BIOTECNOLOGÍA
EN EL SECTOR AGROPECUARIO
Y AGROINDUSTRIAL

· ARTÍCULO DE INVESTIGACIÓN CIENTÍFICA Y TECNOLÓGICA ·

Vol. 18 No 2 · Julio - Diciembre 2020 · ISSN - 1692-3561 · ISSN-e 1909-9959 · DOI: http://dx.doi.org/10.18684

Discriminative and descriptive sensory analysis of guacamole dressing made from "Hass" avocado powder*

Análisis sensorial discriminativo y descriptivo de guacamole a base de polvo de aguacate "Hass"

Análise sensorial discriminativa e descritiva do molho de guacamole feito de abacate em pó "Hass"

MISAEL CORTÉS-RODRÍGUEZ[1], FRANCY STEPHANIE ORREGO-VARGAS[2],
JUAN DIEGO TORRES-OQUENDO[3]

Historial del Artículo
Recibido para evaluación: 1 de Enero 2019.
Aprobado para publicación: 4 de Mayo 2020.

* Research project: "*Development and industrial production of functional foods from avocado (Persea americana* Mill) *Hass variety: a path towards improving the competitiveness of the chain*". Financing: The Ministry of Science Technology and Innovation, Minciencias, Colombia. Ended: June 5 of 2017.

1 Universidad Nacional de Colombia, Facultad de Ciencias Agrarias, Grupo de Investigación de Alimentos Funcionales (GAF). PhD. Ingeniería de Alimentos. Medellín, Colombia. ORCID 0000-0003-3407-1635

2 Universidad Nacional de Colombia, Facultad de Ciencias Agrarias, Grupo de Investigación de Alimentos Funcionales (GAF). MSc. Ciencia y tecnología de alimentos. Medellín, Colombia. ORCID 0000-0001-8270-6039

3 Universidad de Antioquia. Facultad de Ciencias Farmacéuticas y Alimentarias, PhD. Tecnología de Alimentos. Medellín, Colombia. ORCID 0002-6286-6470

Correspondencia: mcortesro@unal.edu.co

ABSTRACT

The guacamole is a product based on avocado very desirable in world gastronomy. The aim of this study was to select a formulation of guacamole prepared with avocado powder and fresh avocado (G_{AP+FA}) from sensory methodologies. Initially, a discriminative ranking analysis was performed, which allowed to select the best overall quality formulation and subsequently a descriptive analysis was performed by a multidimensional approach to the selected G_{PA+AF} and commercial guacamole obtained with fresh avocado (G_{AF}), where descriptors of appearance, color, flavor and texture were evaluated. Trained panelists were used, who evaluated 15 formulations obtained from the variables: dry solids of guacamole ($DS_{Guacamole}$) (30,30–25,25–20,20%), dry solids provided by AF (DS_{AF}) (0-25-50%) and lime color (0–0,015–0,030%). The discriminative methodology selected two formulations: 1) $DS_{Guacamole}$ = 25,25%, DS_{FA} = 25% and lime color = 0,015% (F_2) and 2) $DS_{Guacamole}$ = 30,30%, DS_{FA} = 50% and lime color = 0,030% (F_{16}). According to the greater similarity with the G_{FA} sample, regarding the contribution of $DS_{Guacamole}$ and higher content of dry solids provided by the AP (DS_{AP}), F_2 formula was selected for the descriptive test, which provided descriptors with desirable characteristics by consumers of Tex-Mex products.

KEYWORDS:
Sauce, Salad dressing, Overall quality, Sensory profile.

