- 26.60€)
- Immersion pod: 129\$ (+/- 143.40€)
- TOTAL INVESTMENT: 158.99€ (+/- 170€)

#### 4.2. Hypothesis

An investigation is put in place whether, cost is an important aspect while purchasing a new appliance and therefore would refrain households using this technique at home.

#### Questions related to the hypothesis:

- While purchasing a new kitchen appliance, I look first at the price.  
(Agreement scale)
- When purchasing a culinary appliance, which aspects are the most important to you? (Rating scale)

#### Question analyzed in the next paragraph:

Question 23: “While purchasing a new kitchen appliance, I look first at the price.” (Agreement scale from 1 to 6)

#### 4.3. Analysis

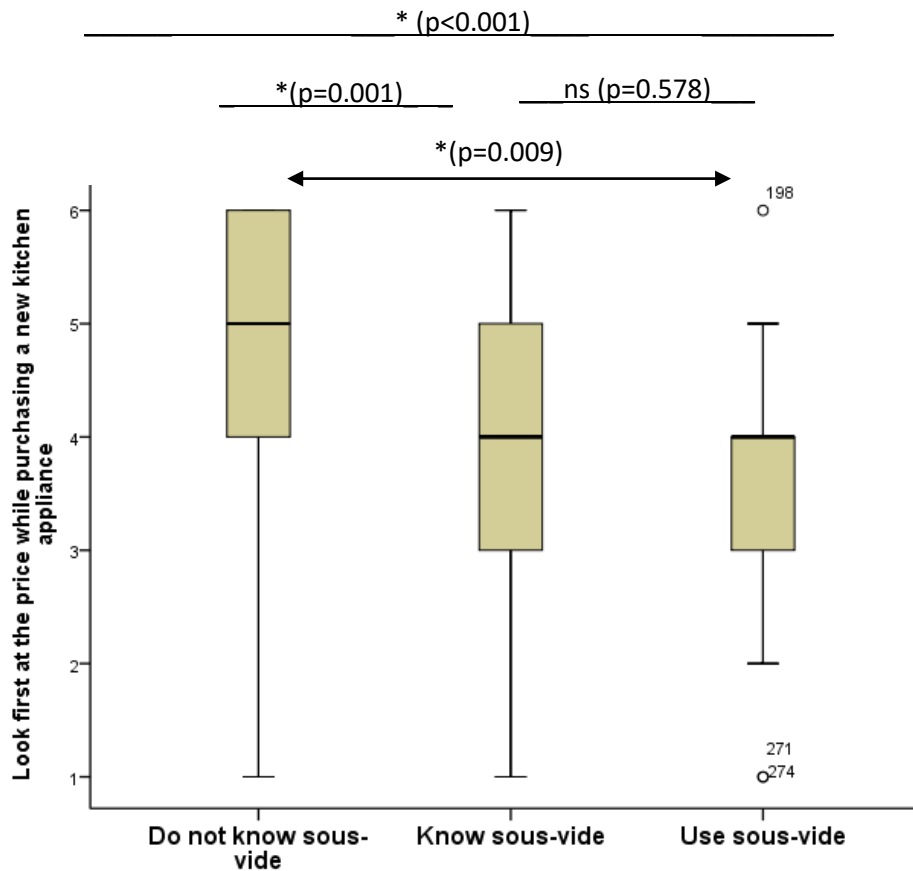
#### Table 5

*Statistics of the Shapiro-Wilk test of the agreement scale on the sentence “While purchasing a new kitchen appliance, I look first at the price” across the 3 groups (n = 280)*

		Shapiro-Wilk		
Q32		Statistic	df	Sig.
Q23	Do not know sous-vide	.881	151	.000
	Know sous-vide	.914	108	.000
	Use sous-vide	.905	21	.044

The result of the test is not significant, the null hypothesis is not rejected and the sample comes from a population which has a normal distribution ( $p > 0.05$ ).

For more details, distribution histograms (see Appendix B4).



**Figure 6.** Box plots (horizontal line: median, box: interquartile range, vertical bar: range, circle: outlier) of agreement scale according the sentence “While purchasing a new kitchen appliance, I look first at the price” per group. ns= non-significance ( $p > 0.05$ ). \* indicates significant differences between groups ( $p < 0.05$ ).

The Tukey test shows there is no difference between the groups “Know sous-vide” and “Use sous-vide” ( $p > 0.05$ ).

However, the test shows a difference between the groups “Do not know sous-vide” and “Know sous-vide” ( $p < 0.05$ ) and the test shows a difference between the groups “Do not know sous-vide” and “Use sous-vide” ( $p < 0.05$ ) (see Figure 6).

#### 4.4. Conclusion

The people not knowing the *precision cooking* technique look more at the price while purchasing a new kitchen appliance than the people knowing this one. Plus, the people not knowing the *precision cooking* method look more at the price while purchasing a new kitchen appliance than the people using already this one at home.

There is no difference between the groups 1 and 2, meaning that this hypothesis is not valid. The price doesn't seem to be an aspect that refrain people to use the *precision cooking* technique.

## 5. Nutritional impact

### 5.1. Definition

Nutrition and dietary are major trends nowadays that are very important for home makers in order to thrive in good health. The daily nutrients intake is now essential. Indeed, it is usual households take a great interest in having all essential nutrients such as proteins or lipids in their daily meals.

It is legitimate to question the nutritional value of the foodstuff since this one is cooked. The impact on the vitamins, mineral elements and antioxidants with the traditional cooking techniques are already known. However, the *precision cooking* technique change the temperature and time parameters compared to the traditional cooking techniques. For example, a piece of beef traditionally takes 25 to 30 minutes to cook while it takes 1 hour 30 minutes with the *precision cooking* technique depending on its size.

Since it takes a longer time to cook at a not-usual low temperature, it is legitimate that homemakers doubt on the nutritional quality with the *precision cooking* method.

### 5.2. Hypothesis

It is studied if, households believe that this technique is not appropriate nutritionally wise.

#### Questions related to the hypothesis:

- Traditional cooking is the healthiest way to cook ingredients. (Agreement scale)
- In term of nutrition, how would you rate these cooking techniques from 1 to 6? (Rating scale)

#### Question analyzed in the next paragraph:

Question 4Sous-vide: “In term of nutrition, how would you rate these cooking techniques from 1 to 6?” (Rating scale)

### 5.3. Analysis

In this analysis, the group 0 has not been studied since this once do not know the precision cooking and therefore the term “sous-vide”. As a result, they could not evaluate the nutrition aspect of this technique. The group 1 and 2 will be analyzed.

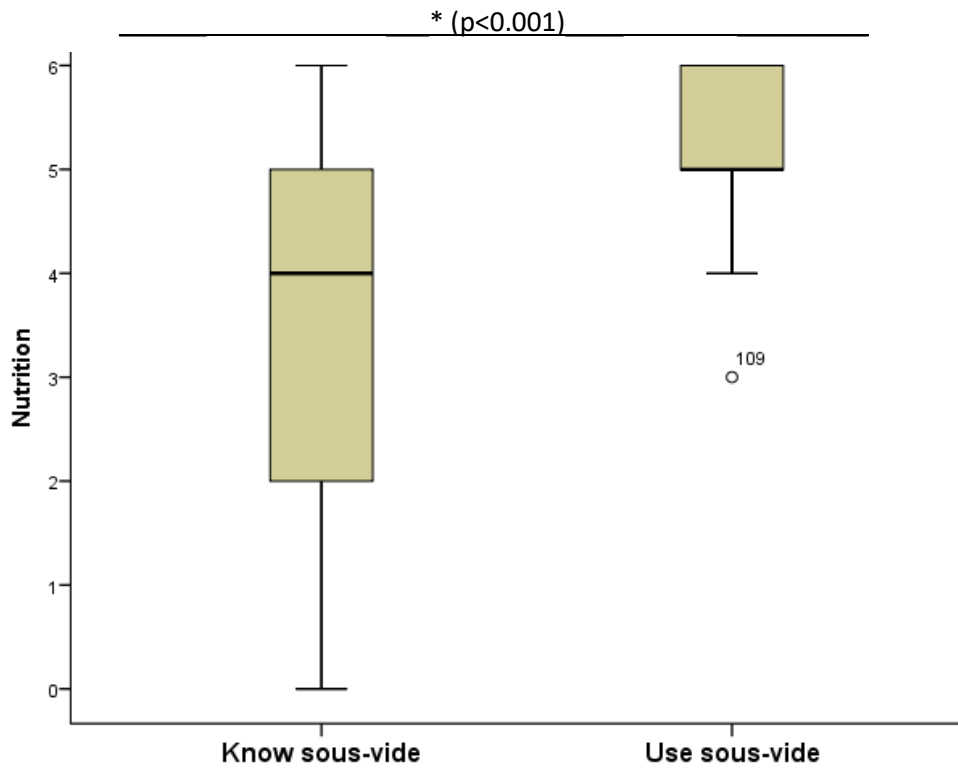
**Table 6**

*Statistics of Shapiro-Wilk test of rating scale on the question “In term of nutrition, how would you rate the sous-vide technique?” across the groups 1 and 2 (n = 129)*

		Shapiro-Wilk		
Q32		Statistic	df	Sig.
Q4Sousvide	Know sous-vide	.894	108	.000
	Use sous-vide	.839	21	.003

The result of the test considerably tends toward significance, rejecting the null hypothesis and rejecting the assumption of normality for the distribution ( $p < 0.05$ ).

