



**PRODUCT DESIGN OF A READY TO EAT *Sous Vide* MARINATED PORK MEAT
BASED ON CONSUMER ACCEPTABILITY AND PREBIOTIC INDEX**

**DISEÑO DE UN PRODUCTO DE CERDO LISTO PARA COMER ELABORADO
MEDIANTE LA TÉCNICA DE *Sous Vide* BASADO EN SU ANÁLISIS SENSORIAL Y
SU ÍNDICE PREBIÓTICO**

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Abstract

New trends in product development are based in the incorporation of prebiotics, however their use must be linked to consumer acceptability. This study compares *in vitro* prebiotic index (PI) and sensory consumer analysis of five different ready-to-eat pork *Sous Vide* marinade prototypes. Sole ingredients used in the marinade (MI) formulations and each prototype was evaluated for their PI, also: MI added with additives and, MI added with additives and prebiotics. Prebiotics were: nopal fiber (*Opuntia ficus-indica*), corn fiber and, chicory inulin (*Chicorium intybus*). Consumer acceptance (n= 205) was evaluated by: landscape segmentation analysis (LSA), just about right (JAR) test and, penalty analysis (PA). Results show that ingredients with good PI (above 1) were obtained with: chipotle (*Capsicum annum*), garlic (*Allium sativum*) and, rosemary (*Rosmarinus officinalis*). Prebiotic prototypes: nopal fiber (*Opuntia ficus-indica*), corn fiber and, chicory inulin (*Chicorium intybus*), showed a prebiotic index of 1.20, 1.83 and, 1.62 respectively. LSA showed that the prototype, which contained chicory inulin as a prebiotic was located nearer to optimal regions, which is in accordance to results obtained by JAR and PA. Results reveal that chicory inulin-marinated *Sous Vide* pork meat possesses an accepted *in vitro* PI and the best sensory characteristics.

Keywords: chicory-inulin, corn-fiber, nopal-fiber, landscape segmentation analysis, prebiotic index.

Resumen

Las tendencias en el desarrollo de alimentos, incluyen la incorporación de prebióticos considerando las características organolépticas. En este estudio se comparó el índice prebiótico (PI) *in vitro* y la aceptabilidad de cinco prototipos de cerdo marinados listos para comer cocinados mediante la técnica de *Sous Vide*. Se analizó el IP de cada ingrediente de las marinadas, de las formulaciones con aditivos y con incorporación de prebióticos. Los prebióticos utilizados fueron: fibra de nopal (*Opuntia ficus-indica*), fibra de maíz e inulina de achicoria (*Chicorium intybus*). La aceptabilidad (n= 205) fue evaluada por un Análisis de Segmentación (LSA), un análisis del valor justamente correcto (JAR) y un análisis de penalidades (PA). Los ingredientes con buen índice prebiótico PI (arriba de 1) fueron obtenidos con chipotle (*Capsicum annum*), ajo (*Allium sativum*) y romero (*Rosmarinus officinalis*). Los prototipos con prebióticos de: fibra de nopal (*Opuntia ficus-indica*), fibra de maíz e inulina de achicoria (*Chicorium intybus*), revelaron un PI de 1.20, 1.83 y 1.62, respectivamente. Según el LSA, el prototipo con inulina de achicoria mostró mejor aceptabilidad, coincidiendo con los resultados obtenidos por JAR y PA, además de presentar un PI *in vitro* adecuado.

Palabras clave: inulina de chicoria, fibra de maíz, fibra de nopal, análisis de segmentación, índice prebiótico.

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1 Introduction

Nowadays, when designing new functional products it is important to consider if it meets specific characteristics regarding consumers' needs, which means if it has the expected functionality (nutritional value and health benefits) and if it possesses the sensory acceptance (Villegas *et al.*, 2010; Beristain *et al.*, 2006). Therefore, functional foods are included in this new market segment (Khan *et al.*, 2013), thus they can be defined as: "food products that provide extra benefits to one's health in addition to basic nutritional values" (Yuen-Ting Wong *et al.*, 2015; Beristain *et al.*, 2006).