RESÚMEN

El guacamole es un producto a base de aguacate muy apetecido en la gastronomía mundial. El objetivo de este estudio fue seleccionar una formulación de guacamole preparada con polvo de aguacate y aguacate fresco (G_{PA+AF}) a partir de metodologías sensoriales. Inicialmente, se realizó un análisis discriminativo tipo ranking, el cual permitió seleccionar la formulación de mejor calidad general y posteriormente se realizó un análisis descriptivo por aproximación multidimensional al G_{PA+AF} seleccionado y a un guacamole comercial obtenido con aguacate fresco (G_{AF}), donde se evaluaron descriptores de apariencia, color, sabor y textura. Se utilizaron panelistas entrenados, los cuales evaluaron 15 formulaciones obtenidas a partir de las variables: sólidos secos del guacamole ($SS_{Guacamole}$) (30,3–25,25-20,2%), sólidos secos aportados por AF (SS_{AF}) (0–25-50%) y color lima (0–0,015-0,030%). Los datos obtenidos se analizaron estadísticamente usando la prueba de Friedman. El análisis discriminativo seleccionó dos formulaciones: 1) $SS_{Guacamole}$ = 25,25%, SS_{AF} = 25% y color lima = 0,015% (F_2) y 2) $SS_{Guacamole}$ = 30,30%, SS_{AF} = 50% y color lima = 0,030% (F_{16}). Debido a la mayor similitud con el G_{AF} en cuanto al aporte de $SS_{Guacamole}$ y al mayor contenido de sólidos secos aportados por el PA (SS_{PA}), la formula F_2 fue seleccionada para la prueba descriptiva, la cual proporcionó descriptores con características deseadas por los consumidores de productos Tex-mex.

PALABRA CLAVE:
Salsa, Aderezo para ensaladas, Calidad general, Perfil sensorial.

PALAVRAS-CHAVE:
Molho, Molho para salada, Qualidade geral, Perfil sensorial.

Cómo citar este artículo: MISAEL-CORTÉS RODRÍGUEZ, FRANCY STEPHANIE-ORREGO VARGAS, JUAN DIEGO-TORRES OQUENDO. Discriminative and descriptive sensory analysis of guacamole dressing made from “Hass” avocado powder. Revista Biotecnología en el Sector Agropecuario y Agroindustrial,18(2),2020.117-126, DOI:http://dx.doi.org/10.18684/BSAA(18)117-125

RESUMO

O Guacamole é um produto a base de abacate que é muito popular na culinária mundial. O objetivo deste estudo foi selecionar uma formulação de guacamole preparada com pó abacate e abacate fresco (G_{PA+AF}) de metodologias sensoriais. Inicialmente, foi realizada uma análise de classificação discriminativa, que permitiu a seleção da melhor formulação de qualidade geral e posteriormente, uma análise descritiva por aproximação multidimensional do G_{PA+AF} selecionado e um guacamole comercial obtido com abacate fresco (G_{AF}), onde os descritores de aparência, cor, sabor e textura foram avaliados. Utilizou-se panelistas treinados, que avaliaram 15 formulações obtidas a partir das variáveis: sólidos secos do guacamole ($SS_{Guacamole}$) (30,30–25,25 –20,20%), sólidos secos fornecidos pelo AF (SS_{AF}) (0–25-50%) e cor de lima (0–0,015-0,030%) e a análise estatística foi realizada a partir do teste de Friedman. A análise discriminativa selecionou duas formulações: 1) $SS_{Guacamole}$ = 25,25%, SS_{AF} = 25% e cor lima = 0,015% (F_2) e 2) $SS_{Guacamole}$ = 30,30%, SS_{AF} = 50% e cor lima = 0,030% (F_{16}). Devido a maior semelhança com o G_{AF} enquanto ao aporte do $SS_{Guacamole}$ e maior teor de sólidos secos fornecido pelo PA (SS_{PA}), a fórmula F_2 foi selecionada para o teste descritivo, que forneceu aos descritores as características desejadas pelos consumidores de Produtos Tex-mex.

INTRODUCTION

Sauces and salad dressings have been part of the human diet for thousands of years ago, they are used to flavor food, moisturizing and masking various culinary preparations [1]. Guacamole, making part of the Mexican dishes that mostly fit the range of "spicy dishes" is classified among the sauces and salad dressings, this category is extended to any product that has in its composition a high amount of Spice-flavored [2]. According to the Colombian technical guide [3], a food sensory analysis is an examination of physical and chemical attributes of a product that are perceived by the senses, allowing to know quantitative and qualitative properties of the food by trained panelists, and still fundamental for the development of new products with greater acceptance by consumers [4].