For more details, distribution histograms (see Appendix B5).



**Figure 7.** Box plots (horizontal line: median, box: interquartile range, vertical bar: range, circle: outlier) of rating scale according the question “In term of nutrition, how would you rate the sous-vide technique?” per group. ns= non-significance ( $p > 0.05$ ). \* indicates significant differences between groups ( $p < 0.05$ ).

The Mann Whitney test shows there is a difference between the groups “Know sous-vide” and “Do not know sous-vide” ( $p < 0.05$ ) (see Figure 7).



#### 5.4. Conclusion

The people using the *precision cooking* method at home have a better perception on the nutrition aspect of the *precision cooking* technique than the people knowing this one.

It seems that more this technique is familiar, better is their perception on its nutrition aspect. Since the group 1 has less familiarity to the *precision cooking* method than the group 2, this last one has a better opinion on its nutritional dimension.

The group 1 seems to be more skeptical about the nutritional aspect of the precision cooking method (due to probably a lack of information) but did not refrain the group 2 to use the method.

The hypothesis that households believe that the *precision cooking* technique is not appropriate in term of nutrition is valid.

## **6. Resistance to change**

### **6.1. Definition**

“We believe that households may engage in convenience behaviors because of perceived resource constraints, even though their attitude towards convenience in meal production is not positive.”, this abstract is made from the theory of planned behavior (Ajzen, 1991) and self-efficacy theory (Bandura, 1986).

This one claims that people may “engage in behaviors to which they have a negative attitude when they believe that they do not have the resources or capabilities to engage in the more desirable behaviors.”

Thanks to these studies, it has been found that people may have a positive perception on a new process or food. Their “perceived resources constraints” will not refrain them to change their behavior. As an extreme, some people are open to innovative foodstuff and technology defined as “neophile” (Ed Robertson, 2006). While neophobic people have a brake towards innovation (Doveya, Staplesb, Gibsonc, & Jason, 2008).

Usually in the food industry, the innovation is most of the time technologic but sometimes also new products or meals (Truchelut, 2012).

## 6.2. Hypothesis

In this research, the hypothesis is tested if the concept of resistance to change has an impact on using the *precision cooking* technique at home.

### Questions related to the hypothesis:

- I like to have the latest technology at home. (Agreement scale)
- I feel comfortable not using a recipe while cooking at home (Agreement scale)
- Do you have a slow cooker in your kitchen? (Yes/No)
- I avoid eating dishes I have never tried. (Agreement scale)

### Question analyzed in the next paragraph:

Question 6: “I like to have the latest technology at home” (Agreement scale)

## 6.3. Analysis

In this analysis, it has been decided to remove the outliers. These ones have an impact on the final result.

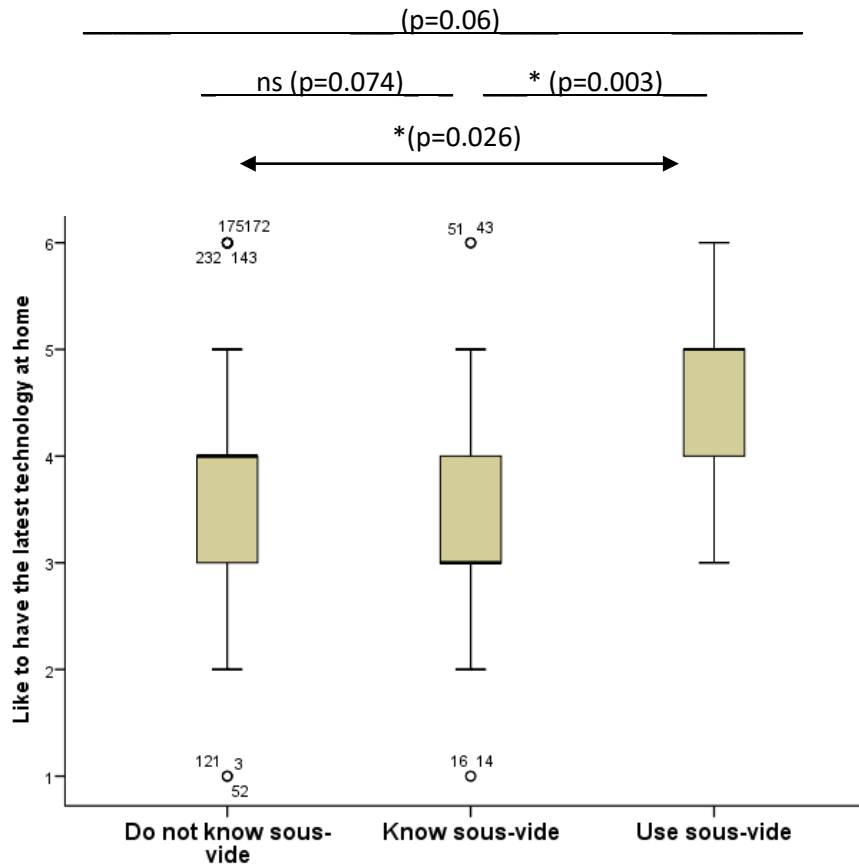
### Table 7

*Statistics of Shapiro-Wilk test of agreement scale according the sentence “I like to have the latest technology at home” across the 3 groups (n =263)*

		Shapiro-Wilk		
Q6	Q32	Statistic	df	Sig.
	Do not know sous-vide	.923	144	.000
	Know sous-vide	.924	100	.000
	Use sous-vide	.873	19	.016

The result of the test is significant, rejecting the null hypothesis and rejecting the assumption of normality for the distribution ( $p < 0.05$ ).

For more details, distribution histograms (see Appendix B6).



**Figure 8.** Box plots (horizontal line: median, box: interquartile range, vertical bar: range, circle: outlier) of agreement scale according the sentence “I like to have the latest technology at home” per group. ns= non-significance ( $p > 0.05$ ). \* indicates significant differences between groups ( $p < 0.05$ ).

The Mann Whitney U test indicates that there is a difference between the three groups ( $p < 0.05$ ). but small between the groups 0 and 1 ( $p > 0.05$ ) (See Figure 8).

#### 6.4. Conclusion

The results show that people using the *precision cooking* method at home like more to have the latest technology at home than the two other groups.

The hypothesis that, households do not adopt the *precision cooking* at home because they avoid changing their habits, is valid.

People knowing or not the *precision cooking* method are not considered as early adopters and need more output and time to purchase new devices.

## **7. Space management**

### **7.1. Definition**

The space might be an issue for some households. Indeed, a vacuum sealer is an important and heavy appliance. For example, the VacMaster® VP215 from Ary® weight 84lbs (38kg) and its size is 20” (50cm) x 14” (35cm) x 15” (38cm). While the FoodSaver® is a smaller appliance but less professional. This last one is 16” (41cm) x 7” (17cm) x 7” (17cm) and mainly made of plastic material which makes it lighter. FoodSaver® company is the leader in, as it is usually called, “external” vacuum sealers. As the bag is not enclosed in a chamber like the professional ones such as VacMaster®, the term “external” is used.

The home renovation expert Lee Wallender mentioned in 2005 that “the average north-American kitchen size has increased over the last 50 years. While stories circulate of kitchens quintupling in average size of the last half century, the increase is more modest: from about 70 to 150 square feet (4.64 to 6.50 square meters).”