Meat can be considered a functional food by itself, because carcasses composition has been improved during the last years due to genetic and nutritional approaches, giving as a result leaner meat which is a good source of: protein, conjugate linoleic acid (CLA), minerals (iron, zinc, selenium) and, vitamins mainly B complex (Olmedilla-Alonso *et al.*, 2013; de Castro Cardoso Pereira and dos Reis Baltazar Vicente, 2013). Moreover, pork meat has shown to be tasteful, and its price has made it more available to consumers; therefore making it is suitable for processed ready to eat meat products.

Incorporation of prebiotics as functional ingredients can stimulate growth of specific lactic acid bacteria (lactobacilli and bifidobacteria) in the gastrointestinal tract of the host (Sridevi *et al.*, 2014) improving physiological health properties such as: reduction of diabetes risk, lipid regulation in blood, preventing cardiovascular diseases, diminishing colon cancer risk and, regulation of intestinal transit (Olmedilla-Alonso, *et al.*, 2013; Saad *et al.*, 2013). It can also improve technological characteristics such as: water/oil retention and emulsion stability; which gives as a result increase in moisture and texture that improves taste (Olmedilla-Alonso *et al.*, 2013).

Consumption of ready to eat meat products has increased for the last decade based on new consumers' trends related to: age, gender, taste, cooking skills and, working status (accelerated life style). Nevertheless, consumers are looking for homemade style meals that are easy to prepare, and that can be nutritious in order to prevent overweight (Van der Horst *et al.*, 2011).

The use of *Sous Vide* has increased, and it can be defined as a "low heat treatment based on vacuum-packed-food for longer periods of time" (Baldwin, 2012). In this kind of cooking treatment, temperature and time has to be taken into consideration in order to preserve the physicochemical, textural and,

structural properties of the food product (Sánchez del Pulgar *et al.*, 2011). *Sous Vide* increases shelf life because it: preserves sensory characteristics within the product such as: tenderness and flavor; moreover, it reduces damage to proteins and lipids which preserves nutrients (Baldwin, 2012).

It has become an important issue to determine if a product has a proven functional characteristic. Therefore, in order to determine prebiotic *in vitro* character, Palframan *et al.* (2003) reported a method where probiotics were grown in a simple media with a carbon source (prebiotic), changes (numbers of microorganisms at a given time / number of microorganisms at inoculation) were measured during fermentation and introduced in a mathematical equation; reporting that if the value is above 1 it is considered to have a good prebiotic index (PI).

Other approach for establishing functionality has been reported by Romero *et al.* (2015) that studied *in vitro* fermentation of fructooligosaccharides in aguamiel (*A. atrovirens*) and analyzed short fatty acid production through gas chromatography. Results showed a production of acetic, propionic and, butyric acid. The last compound could diminish colon cancer incidence. It is then demonstrated that aguamiel could be a good ingredient to incorporate in new products, however, it is important to preserve its functionality during its extraction. Spray drying conditions in order to obtain the best yield and quality were studied by Chávez-Rodríguez *et al.* (2016) in (*A. tequilana*) establishing the best inlet temperature (198 °C), outlet temperature (80 °C) and airflow 720 (m³h⁻¹), however it is important to determine the prebiotic character in the final ingredients used for food formulations in order to have a precise idea of its functionality.

Therefore, a more rational decision can be taken when choosing prebiotics ingredients in food development, but it is not only important the functionality of the ingredients used, but the overall acceptance of consumers. A new food product must meet consumers' expectations, therefore, the use sensory analysis is a unique tool for research and development (R&D), several techniques of analysis have been published such as: Landscape Segmentation Analysis (LSA), Just About Right (JAR) and Penalty Analysis. Each one of them provides different information. For example, LSA takes into consideration consumers liking ratings showing how close the new product is to an ideal within a sensory map (Rousseau *et al.*, 2012; Ennis *et al.*, 2013). Just About Right (JAR) determines if the attribute intensity is in its optimal level (Li *et al.*, 2014; Gacula

et al., 2007). Penalty Analysis correlates JAR and overall linking ratings (Lawless, 2010; Narayanan et al., 2015).