The main sensory characteristics that are taken into account to assess the quality and sensory shelf life of a sauce and salad dressings are attributes such as color, flavor, consistency, appearance, texture and overall quality [5]. The texture is one of the major qualitative parameters that can be seen by the senses of touch, sight, and hearing; It is related to the rheological properties and structure of foods [6]. The appearance or visual impression is the outward appearance that foods show, as the resulting expression of color, size, shape and quality status of food [7]. The taste and smell are perceived by chemoreceptors that can receive specific notes of taste and smell (taste + smell) for each food, like spicy attributes of dressings and sauces [8]. The pulp of ripe avocado which avocado is made with is characterized by having excellent sensory attributes, such as bright green moist creamy texture [9] and attributes of flavor as floral, herbal, green, sweet and oily, among others.

The aim of this study was to select by sensory methodologies a guacamole formulation made from avocado powder (AP) and fresh avocado (FA) (G_{AP+FA}), with quality attributes similar to a commercial guacamole made from 100% fresh avocado (G_{FA}).

METHOD

This research was carried out in the Laboratory of Sensory Food Analysis at the University of Antioquia. The average environmental conditions were 24.8 °C and 51% relative humidity.

Materials

Avocado powder (AP) was obtained by spray drying, according to the methodology described by Marulanda *et al.* (2018) [10]. For AP, avocado "Hass" (*Persea americana* Mill) from the eastern region of Antioquia was used; also, red onion (*Allium cepa* L.), paprika (*Capsicum annuum*), coriander (*Coriandrum sativum*), garlic (*Allium sativum*) and additives in the following categories: preservatives (sodium benzoate and potassium sorbate), antioxidants (Butyl hydroxytoluene and sodium erythorbate), acidulants (citric acid) and hydrocolloids like rubber xanthan were used.

Guacamole preparation

The formulation of the G_{AP+FA} was prepared to reconstitute the AP at 50% of the water of the formulation, using a blender Kitchen Aid Artizana 194 rpm (position 6) for 4 min; then vegetables, spices, and additives previously disintegrated with the remaining water were added and stirred for 2 min.

Fifteen formulations obtained by combining the variables: dry solids of guacamole ($DS_{Guacamole}$) (30,30 – 25,25 – 20,20%), dry solids provided by AF (DS_{AF}) (0 – 25 - 50%) and lime color (0 – 0,015 – 0,030%) were evaluated. The statistical analysis was performed from the Friedman test.

The dependent variable was: sensory general quality of $G_{PA+AF.}$ First a discriminative test (ranking methodology), later, the sample with a best general quality was compere with a G_{AF} through a descriptive test (sensory profile by multidimensional approximation, where descriptors of appearance, color, flavor and texture were evaluated).

General conditions for discriminative and descriptive trials

The trials were conducted in the Laboratory of Sensory Analysis of Food of Universidad de Antioquia, by means of a trained panel with and age range between 25 and 55 years, of male and female gender. Relative humidity conditions were recorded in the area of testing, at the beginning and end of the study. Cubicles separated and fitted according to regulations and white light were used. The regulatory framework for sensory analysis [3, 11, 12] was taken into account.

Discriminative sensory analysis

15 formulations were evaluated, with the participation of 7 trained judges, which were identified according to experimental design and in addition, a test code for each sample was designated. The formulas were strategically organized based on the guacamole soluble solids ($DS_{Guacamole}$) in three groups with an E_1, E_2, and E_3 delivery order. For each of these groups, it was conducted the methodology of ranking test, according to the general quality [13] and it was selected the one with the highest score of each group, in cases in which equal scores were obtained a pairwise comparison test [14] was carried out. Finally, a fourth group comprised of samples with the highest scores of the other three groups was submitted to the last ranking test, to choose the best formulation of the whole 15 samples collection. General quality analysis having the G_{FA} as the pattern was considered.