On one side, the kitchen proportion in a home has increased. On the other side, more kitchen appliances have been created to the need of the households since then and have still created a lack of space in the north-American kitchens.

Recently, the German manufacturer Miele® has launched in the late 2016 the “sous-vide” drawer inserted with the other appliances of your kitchen. Unfortunately, this one is only available in the French market.

Another aspect of the *precision cooking* technique is the use of warm water bath in order to simmer the bags and cook the food. Generally, professionals have large space in their kitchen and therefore allow themselves to have large boxes to pour their bags in.

A pot families already have at home is enough. In that way, the only appliance necessary would be an immersion blender easy to store in a drawer of their kitchen such as the Anova® or the Joule®.

Some brands like Sous-Vide Supreme® offers a water bath with a cover. This one is optional since households already have pots at home and only need to buy a small immersion circulator. And as it has been previously mentioned, the efficiency is similar. However, these covered water baths have the advantage in term of safety for families with young children.

Moreover, households may already have at home a steam oven which also be used to cook the ingredients at a low temperature. This may be a real solution for space issue, the ideal situation being the “sous-vide” drawer and steam oven both built in the kitchen.

## 7.2. Hypothesis

The hypothesis that, households do not use *precision cooking* technique at home because they believe there is no space in their kitchen for it, is tested.

### Questions related to the hypothesis:

- When purchasing a culinary appliance, which aspects are the most important to you? (Importance scale)
- I need space while cooking at home. (Agreement scale)
- Which appliance do you have in your kitchen? (Multiple choices)
- Space to cook is more important than having appliances. (Agreement scale)
- I have tried to reduce my small kitchen appliances purchases because I don't have enough space for them. (Agreement scale)
- What is the best answer that suits your current situation in regards to your small kitchen appliances at home? Portable or semi-portable machines, generally used on table-tops, counter-tops, or other platforms, to accomplish a household task. Examples include microwave ovens, toasters, humidifiers, and coffee makers. (One choice)

### Question analyzed in the next paragraph:

Question 29: "I have tried to reduce my small kitchen appliances purchases because I don't have enough space for them" (Agreement scale)



### 7.3. Analysis

**Table 8**

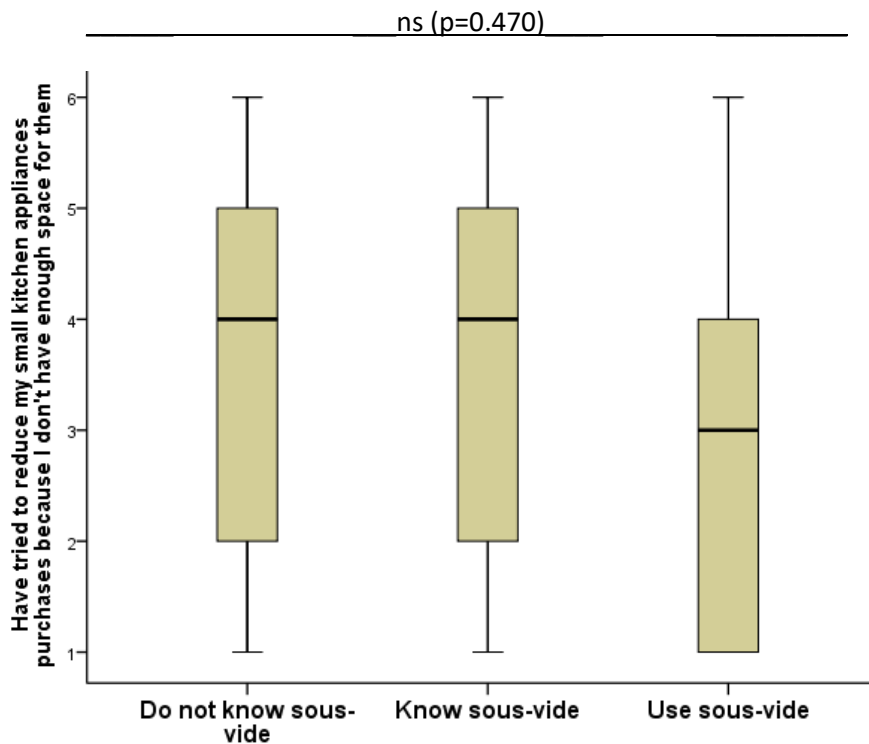
*Statistics of Shapiro-Wilk test of agreement scale according the sentence “I have tried to reduce my small kitchen appliances purchases because I don’t have enough space for them” across the 3 groups (n =280)*

Q32		Shapiro-Wilk		
		Statistic	df	Sig.
Q29	Do not know sous-vide	.903	151	.000
	Know sous-vide	.908	108	.000
	Use sous-vide	.857	21	.006

**Group “Do not know sous-vide” and “Know sous-vide”:** The result of the test is significant, rejecting the null hypothesis and rejecting the assumption of normality for the distribution ( $p < 0.05$ ).

**Group “Use sous-vide”:** The result of the test is not significant; the null hypothesis is not rejected and the sample comes from a population which has a normal distribution ( $p > 0.05$ ).

For more details, distribution histograms (see Appendix B7).



**Figure 9.** Box plots (horizontal line: median, box: interquartile range, vertical bar: range, circle: outlier) of agreement scale according the sentence “I have tried to reduce my small kitchen appliances purchases because I don’t have enough space for them” per group. ns= non-significance ( $p > 0.05$ ). \* indicates significant differences between groups ( $p < 0.05$ ).

The Kruskal Wallis test shows there is no difference between the three groups ( $p > 0.05$ ) (see Figure 9).

#### 7.4. Conclusion

Households already using the *precision cooking* technique at home have the same opinion than the people knowing or not this one. This difference shows that space management seems not to refrain the people using the *precision cooking* technique at home.

The hypothesis that, people do not use *precision cooking* method at home because they have no space in their kitchen, is not valid.

### F. DISCUSSION

Three groups have been identified differing their relationship with the *precision cooking* technique. These groups are as followed: “Do not know the *sous-vide* technique” (n = 151), “Know the *sous-vide* technique” (n = 108) and “Use the *sous-vide* technique” (n = 21).

Perceptions have been investigated between these three groups in order to identify the hindrances to acceptance of *precision cooking* method in north-American kitchens. However, the interpretation and generalization of the results of this study are limited due to the large geographic area of the United States as well as the restricted time spent collecting and analyzing these results.

At the same time, this same study includes 280 respondents who answered an online questionnaire with a geographic equilibrium and balance of age.

People knowing the *precision cooking* technique have a general “positive” opinion on their experience with the cooking results using this technique (Median = 3). “Flavor”, “Texture” of “Proteins” are the most important motives to this “positive” opinion.

Still 72 percent of people knowing the *precision cooking*, did not adopt this technique at home.

An investigation has been therefore undergone so as to identify and understand the brakes to use the state-of-the-art cooking method at home.

For this purpose, hypotheses have been raised such as the use of plastic or the low temperature.

The *precision cooking* technique requires the use of non-reusable plastic bags but has no impact on the interest to use the cooking method at home. Indeed, the three different groups (mentioned above) have the same opinion on the sustainability dimension of the *precision cooking* technique; they do not look out for the ecology while using plastic bags in their everyday life.

Regarding the safety of using hot plastic on food concerns, the three groups appear to assume it is not safe. The safety of using hot plastic on food concerns on the contrary these three groups who assume it is not safe. However, it did not refrain the ones from using who use already the *precision cooking* in the kitchen.

So as to attract new users of the *precision cooking* method, providing objective and reliable information on hot plastic's safety in contact with food. The reliability can be supported by federal north-American organizations.

Moreover, this same probable lack of information lead to a poorer opinion on the nutritional aspect of the group knowing the *precision cooking* as compared to the group using this one as of now. Additional indications on this subject would help people to take that last step and use the *precision cooking* method. These indications can include the nutritional benefits of the method compared to the traditional ones.

The level of communication seems to be one of the main reasons why the groups knowing or not the *precision cooking* did not adopt this one besides being “expensive” and “have no interest” (see Figure 10).

Since the important dimension of the *precision cooking* method is the “low temperature”, the perception of this one has been investigated across the three groups.

Most of them have adopted the low temperature cooking methods yet. Indeed, 86 percent of the respondents have a slow cooker at home using this method (data not shown from Question 12). It indicates that this aspect is not a hindrance to adopt the *precision cooking* method at home.