This research aims to evaluate the prebiotic index of different ingredients used in marinades, as well as in three different prebiotic marinade formulations of ready to eat marinated pork meat elaborated with *Sous Vide* technique in order to create a product with adequate sensorial characteristics.

2 Materials and methods

2.1 Lactic acid bacteria

L. rhamnosus GG, which is a prebiotic lactic acid bacteria, was given by the Laboratory of Food Biotechnology at the Universidad Autonoma Metropolitana in México City.

2.2 Inoculum preparation

Bacteria was grown on a Mann-Rogosa-Sharpe (MRS) culture which was sterilized at 121 °C for 15 minutes and inoculated at a 4%v/v. Fermentation took place at 37 °C for 16 h.

2.3 Fermentation

A minimal medium was designed on an Erlenmeyer flask of 200 mL containing: (1) yeast extract 0.3%, (2) casein peptone 0.5% and, (3) a carbon source 1%, which refers to the use of each ingredient in the marinade as a sole carbon source in a 1% w/w. The carbon sources were: (1) chicory inulin (*Cichorium intybus*) (Tate and Lyle, U.S.),

(2) nopal fiber (*Opuntia ficus-indica*) (Deshidratadora Aguascalientes Mexico), (3) corn fiber (Tate and Lyle, U.S.), (4) commercial additive, (Almix, Mexico, containing: salt, sugar, phosphates and additives: E452, E621, E331, (5) chipotle chili (*Capsicum annum*, Mexico), (6) jamaica (*Hibiscus sabdariffa* L., Mexico), (7) garlic (*Allium sativum*; Carmencita, Mexico), (8) onion (*Allium cepa*; Escosa, Mexico) and, (9) rosemary (*Rosmarinus officinalis*; Terana, Mexico). And the combination of each of these with the selected prebiotics, referring to marinade AF3, AF4 and, AF5, as shown in Table 1 and 2. The culture was sterilized 121 °C for 15 minutes, when volume was adjusted according to the McFarland scale to a 0.5 value the inoculum was added. Incubation took place at 37 °C with stirring at 50 rpm.

2.4 Evaluation of microbial growth

From each flask 1 mL was extracted at 12 h under anaerobic conditions. The optical density was measured by triplicate at 600 nm (O.D.) in a Shimadzu spectrophotometer UV Spectrophotometer UV 1800.

2.5 Prebiotic index

The prebiotic index was measured based on Palframan et al. (2003) correcting the interference of each carbon source given by the initial optical density. The prebiotic equation is based on bacterial growth *in vitro* using *L. rhamnosus* GG. Duplicate samples were used.

$$\text{Prebiotic index} = \frac{\text{OD ingredient 12h} - \text{OD ingredient 0h}}{\text{OD control 12h} - \text{OD control 0h}} \quad (1)$$

Table 1. Marinade composition. Ingredients used are established as the base of the formulation

Ingredients	Marinade composition (g/100g)
Water	72.88
Chipotle chili, Deshidratadora Aguascalientes.	7.29
White vinegar, La Costeña, México	7.29
Oil, Mazola, México	6.56
Jamaica (<i>Hibiscus sabdariffa</i>), México	4.37
Garlic powder, Carmencita, México	0.73
Onion powder, Escosa, México	0.44
Rosemary (<i>Rosmarinus officinalis</i>), Terana, México	0.29
Pepper, Carmencita, México	0.15

Table 2. Composition of the five different formulations used.