Statistical analysis

For the four groups of formulas the Friedman test (F_{test}) was applied (equation 1) to establish significant differences among the samples graded with respect to the overall quality, this considering that if $F_{test} > F$, it is concluded that there are consistent differences between the ranks order. In case of finding minimum significant difference according to the Friedman test, it should be carried out a test of minimum significant difference (MSD) (equation 2). A null hypothesis where there is a significant difference between the sums of ranks of samples and an alternative hypothesis where there is a significant difference between the sums of ranks of samples are proposed.

$$F_{test} = \frac{12}{j\,.\,p\,(p+1)}\left[R_1^2 + R_2^2 + R_3^2 + R_4^2\right] - 3\,j\,(p" + 1) \quad \text{(Eq. 1)}$$

Where: j =7 judges; R= sum of ranks for each sample; p” = number of samples.

$$MSD = z * \sqrt{\frac{j\ p"\,(p"+1)}{6}} \quad \text{(Eq. 2)}$$

Where: z = 1,96; j = 7 judges; p” = 5; significance level: 5%. If the absolute value of the difference between the sums of ranks of two products is equal to or greater than the MSD, it is concluded that the two products have received significantly different ranks.

Descriptive sensory analysis

The descriptive test was performed with the participation of 6 trained judges, who identified and selected sensory descriptors which enable the establishment of a sensory profile by a multidimensional approach for (G_{FA}) and (G_{AP+FA}) products, this last being selected throughout the discrimination analysis. Following the NTC 3932/1996 [14], it was initially performed a selection of descriptors in terms of appearance, smell, taste, and aroma of G_{FA} and G_{AP+FA}, then an assortment of the most representative descriptors was obtained by means of a group consensus, finally an intensity evaluation of the of each of these descriptors on an individual basis was carried out. The result of the entire assessment gives rise to a sensory profile and an overall quality of each product. Statistics were analyzed by using the Friedman test method.

Microstructural analysis

The micrographics of G_{AP+FA} y G_{FA} were performed on a optical compound microscope Nicon E200, the samples were put in the slides, and lenses in 10X.

RESULTS

Discriminative analysis

The conditions of temperature and relative humidity recorded during the sessions of sensory evaluation for the 15 formulations were: for the session 1: 25,2–25,9°C (±0,1°C) and 41,0–52,0% (±1,0%); and for the session 2: 23,0–25,0°C (±0,1°C) and 55,0–56,0% (±1,0%) respectively.

Table 1 describes the general quality of the guacamole formulations evaluated. The order from highest to lowest in terms of the overall quality of the four-valued groups was as follows:

- Group 1 (F_{16}, F_{19}, F_1, F_9, F_{14}): The *Friedman test* established minimum differences between these samples, therefore the test (MSD) was carried out, in which minimal differences between the samples of higher score were not found, then, a consensus was achieved among panelists on choosing F_{16} formula as the one with the greatest balance in smell and taste, also, soft, viscous and pasty texture attributes. Results: F_{test}: 9,90 F*=9,11 and MSD = 11,59.
- Group 2 (F_2, F_3, F_{17}, F_8, F_{13}) significant differences with the Friedman test were found among these formulas, also, MSD test was performed, which no minimum significant difference among samples with highest scores was found. Then a pairwise comparison between F_2 and F_3 was performed. In terms of overall quality sample, F_2 was chosen by its greatest balance in smell and taste, fleshy, doughy and viscose texture. Results: F_{test}: 14,51, F*=9,11 and MSD = 11,59.
- Group 3 (F_5, F_4, F_6, F_{18}, F_{10}), no significant difference during the Friedman test were found, so F_4 was selected by consensus among panelists on organoleptic attributes appointing out this formula as the one with the best slightly viscous texture, spicy and with more balance in taste and smell. Results: F_{test}: 8,57 and F*= 9,11.
- Group 4 (F_2, F_{16}, F_4) significant differences with the Friedman test were found among these formulas, also, MSD test was performed, which no minimum significant difference among samples with highest scores was found. Then a pairwise comparison between

Table 1. General quality of guacamole formulations.