The return on investment are a usual dimension that is taken into account when adopting a new appliance/change at home. Therefore, this dimension has also been investigated in the present study.

First, the financial investment doesn't seem to be an important brake to adopt the *precision cooking* technique at home. However, the people knowing the method look more at the price while purchasing a new kitchen appliance than the people already using this one at home. The cost being the third element they all look at while purchasing a new kitchen appliance after the dimensions “Easy to use” and “Time” (see Figure 11).

Moreover, the dimension “expensive” is one of the justifications not to use the technique that has been mentioned by the group of people who know it. A lack of research or communication is a potential purpose yet again.

Second, the three groups believe to have enough space in their kitchen for incoming small appliances. Furthermore, the “Size” of a device does not seem to be an important aspect they look at while purchasing a new kitchen appliance (see Figure 11).

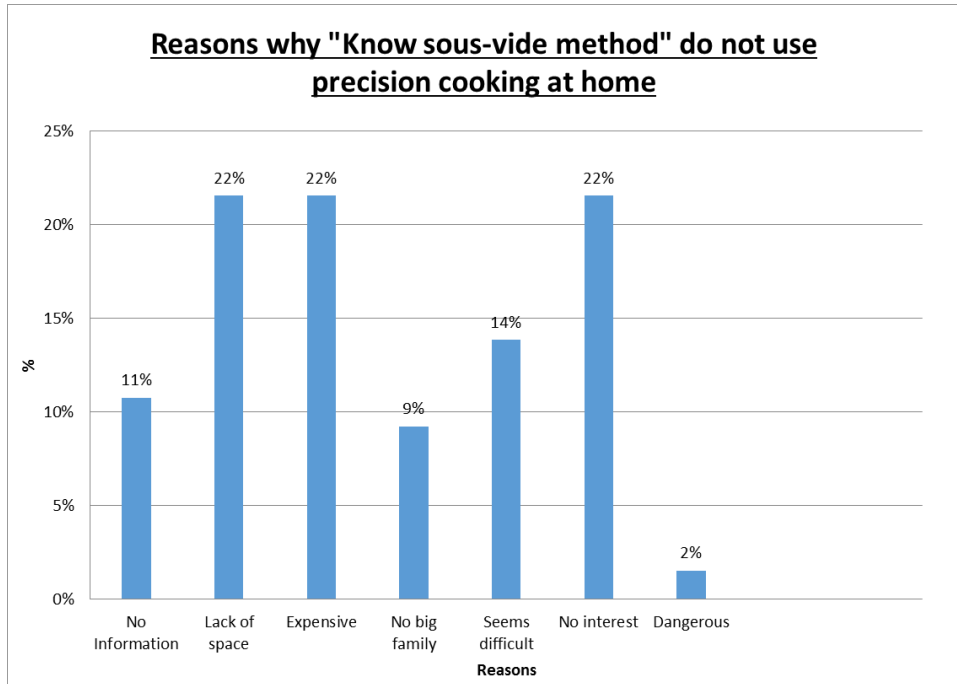
Additionally, when it comes to having the latest technologies at home there seems to be a difference between the three groups.

The people already using the *precision cooking* at home like more to have the state-of-the-art devices at home than the people knowing or not this technique. It seems to be obvious since they use as of now the *precision cooking* method. Plus, the difference is considerable between the group using the method and the group knowing the technique.

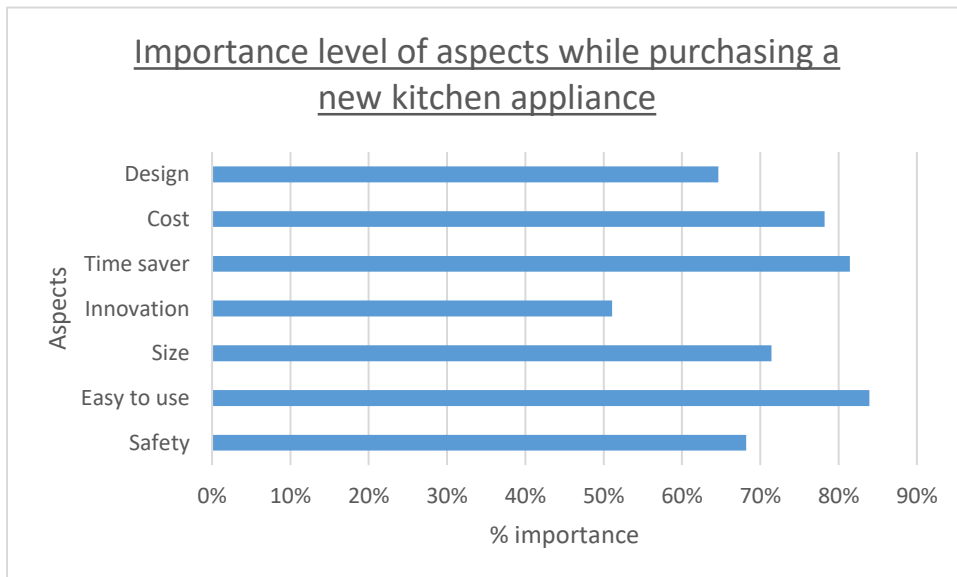
Therefore, more time and communication on this new cooking method is required for the people knowing or not this one.

Finally, the most important aspect to look at while purchasing a new kitchen appliance are “Time” and “Easy to use” (see Figure 11). This last aspect is also mentioned by the people knowing the *precision cooking* as the major reason not to adopt this one.

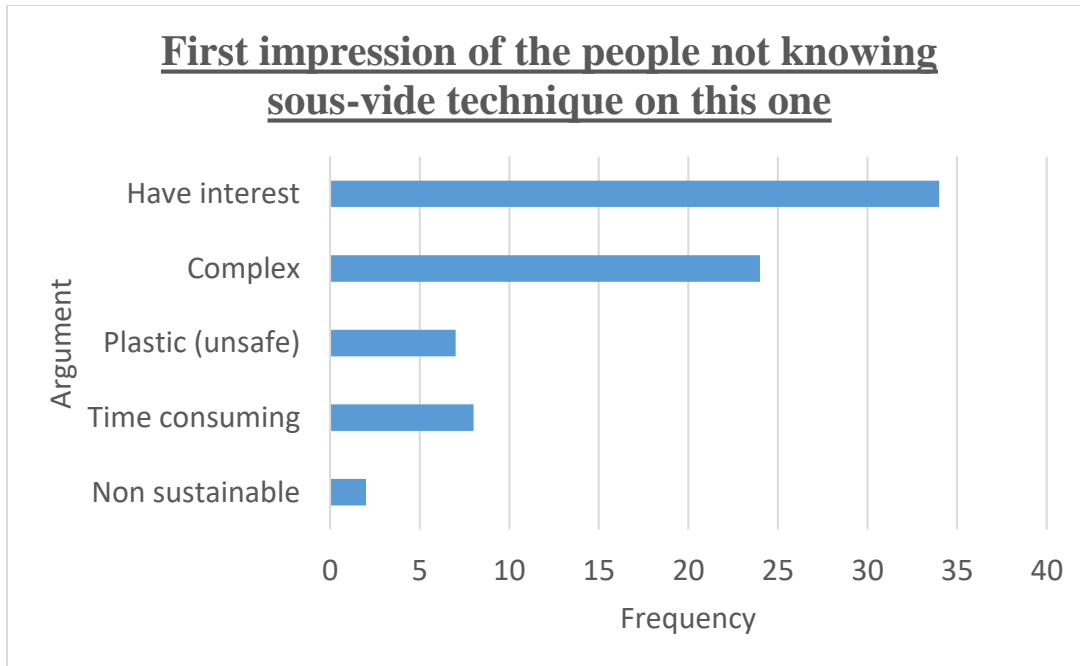
The perception of people not familiar with the technique have a similar first impression as the people knowing the technique: “complex” and “time consuming”. Nonetheless, the first group shows a big interest in this new cooking method (see Figure 12) which is perceived as “trendy” by the people knowing the *precision cooking* method.



**Figure 10.** *Reasons why “Know sous-vide method” do not use precision cooking at home” (n = 108)*



**Figure 11.** *Importance level of aspects while purchasing a new kitchen appliance (n = 280)*



**Figure 12.** *First impression of the people not knowing sous-vide technique on this one (n = 151)*



## G. CONCLUSION

Based on these results (see Table 9), companies to be approached are the immersion circulator producers.