Treatment (1)	Base Ingredients (BI)		Prebiotics Tested		
	Marinade composition (2)	Commercial additive (3)	Chicory Inulin (<i>Cichorium intybus</i>) (4)	Corn soluble fiber (5)	Nopal Fiber (<i>Opuntia ficus-indica</i>) (6)
AF1	+				
AF2	+	+			
AF3	+	+	+		
AF4	+	+		+	
AF5	+	+			+

1. It refers to the five treatments used in this study.

2. Commercial additive (4.5 g) containing: salt, sugar, phosphates, and additives: E-452, E-621, E-331 (Almix, Mexico)

3. Chicory inulin (6g) (*Cichorium intybus*) (Tate and Lyle, United States)

4. Corn soluble fiber (6g) (Tate and Lyle, United States)

5. Nopal fiber (6g) (*Opuntia ficus-indica*) (Deshidratadora Aguascalientes, Mexico)

2.6 Development of five different marinade ready-to-eat prototypes

Loin pork meat (Empacadora de Carnes San Francisco, México) was cut into pieces of 3 x 3 cm. Ingredients in the amounts established in Table 1 were dissolved in hot water during 10 min and were blended for 1 min. To this marinade mixture (100g), pork meat (200g) was added and mixed with other ingredients (Table 2). Therefore five different formulations were prepared as described in Table 2. Each formulation was introduced into a rotary drum (Flavor Maker F-8, USA) during 15 min at 15 in of Hg and was divided into individual samples containing 30 g of each formulation, which were vacuumed sealed at 0.75 bars during 18 s (Smartvac Mini 28, Carnotex, S.A. de C.V., México) and treated under a water bath runner to achieve *Sous Vide* conditions (Sirman, Mod. Softcooker y09, Italy) for 3 h at 60°C. Lastly, samples were kept in refrigeration at 3°C.

2.7 Sensory evaluation

Sensory evaluation performed by 205 subjects was conducted in Aguascalientes, Mexico. The aim was to determine the acceptance of the products using Just About Right scales on the following sensory attributes: color, softness, juiciness, flavor and, acidity. Additionally, overall liking was rated on a Just About Right scale that ranged from 1 to 5.

The subjects ranged from 18 to 66 years old, and were women and men who could become potential consumers of these products. Samples were put on a microwave oven for 1 minute and served in a coded plate (10 g). Then it was offered to consumers that received an evaluation sheet. Consumers were requested to evaluate: acidity, color, flavor, juiciness

and, softness by placing a mark on the JAR scale. Consumer decision depended on the sensorial characteristics of the products according to Morais *et al.* (2014).

2.8 Statistical analysis

Prebiotic index was performed by duplicated and average and standard deviation was calculated. With the information gathered by 205 consumers Landscape Segmentation Analysis® was analyzed with use of IFProgramsTM, and Just About Right and Penalty Analysis were performed with XLstat®, Addinsoft 2015.

3 Results and discussion

3.1 Prebiotic index

Prebiotic index gives an *in vitro* behavior on how certain probiotics can grow in our gastrointestinal track related with the carbon source available. *Lb. rhamnosus* GG is a probiotic strain that was capable of growing in a minimum medium as shown in Table 3. A prebiotic index above 1 shows that the carbon source used has a prebiotic effect according to Palfram *et al.* (2003). Adebola *et al.* (2014) established that optimum *in vitro* growth is only achieved with specific combination of probiotics and prebiotics.

Our results demonstrated that most of the ingredients tested have a prebiotic characteristic as shown in Table 3.

It has been reported that chipotle pepper, which is smoked jalapeño pepper, has functional properties such as phenolic activity related to antioxidant capacity (Ornelas-Paz, 2010, Moreno-Escamilla *et*

al., 2015), additionally, in this study we show that it also exhibits high prebiotic index (2.30 ± 0.00), therefore making it a good ingredient for use in food formulations.

Garlic exhibited prebiotic character (2.24 ± 0.06) this characteristic was expected. However, onion used as an ingredient in this marinade did not show any prebiotic activity (Table 3). It has been reported that garlic and onion have prebiotic and antioxidant effect (Kim et al., 2010; Al-Sheraji et al., 2013; Nurwantoro et al., 2015).