Sample	$DS_{Guacamole}$ (%)	DS_{FA} (%)	Lime color (%)	Code	Delivery order	Sum of ranges (General quality)
Standard or commercial sample	25,25	25	0	422	Initial	Initial
F_1	30,30	50	0	791	E_1	23
F_9	20,20	50	0,030	219	E_1	17
F_{14}	20,20	50	0,000	922	E_1	12
F_{19}	25,25	50	0,015	123	E_1	24
F_{16}	30,30	50	0,030	179	E_1	29
F_2	25,25	25	0,015	871	E_2	28
F_3	30,30	25	0,015	21	E_2	27
F_8	25,25	25	0	500	E_2	17
F_{13}	20,20	25	0,015	313	E_2	9
F_{17}	25,25	25	0,030	944	E_2	24
F_4	30,30	0	0,030	611	E_3	26
F_5	30,30	0	0	532	E_3	27
F_6	25,25	0	0,015	111	E_3	23
F_{10}	20,20	0	0	305	E_3	14
F_{18}	20,20	0	0,030	549	E_3	15

F_2 and F_{16} was performed. It was concluded, by the panelists, that both formulas have the greatest quality characteristics scores, and that there are no significant differences between them. Results: F_{test}: 225,0, F*=9,11 and MSD = 7,33.

The comparison of F_2 and F_{16} formulations in terms of increased use of AP was determining the relationship between DS_{AP} and DS_{FA} (DS_{AP}/DS_{FA}), which was 2,594 and 0,831, respectively. This result evidence that F_2 formulation ($DS_{Guacamole}$ = 25,25%, DS_{FA} = 25,0% and lime color = 0,015%) favors a greater use of the AP in the formulation. Now, by similarity with the commercial standard (G_{FA}) as to the contribution of $DS_{Guacamole}$ and greater representation in the DS_{AP} (%), was selected F_2 (G_{AP+FA}) to the descriptive test.

Descriptive test

Sensory analysis by multidimensional approach was performed to G_{FA} and G_{AP+FA} in a session with room conditions of initial temperature = 24,7°C and final 25,4°C, initial relative humidity of 55% and 60% at the end. The sensory descriptors obtained for G_{FA} and G_{AP+FA} based on parameters of appearance, color, flavor, texture, are set out in table 2 and figure 1.

Table 2. Quality descriptors for G_{FA} y G_{AP+FA} products (*p<0,05).

Descriptor	G_{FA}	G_{AP+FA}	Valor p
Bright appearance	4,0	4,0	1,000
Spice presence appearance	3,3	3,5	0,317
Appearance of color homogeneity	4,3	4,5	0,317
Lumpy appearance	1,0	1,3	0,317
Avocado odor	4,0	3,5	0,083
Odor Salty	2,0	2,0	1,000
Odor Sweet	1,0	1,3	1,000
Odor Herbal	3,0	2,8	0,083
Odor acid	2,5	2,3	0,180
Odor Alliaceous	2,3	3,0	0,025*
Odor spicy	3,0	3,5	0,180
Odor chemical	1,0	1,0	0,554
Odor oily	1,0	2,0	0,045*
Sweet taste	1,8	1,8	0,180
Acid flavor	3,0	3,0	1,000
Oily flavor	3,0	3,8	0,143
Salty flavor	3,0	2,8	0,317
Bitter taste	1,3	1,8	1,000
Green flavor	2,0	2,0	0,563
Herbal flavor	2,8	2,3	0,647
Avocado flavor	3,8	4,0	0,564
Alliaceous flavor	2,5	3,0	0,025*
Spices flavor	3,0	3,3	0,317
Astringent taste	2,0	2,0	1,000
Spicy taste	2,0	2,3	0,317
Chemical flavor	1,0	1,3	0,083
Soft texture	3,3	3,3	0,317
Oil texture	2,5	3,3	0,103
Viscous texture	3,0	3,0	0,157
Fibrous texture	2,3	1,5	0,103
Overall Quality	3,0	2,0	0,083