First, it is the producer's responsibility to provide the adequate and easy understandable information about the *precision cooking* method.

More precisely, they are expected to deliver substantiated and objective communication about the return on investment using this technique.

This current research provides data which could be included in these future campaigns about the usability and nutritional aspects. Providing clear scientific statements about the nutritional value of the *precision cooking* method is one example.

The use of famous north-American chefs such as Thomas Keller is an interesting marketing tool since households refer a lot to renown chefs.

In order to improve the perception of this new technique, campaigns should be focused on the ease of use of the technique leading to time advantage. These arguments would help to improve the perception of the *precision cooking* method and as a result motivate people to implement this one in north-American households. It is important for these companies that this cooking method is not only a temporary trend but a permanent one.

For further research, it is recommended to extend the sample due to the large geographic area and extend the time dedicated to answer the survey supporting the hindrances to acceptance of precision cooking method in households. Furthermore, a sample more important of precision cooking method adopters should also be included for future research.

Plus, so that to explore the evolution of the sample's interest level in the *precision cooking* method, I would suggest that the same sample answer a similar survey about three months after the first one. It would enable to see if there is progress in *precision cooking* potential adoption at home.

**Table 9**

*Summary of the validity of the seven hypotheses*

<b>Hypothesis</b>	<b>Valid</b>	<b>Not Valid</b>
Sustainability		X
Safety : Low temperature		X
Safety : Use of plastic		X
Return on investment : the cost		X
Nutrition	X	
Resistance to change	X	
Space management		X

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## **Appendix A**

### **COOKING TECHNIQUES IN HOUSEHOLDS**

Hello,

First, thank you for agreeing to take part in this important survey measuring the perception of cooking techniques in households of the United States.

We will be gaining your thoughts in order to better understand your viewpoint about the cooking techniques.

There are no bad or good answers, please express yourself freely in this survey. It should only take about 20 minutes to complete.

Be assured that all answers you provide will be kept in the strictest confidentiality and are completely anonymous.

Moreover, responses will not be identified by individual. All responses will be compiled together and analyzed as a group.

Participation in the survey is completely voluntary, and you may quit at any time.

Thank you again for your precious collaboration!

Please do not hesitate to contact me if you encountered any issue with the survey.

Auriane Borremans

Contact : [auriane.bo@gmail.com](mailto:auriane.bo@gmail.com)

Master's Food Leadership and Innovation Student (Paul Bocuse Institute, France)

#### **1. Are you the main cook at home?**

*Choose one answer*

- No, I don't like cooking
- No, I don't know how to cook
- No, I don't have enough time
- No, but I sometimes cook
- Yes, I try to do my best
- Yes, I love it !

#### **2. On average, how many hours per week do you dedicate to cooking at home?**

*Choose one answer*

- 0 to 3 hours
- 4 to 6 hours
- 7 to 10 hours

- 11 to 14 hours
- More than 14hours

**3. Rank the term "Good meal"**

*Rate the importance of these terms in creating/having a good meal. Mark from 1 (low importance) to 6 (high importance).*

	1	2	3	4	5	6
Balanced						
Fast						
Sensorial						
Fresh						
Price (cheap)						
Innovation						
International						
Organic						
Local						
Traditional						
Simple						
Recipe respect (Following a recipe)						
Technique						

**4. In term of nutrition, how would you rate these cooking techniques from 1 to 6?**

*Mark from 1 (poor) to 6 (good), or 0 (I don't know what this is)*

	0	1	2	3	4	5	6
Sear							
Grill							
Boil							
Poach							
Bake							
Fry							

Microwave							
Steam							
Slow cook							
Pressure cook							
Sous vide							

**5. When purchasing a culinary appliance, which aspects are the most important to you?**

Mark the importance from 1 (low) to 6 (high), or 0 (I don't know what that is)

	0	1	2	3	4	5	6
Safety							
Easy to use							
Size							
Innovation							
Time saver							
Cost							
Design							

**6. I like to have the latest technology at home.**

Choose one answer

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**7. What type of cuisine do you like?**

Choose one or multiple answers

- American
- Italian
- French
- Chinese
- Japanese
- Spanish
- Mexican



- Indian
- Other: \_\_\_\_\_

**8. I feel comfortable not using a recipe while cooking at home.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**9. Cooking in the microwave is safe.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**10. Warm plastic in contact with food is dangerous.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**11. Glass packaging is safer than plastic or metal.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**12. Do you have slow cooker in your kitchen?**

*Choose one answer*

- Yes
- No

**13. If you do have it, how often do you use the slow cooker per week?**

*Choose one answer*

- Never
- Less than once
- 1 to 2 times
- 3 to 4 times

**14. I eat raw meat/fish (for example: sushi, ceviche, carpaccio, steak tartar...).**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**15. Fully cooked meat/fish fully cooked is safer for our health.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**16. Cooking at low temperature is unsafe.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**17. I never use plastic bags in the grocery store.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**18. I buy local products for sustainability purposes.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**19. I care about the amount of garbage made at home.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**20. I need space while cooking at home.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**21. Which appliances do you have in your kitchen?***Choose one or more answers*

- Blender
- Hand mixer
- Juicer
- Toaster
- Fryer
- Microwave
- Ice cream maker
- Bread maker
- Pasta machine
- Dehydrator
- Food processor
- Other : \_\_\_\_\_

**22. In term of CONVENIENCE, how would you rate these appliances from 1 to 6?***Mark from 1 (poor) to 6 (good), or 0 (I don't know what that is) for each appliance.*

	0	1	2	3	4	5	6
Blender							
Stand mixer							
Hand mixer							
Juicer							
Toaster							
Fryer							
Microwave							
Ice cream maker							
Bread maker							
Pasta machine							
Dehydrator							
Food processor							

**23. While purchasing a new kitchen appliance, I look first at the price.***Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**24. I am confident in leaving cooking appliances turned on while I am not in the kitchen.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**25. I avoid eating dishes I have never tried.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**26. Food must always be cooked above 212°F/100°C.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**27. Traditional cooking is the healthiest way to cook ingredients.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**28. Space to cook is more important than having appliances.**

Choose one answer

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**29. I have tried reducing my small kitchen appliances purchases because I don't have enough space for them.**

Choose one answer

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**30. What is the best answer that suits your current situation in regards to your small kitchen appliances at home?**

***Small kitchen appliances definition :Portable or semi-portable machines, generally used on table-tops, counter-tops, or other platforms, to accomplish a household task. Examples include microwave ovens, toasters, humidifiers, and coffee makers***

Choose one answer.

- I have space for them and I use them at home
- I have space for them and I don't use them at home
- I don't have space for them and I use them at home
- I don't have space for them and I don't use them at home
- I don't understand the question
- I don't have kitchen appliances at home.

**31. At question 4, you have been asked to rate the nutrition aspect of the cooking techniques. In terms now of convenience, how would you rate this cooking techniques ?**

Mark for each cooking technique, from 1 (poor) to 6 (good), or 0 (I don't know what that is)

	0	1	2	3	4	5	6
Sear							
Grill							
Boil							
Poach							
Bake							
Fry							
Microwave							
Steam							
Slow cook							
Pressure cook							
Sous vide							

**32. Have you ever heard of the "sous-vide" technique?**

Choose one answer

- No, I haven't *[Skip to question 43]*
- Yes, I just hear about it in the media (TV, radio, web) but I don't know what it is exactly
- Yes, I tasted a meal prepared using this process, but I don't how it is done.
- Yes, I haven't tasted any meals made with this method but I "know" the technique.
- Yes, It tasted a meal made using it and I understand more or less the technique.
- Yes, I like preparing meals with this technique at home.

**33. What is "sous-vide" cooking technique for you?**

Write your answer in the box

**34. Have you ever tasted a sous-vide product?**

Choose one answer

- Yes
- No *[Skip to question 37]*

**35. What is your impression in terms of taste ?**

Choose one answer

- Very negative
- Negative
- Positive
- Very positive

**36. Based on your answer at question 35, why did or didn't you like it?**

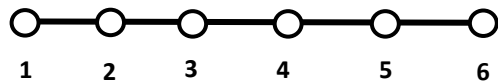
Write your answer in the box

**37. What adjective defines the sous-vide technique best?**

Split your adjectives between negative or positive perception of it.

**38. How would you rate the sous-vide cooking technique?**

Choose one answer from 1 (good) to 6 (poor).