Chicory inulin, is the most common prebiotic used in the industry, it can be extracted from chicory root and contains fructose chains ranging in degree of polymerization from 3 to 60 (Pompei et al., 2008). Kuntz et al. (2013) made a revision of the food products that used inulin as ingredient, showing its technological properties as fat and sugar replacer, and as moisture retainer. The prebiotic index showed in Table 3 for this ingredient was of 1.79 ± 0.06 .

Corn fiber, has also a prebiotic character 1.75 ± 0.12 , so it could be used in food formulations. Rosemary (*Rosmarinus officinalis* L.) has a prebiotic index is of 1.03 ± 0.01 , so it can also be considered to possess a good prebiotic character according to the results obtained in this study (Table 3). It has also been reported to inhibit growth of *Shigella* sp. (Davidson et al., 2013), and to improve oxidative stability in pork (Chinprahast et al., 2012).

Jamaica (*Hibiscus sabdariffa* L.) is used in some parts of the world as an infusion, many beneficial attributes have been reported such as: anti-hypertensive, anti-inflammatory and, antioxidant (Da-Costa-Rocha et al., 2014). However, its prebiotic index is below 1 (0.23 ± 0.00) indicating no prebiotic activity.

As expected the commercial marinade had a prebiotic index of 0.51 ± 0.00 , therefore this ingredient is not considered a prebiotic. Its composition is based on: salt, sugar, polyphosphates (E-452), flavor (E-621) and, an antioxidant mixture (E-316 y E-331). Phosphate and salt improve moisture retention, which is a characteristic expected in the food Industry. However, the use of the ingredients tested in this study could also have some of the functions of phosphate and salts, for example, Jarvis et al. (2012) substituted phosphates with dried plum in chicken marinade with good results. Nowadays, consumers are expecting phosphate free marinades with low salt content, because it has been reported that salt intake is related with health problems such as hypertension

Table 3. Prebiotic Index (PI) of ingredients.

Carbon Source	Prebiotic index
Chipotle (<i>Capsicum annuum</i>)	2.30 ± 0.00
Garlic powder (<i>Allium sativum</i>)	2.24 ± 0.06
Chicory inulin (<i>Cichorium intybus</i>)	1.79 ± 0.06
Corn fiber	1.75 ± 0.01
Rosemary (<i>Rosmarinus officinalis</i>)	1.03 ± 0.01
Universal Marinator	0.51 ± 0.00
Nopal fiber (<i>Opuntia ficus-indica</i>),	0.50 ± 0.00
Jamaica (<i>Hibiscus flower</i>)	0.23 ± 0.00
Onion (<i>Allium cepa</i>)	0 ± 0.00

(Sheard et al. 2012).

Prebiotic formulations analyzed in this study, which included the ingredients of the marinade (Table 1) added with the commercial additives and with a different prebiotic, showed (Table 4) a prebiotic values higher than one. The prebiotics tested were: nopal fiber (*Opuntia ficus-indica*), corn fiber and, chicory inulin (*Chicorium intybus*), with a prebiotic index of 1.20, 1.83 and, 1.62 respectively. Therefore, these marinades have an excellent *in vitro* prebiotic character.

3.2 Landscape segmentation analysis

Landscape Segmentation Analysis is obtained when consumers perform a sensory evaluation, which is analyzed and the optimal formulation can be found on a sensory map where the optimal liking segments can be identified (Ennis et al. 2014). Our results show (Fig. 1) three optimal liking segments which are represented in orange, the best formulation corresponds to the one found nearer to these three zones, making the chicory inulin product (AF3) the best formulation.

Results show that age had effect ($\alpha \leq 0.05$) on the liking of the formulations presented (Fig. 2). It can be observed that people ranging 18 to 50 years are near to the product elaborated with chicory inulin (AF3). People ranging 51 to 58 years old prefer the product that only included the marinade (AF1) which could be explain due to their consuming habits meaning that they are unlikely to consume ready to eat products.

The effect of consuming pork on a regular basis was analyzed on liking (Fig. 3), differences were found ($\alpha \leq 0.05$) and it was observed that the liking segment of people who did not eat pork regularly were closer to the chicory inulin product (AF3), which could be explained that this product was considered as a ready-to-eat product rather than a pork product.