For appearance and texture descriptors, it can be seen that no significant differences (p>0,05) were found. In descriptors evaluated for odor and taste, only attributes oily smell, alliaceum smell and alliaceum taste presented significant statistical differences (p<0,05). Attributes found for the guacamoles were the presence of spices, bright appearance and lumpy appearance among others. The spicy appearance, taste, and odor are typical of Mexican, Indian and some Asians sauces and dressings (Sheldrake, 2003). The lumpy appearance and fibrous texture are characteristic attributes of the guacamole, desired by the modern consumer that is also related to a more natural product. The homogeneity of the color appearance was given by the visualization of spice particles with their respective chromaticities, within the green bright avocado matrix [16]. Bright appearance of F_2 is consistent with the oil content of avocado, which comprised the dispersed phase in the guacamole dressing; this descriptor was also been evidenced in dressings like mayonnaise [17].

Oily smell presented significant statistical difference (p<0,05) where G_{PA+FA} acquired the highest score, which could be attributed to the physical form of the oil drops in G_{AP+FA} inducing a greater perception of oily smell [18]. On the one hand, the raw material AP consists of droplets of oil below 50µ diameter which occupy a greater surface area in G_{AP+FA}. On the other hand, the FA presents bigger drops of oil (millimetric) with considerable space between them as shown in the images of figure 2. The oily texture descriptor did not present significant statistical differences (p > 0,05) with respect to the two products. This parameter is characteristic of the oil emulsions in water, where the oily phase is responsible for providing attributes desired by the consumer as a creamy, soft, nutty and buttery flavor [9].

Alliaceous odor and taste attributes presented significant statistical differences (p<0,05) regarding both products, which is characteristic of the spiced garlic, that, in this case, was not expected (G_{PA+AF} presented the highest score), since both products have the same spice proportion. This effect could be associated with the lower fat content of G_{PA+AF} (28,9% db) versus G_{FA} (55,8% db), due to the ability of the lipid fraction to capture or enhance flavors depending on the food matrix. First, the fat can form a barrier between taste compounds and taste receptors, resulting in a decrease in the intensity of the perceived flavor, this being a masking effect. Second, fat can increase the concentration of water-soluble flavor compounds in the aqueous phase, creating a mass with a greater flavor intensity (enhancer effect) [19].

There were no significant statistical differences (p>0,05) in the attributes of avocado taste and odor, with respect to both products. The result of great importance taking into account that PA is obtained with the spray drying technology that involves high temperatures, also several investigations have reported the loss of volatile compounds in avocado submitted to global warming [20]. Some of the common descriptors between the two products like green (unripe), herbal and spicy odor and taste, showed no significant statistical differences (p>0,05), which correlates with avocado characteristic flavor volatile

Figure 1. Sensory profile by a multidimensional approach for samples G_{FA} and G_{AP}+F_A.