**39. Do you cook sous-vide at home?**

Choose one answer

- Yes
- No



**40. If your answer is “no” at the previous question, why don't you cook sous-vide at home?**

*Choose one or more answers*

- No information
- Lack of space
- Expensive
- No big family
- Seems difficult
- No interest
- Dangerous
- Other: \_\_\_\_\_

**41. I would like to cook sous-vide at home.**

*Choose one answer*

- 1 (Disagree strongly)
- 2
- 3
- 4
- 5
- 6 (Agree strongly)

**42. Check the material that you believe you need to make sous-vide.**

*Choose one or more answers*

- Special cooking plastic bags
- Immersion circulator
- Pot
- Stove
- Vacuum sealer
- Thermometer
- Other: \_\_\_\_\_

**43. What is your first perception about this technique?**

Sous-vide definition : It is a process by which ingredients are sealed in a pouch under vacuum, and subsequently cooked at a series of precisely defined temperatures to reach a desired result.

*Write your answer in the box*

**44. What is your gender ?**

*Choose one answer*

- Male
- Female

**45. What is your age range?**

*Choose one answer*

- 20-30
- 31-40
- 41-50
- 51-60
- 61 and above

**46. What is your current home situation?**

*Choose one answer*

- I live alone
- I am with a significant other
- I live with my family
- I live with my roommates
- Other: \_\_\_\_\_

**47. (If the answer is “I live with my family” in question 47) What age cohort do your children fit in ?**

*Choose one or more answer*

- Under 5
- Between 5-13 years' old
- Between 14-18 years' old
- Between 19-25 years' old

**48. What is your current occupation?**

*Choose one answer*

- Student
- Employee for wages
- Self-employed
- Out of work and looking for work
- Out of work but not currently looking for work
- Homemaker
- Military
- Retired
- Unable to work
- Other : \_\_\_\_\_

**49. What is your Zip code ?**

*Write your answer in the box*

**50. Your e-mail address in the box if you wish to receive the results of this research (End of June 2017).**

*Write your answer in the box*

**Special Thank You !**

Thank you for taking the time to complete this survey. I truly value the information you have provided. As a respondent, the results of the survey will be beneficial to my research.

Sincerely,

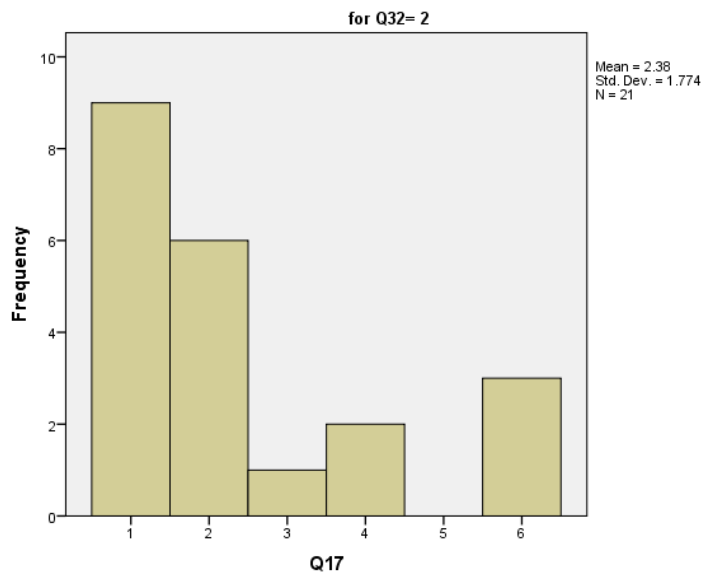
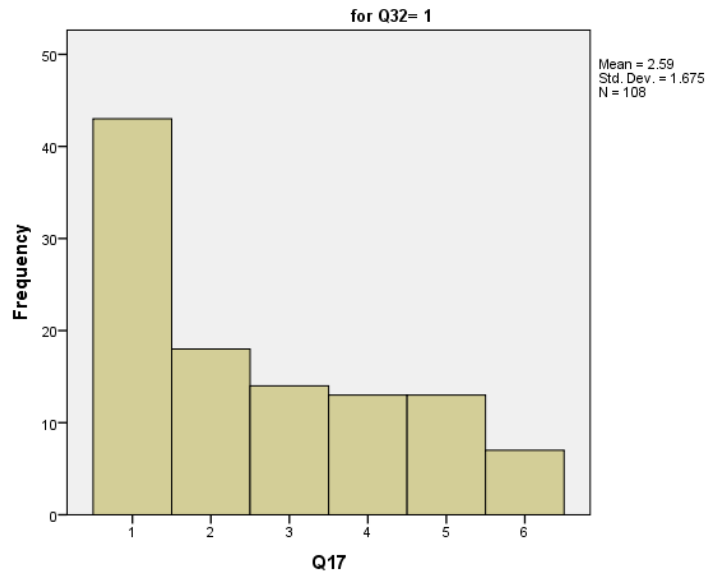
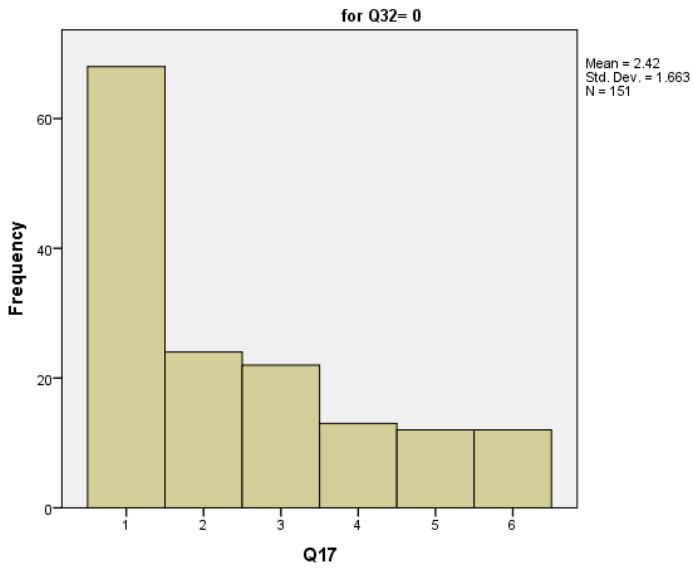
Auriane Borremans

Master's degree in Culinary Leadership and Innovation student.

**APPENDIX B**

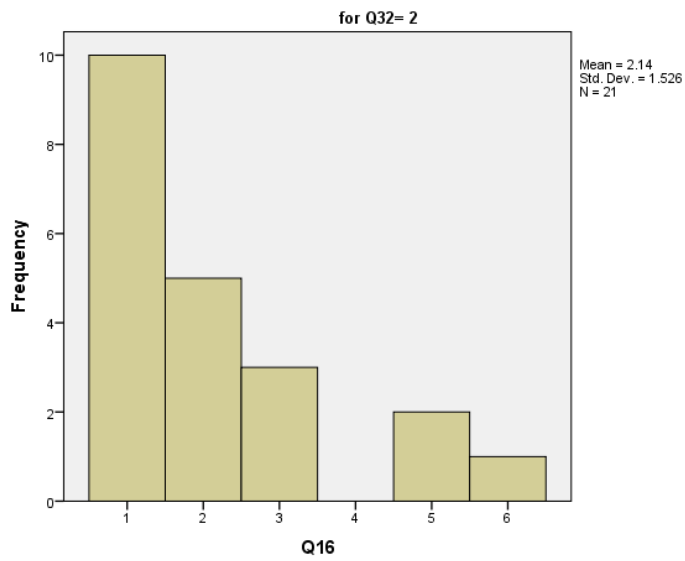
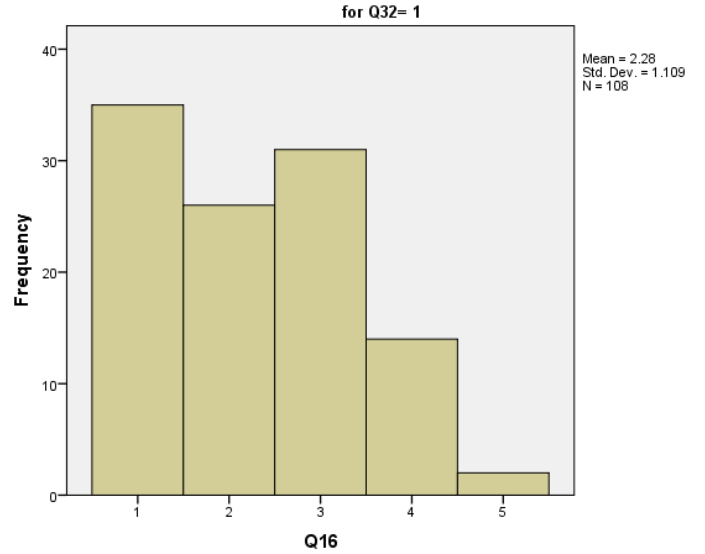
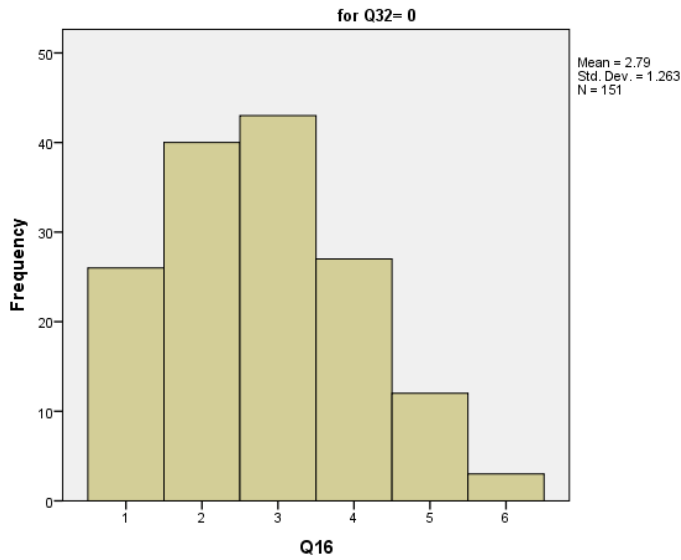
**APPENDIX B1**