Table 4. Prebiotic Index (PI) of formulations tested.

Prebiotic formulations	Prebiotic index
AF3: Base ingredients (BI=AF1+ AF2) + chicory inulin (<i>Cichorium intybus</i>),	1.62 ± 0.02
AF4: base ingredients (BI=AF1+ AF2) + corn fiber	1.83 ± 0.00
AF5: Includes the base ingredients (BI=AF1+ AF2) + nopal fiber (<i>Opuntia ficus-indica</i>).	1.20 ± 0.08

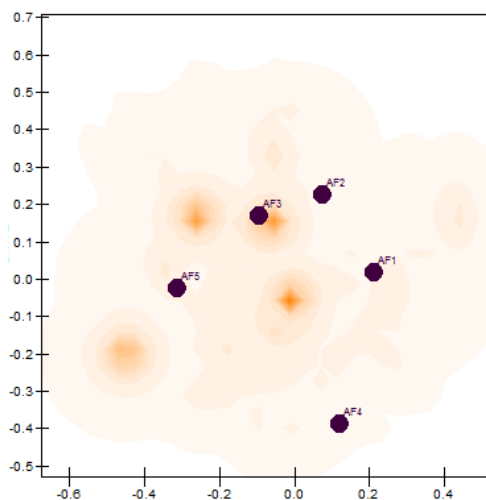


Fig. 1. Landscape Segmentation Analysis (LSA), which shows the five formulations analyzed describe as AF1, AF2, AF3, AF4 and, AF5. Orange dots described the liking zone. Consumers prefer formulations next to the orange dots. Subjects n= 205. AF1: refers to the marinade formulation; AF2: refers to marinade formulation plus commercial additive; AF3: Includes the base ingredients (BI=AF1+ AF2) + chicory inulin (*Cichorium intybus*), AF4: Includes the base ingredients (BI=AF1+ AF2) + corn fiber and, AF5: Includes the base ingredients (BI=AF1+ AF2) + nopal fiber (*Opuntia ficus-indica*).

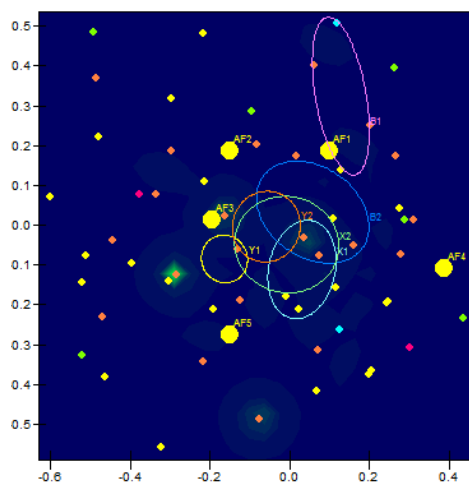


Fig. 2. Landscape Segmentation Analysis of the five prototypes correlating the effect of age. Age segments analyzed: Y1: 18-26; Y2: 27-34; X1:35-42; X2:43-50; B1:51-58; B2:59-66. Subject R squared: 0.71, Product R squared: 0.99 Subjects n= 205. Where: AF1: refers to the marinade formulation; AF2: refers to marinade formulation added with commercial additive; AF3: Includes the base ingredients (BI=AF1+ AF2) + chicory inulin (*Cichorium intybus*), AF4: Includes the base ingredients (BI=AF1+ AF2) + corn fiber and, AF5: Includes the base ingredients (BI=AF1+ AF2) + nopal fiber (*Opuntia ficus-indica*).