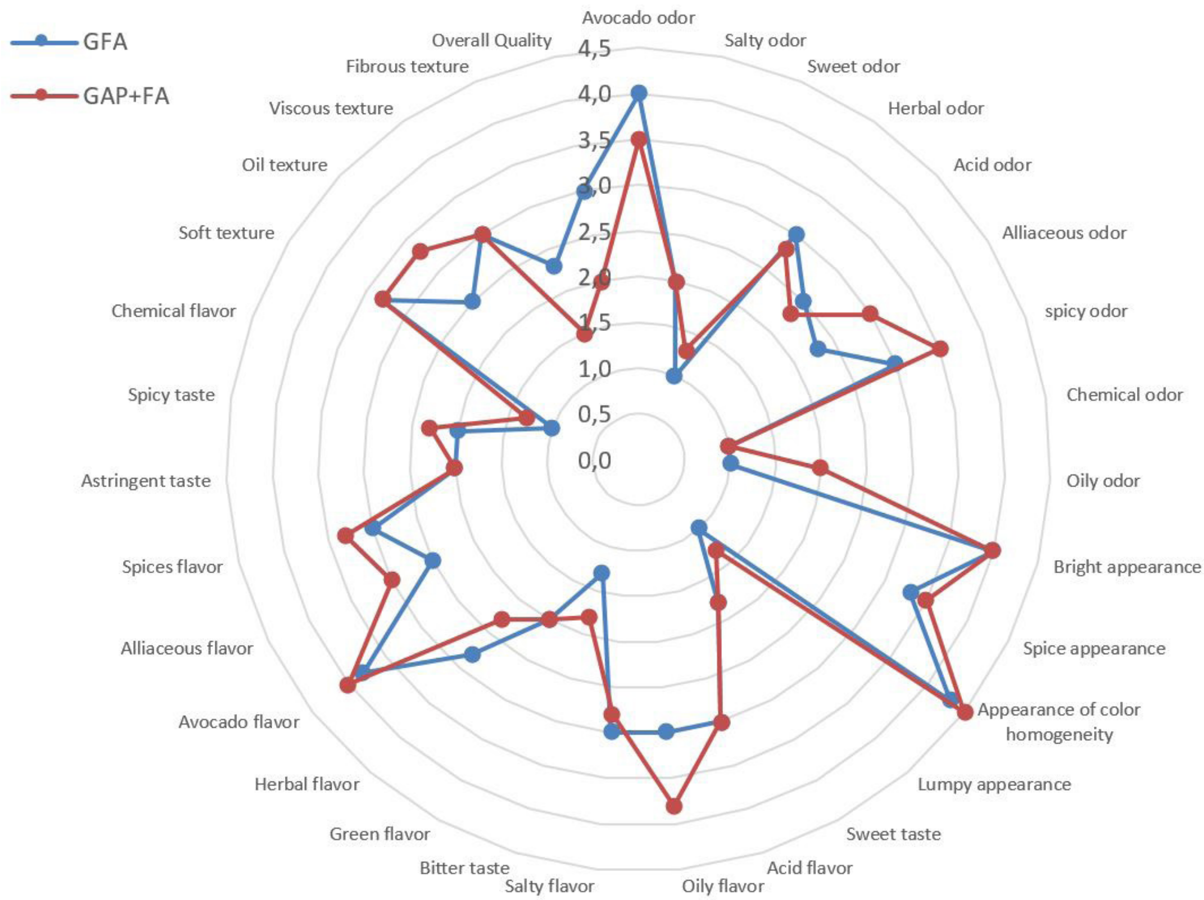
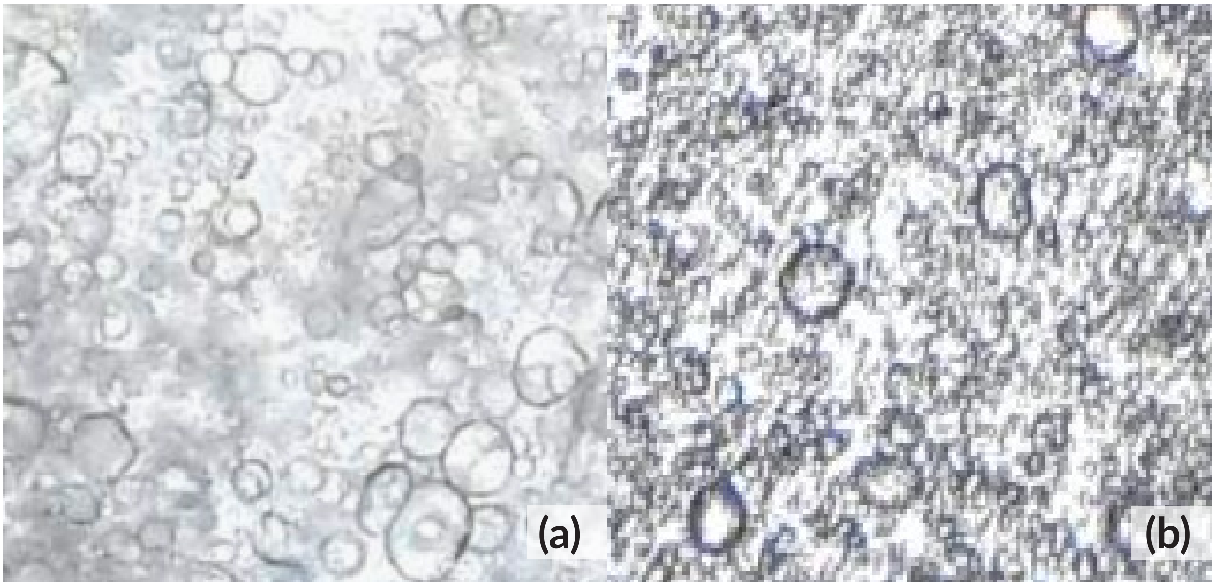