*Frequency distribution of question 17 compared to three groups of question 32 (Total number of observations = 280)*



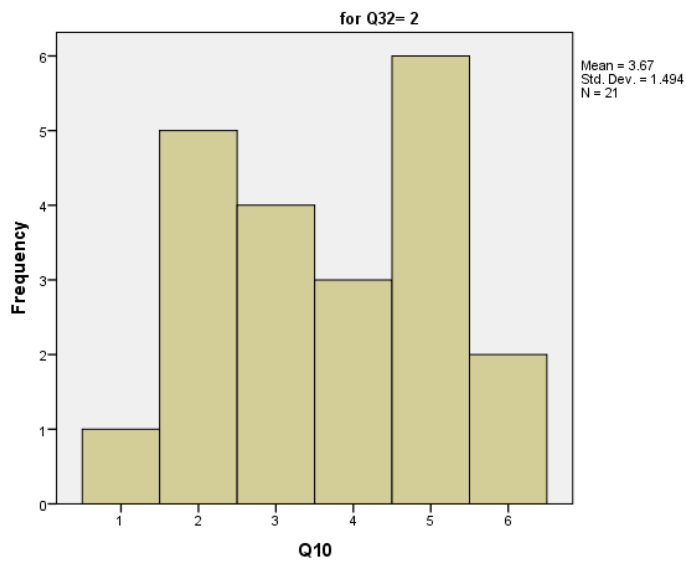
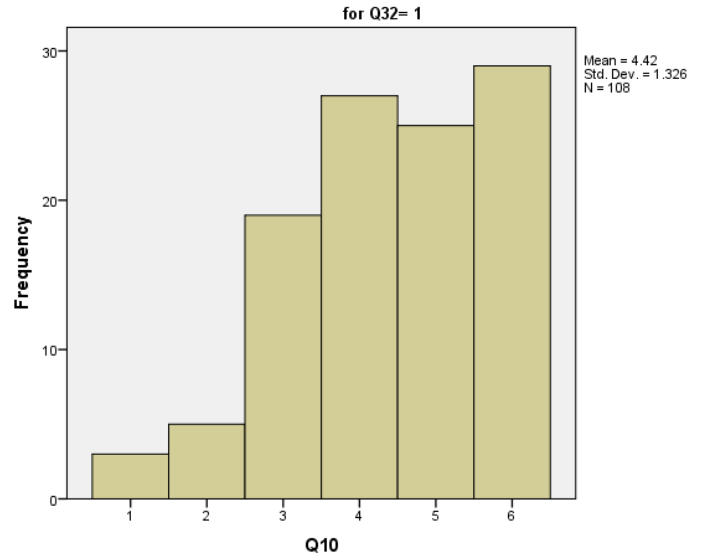
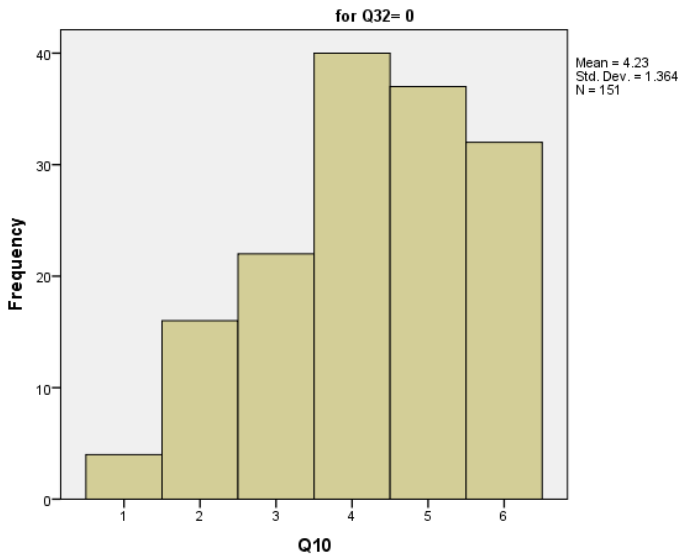
APPENDIX B2

*Frequency distribution of question 16 compared to three groups of question 32 (Total number of observations = 280)*



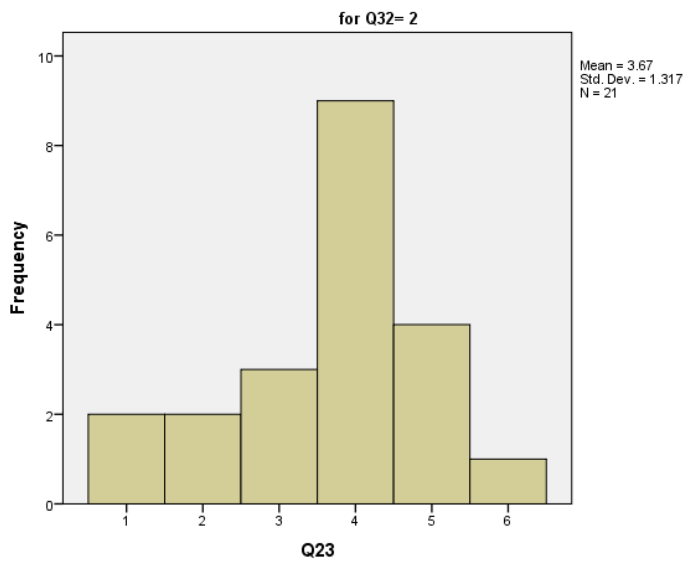
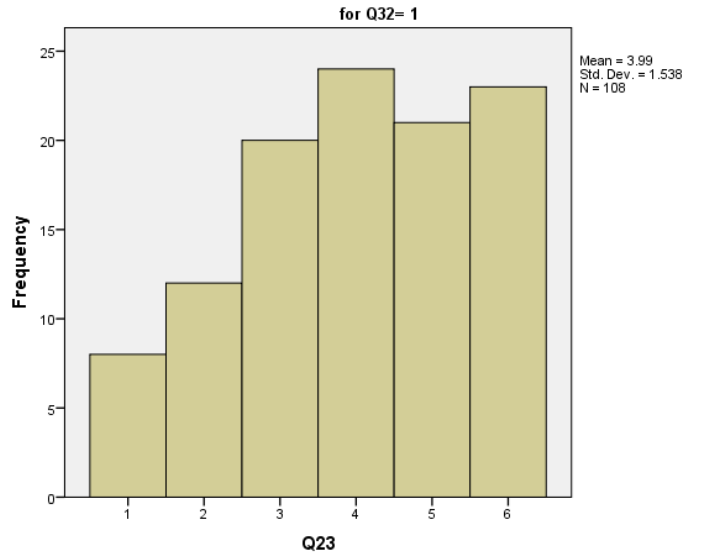
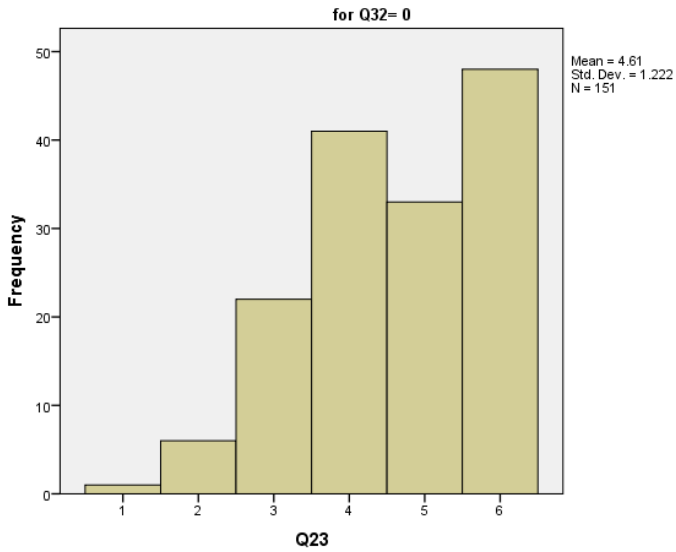
APPENDIX B3