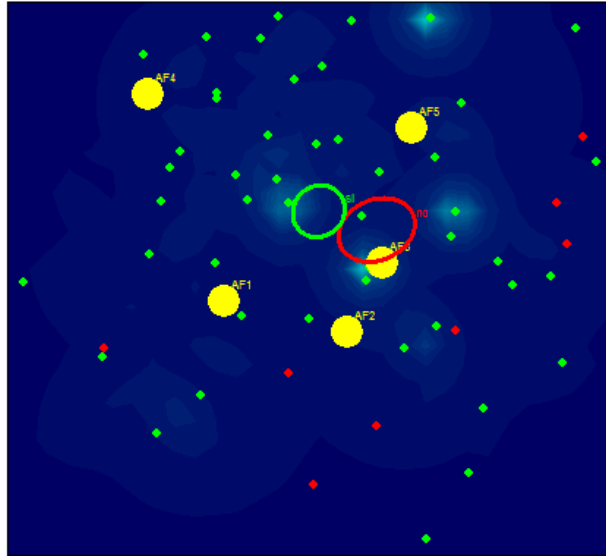


Fig. 3. Landscape Segmentation Analysis of the five prototypes correlating the effect of pork consumption. The dots in green means that people consume pork on a general basis, red means that they not regularly consume pork. Subjects n= 205. Where: AF1: refers to the marinade formulation; AF2: refers to marinade formulation added with commercial additive; AF3: Includes the base ingredients (BI=AF1+ AF2) + chicory inulin (*Cichorium intybus*), AF4: Includes the base ingredients (BI=AF1+ AF2) + corn fiber and, AF5: Includes the base ingredients (BI=AF1+ AF2) + nopal fiber (*Opuntia ficus-indica*).

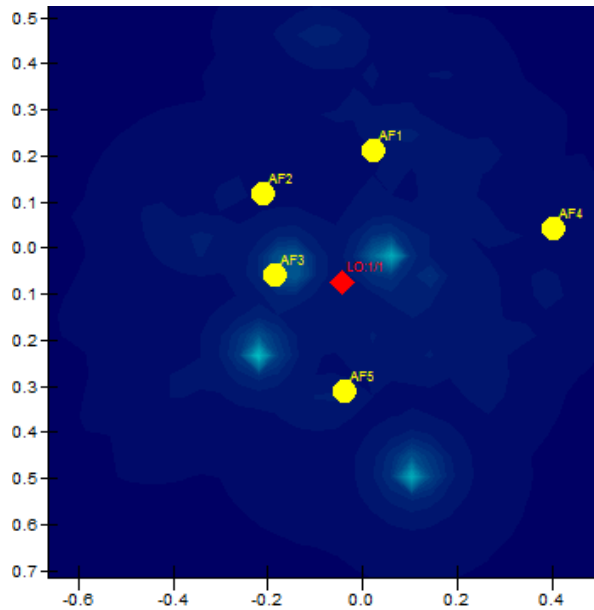


Fig. 4. Prediction of optimal prototype by the use of Landscape Segmentation Analysis, according to ingredients used in marinade established in Table 1 and 2. Subjets n= 205. Where: AF1: refers to the marinade composition; AF2: refers to marinade composition added with the commercial additives; AF3: Includes the base ingredients (BI=AF1+ AF2) + chicory inulin (*Cichorium intybus*), AF4: Includes the base ingredients (BI=AF1+ AF2) + corn fiber and, AF5: Includes the base ingredients (BI=AF1+ AF2) + nopal fiber (*Opuntia ficus-indica*).

Table 5. Flavor and acceptability regarding age range of the prototype elaborated with chicory Inulin, formulation established as AF3 (*Cichorium intybus*). Subjects n= 205.

Age range (years)	Flavor	Acceptability
18-26	3.31 ± 0.54	2.98 ± 0.46
27-34	3.33 ± 0.59	2.96 ± 0.57
35-42	2.80 ± 0.47	2.76 ± 0.50
43-50	3.10 ± 0.55	2.93 ± 0.50
51-58	2.75 ± 0.50	2.00 ± 0.0
59-66	2.58 ± 0.69	2.64 ± 0.50

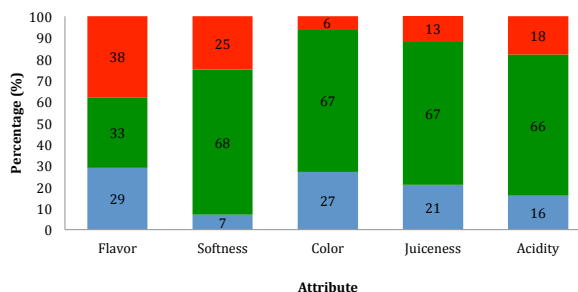


Fig. 5. Consumer assessment distribution of Just About Right response of the chicory inulin formulation AF3 (*Cichorium intybus*) formulation using the 5-point just about right scale: too weak (blue), just about right (green), and strong (red). Subjects n= 205.

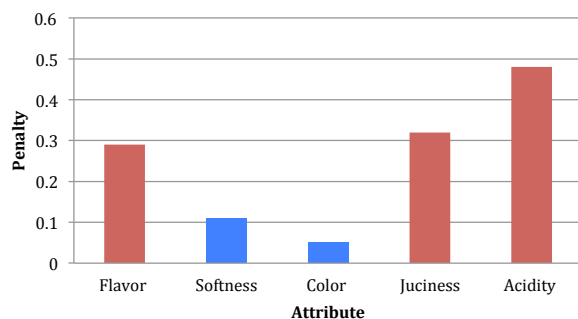


Fig. 6. Consumer assessment distribution of Penalty Analysis for the inulin formulation using the 5-point Just About Right scale: too weak (blue), Just About Right (green), and strong (red). Subjects n= 205.

According to the liking of the consumers' analyzed, the best prototype for launching into market can be predicted (Fig. 4), and it can be observed in a dot represented in red. It is important to mention that it is next to the prototype made out of chicory inulin, therefore the AF3 prototype could be considered a good product for scaling up.

3.3 Attributes evaluation by just about right

All formulations were evaluated by Just about right analysis, however the results presented here only explain the chicory inulin formulation (AF3) because according to Landscape Segmentation Analysis it resulted to be the most liked product as shown in Figure 1.

Frequency proportions of responses were grouped into three groups as shown in Figure 5: one that refers that the product has much of the attribute, the second it is below the optimal and, the optimal known as Just About Right (JAR). It can be observed that in the attributes evaluated of color, juiciness, acidity and, softness JAR was above 65%. Popper (2014) mentions that when 75% of the attributes tested are JAR the product should be scaled up and put into market. However, this depends on the type of products tested, for example, in low fat dairy products when 60% of the potential consumers consider the product JAR in the attributes studied, the product can be considered a good product for marketing. No reports have been done in pork marinades, however we can consider that the prototype of chicory inulin can be in scaled up taking into consideration that most of the attributes tested have more than 65% JAR. However, a deeper analysis on flavor should be done due to the fact that it presented 33% of JAR, 38% of too much and, 29% below optimal.

When analyzing Penalty Analysis (Fig. 6) and taking into consideration age (Table 5) in the liking decision, we can observe that younger people evaluated the prototype made up of chicory inulin (AF3) with higher flavor and acceptability rates, whereas older consumers prefer products with less flavor.

The subjects that performed the sensory analysis were asked, which product they preferred and the results revealed that 29% of the potential consumers chose chicory inulin formulation (AF3), which is in

accordance with the results obtained in this study.

Conclusions

Chipotle chili, garlic and, rosemary are natural ingredients that can be considered a good source of prebiotics, meaning that they can be incorporated in ready to eat *Sous Vide* pork products, not only for the sensory characteristics they offer but also because of their prebiotic character. Therefore, our results showed that when taking into consideration that incorporation of different natural prebiotics ingredients to marinades, prebiotic intake could be increased with this type of ready to eat *Sous Vide* products. But more important, adequate sensory characteristics can be achieved as proven by Landscape Segmentation, Just About Right and, Penalty Analysis. Results indicated that among the five prototypes assayed, chicory inulin- marinated *Sous Vide* pork meat presented a high prebiotic character and can offer adequate sensory characteristics that consumers are expecting, which could make it the best choice for marketing. Thus, this product could be considered a good product for scaling up.

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