*Frequency distribution of question 10 compared to three groups of question 32 (Total number of observations = 280)*



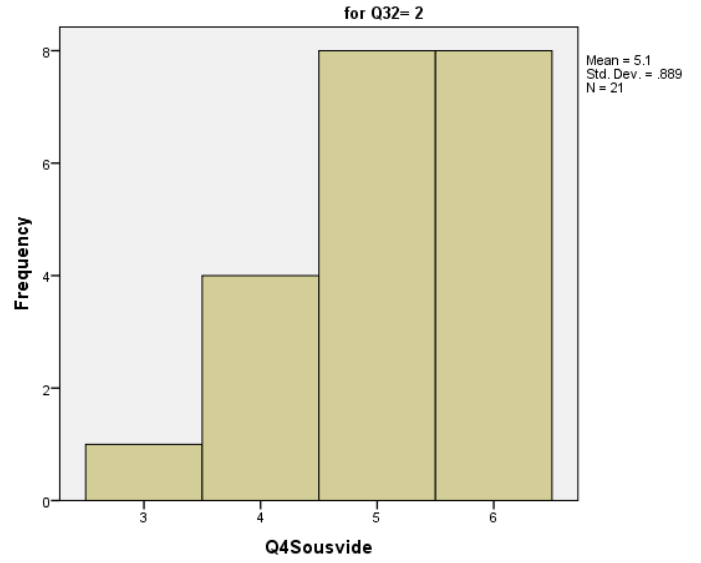
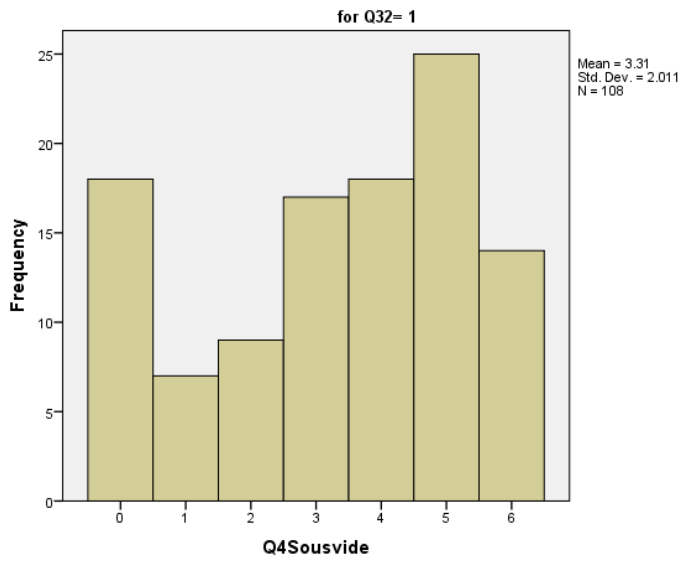
APPENDIX B4

*Frequency distribution of question 23 compared to three groups of question 32 (Total number of observations =280)*



APPENDIX B5

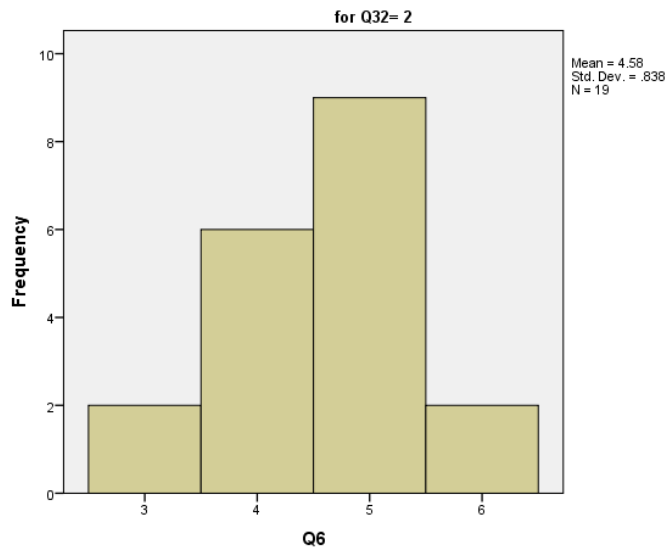
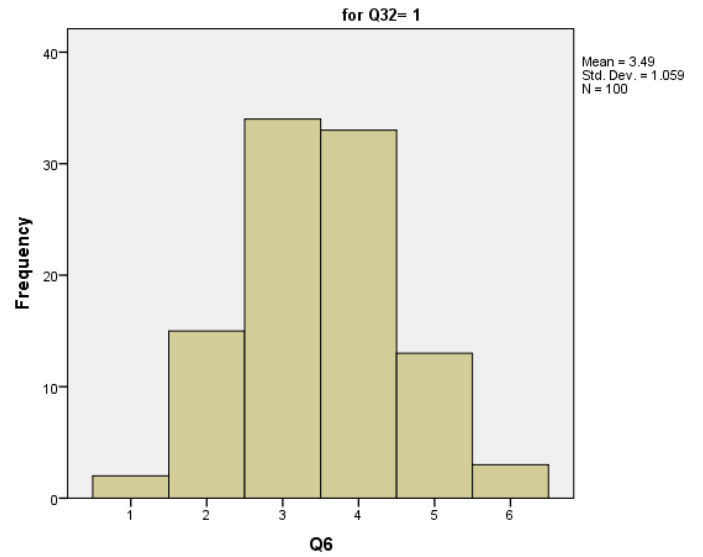
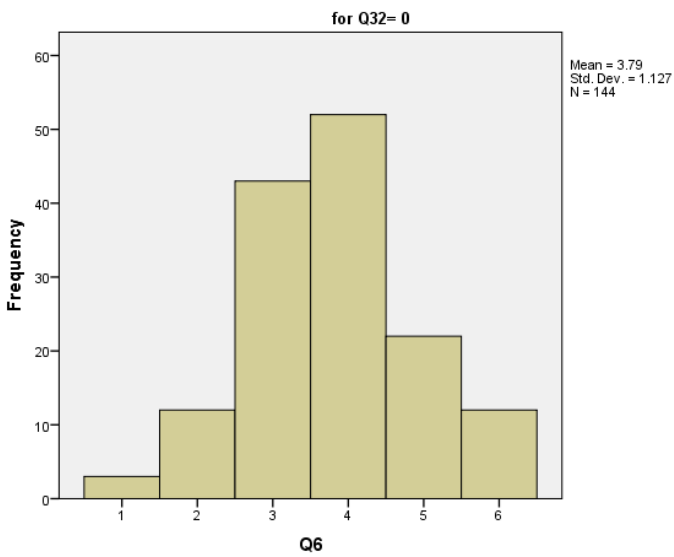
*Frequency distribution of question 4Sous-vide compared to group 1 and 2 of question 32 (Total number of observations = 129)*





**APPENDIX B6**

*Frequency distribution of question 6 compared to three groups of question 32 (Total number of observations = 263)*



APPENDIX B7

*Frequency distribution of question 29 compared to three groups of question 32 (Total number of observations =280)*