Figure 2. Micrographs of G_{AP+FA} (a) y G_{FA} (b) by an optical microscope with lenses 10X.



compounds as Hexanal and E-2-Hexanal, found in the investigation of [21] in avocado pulp. Finally, the overall quality that corresponds to the global appreciation of the panelists regarding the quality of the products, did not present significant statistical differences (p>0,05) among.

CONCLUSIONS

The selected formulation through the sensory-discriminative analysis was F_2 by its greatest balance in smell and taste, pulpy, pasty and viscous texture, being the G_{AP+FA} made with $DS_{Guacamole}$: 25,25%, DS_{FA}: 25% and lime color: 0,015%. The descriptive sensory analysis for G_{FA} and G_{AP+FA} did not show statistically significant differences based on odor and taste of avocado. It was possible to potentiate the spicy flavor of Tex-Mex products in the two products. Attributes obtained to assess sensory guacamole products serve as a reference for research where required sensory understanding and evaluating quality in salad dressings and sauces made of avocado.

REFERENCES

[1] GARCÍA-CASAL, M. and PEÑA-ROSAS, J. Sauces, spices, and condiments: definitions, potentialbenefits, consumption patterns, and global markets. Annals of the New York Academy of Sciences, 1379(1), 2016, p. 3-16. doi: https://doi.org/10.1111/nyas.13045

[2] ARAUJO, R.G. *et al.* Avocado by-products: Nutritional and functional properties. Trends in Food Science & Technology, 80, 2018, p. 51-60. doi: https://doi.org/10.1016/j.tifs.2018.07.027

[3] INSTITUTO COLOMBIANO DE NORMAS TÉCNICAS (ICONTEC). Guía técnica colombiana (GTC) 165, Análisis sensorial. Metodología. Guía general. Bogotá (Colombia): 2014, p. 26.

[4] YU, P., MEI YIN LOW, M.Y. and ZHOU, W. Design of experiments and regression modelling in food flavour and sensory analysis: A review. Trends in Food Science & Technology, 71, 2018, p. 202-215. doi: https://doi.org/10.1016/j.tifs.2017.11.013

[5] BORTNOWSKA, G. *et al*. Effects of waxy rice and tapioca starches on the physicochemical and sensory properties of white sauces enriched with functional fibre. Food Chemistry, 202, 2016, p. 31–39. doi: https://doi.org/10.1016/j.foodchem.2016.01.077

[6] LANDIM, A.P.M., BARBOSA, M.I.M.J. and JÚNIOR, J.L.B.. Influence of osmotic dehydration on bioactive compounds, antioxidant capacity, color and texture of fruits and vegetables: a review. Ciência Rural, 46(10), 2016, p. 1714-1722. doi: http://dx.doi.org/10.1590/0103-8478cr20150534

[7] ROMÁN, L., REGUILÓN, M.P. and GÓMEZ, M. Physicochemical characteristics of sauce model systems: Influence of particle size and extruded

flour source. Journal of Food Engineering, 219, 2018, p. 93–100. doi: https://doi.org/10.1016/j.jfoodeng.2017.09.024

[8] MAMEDE, M.E.D.O. and BENASSI, M.D.T. Efficiency assessment of Flash Profiling and Ranking Descriptive Analysis : a comparative study with star fruit-powdered flavored drink. Journal of Food Science and Technology, 36(2), 2016, p. 195-203. doi: http://dx.doi.org/10.1590/1678-457X.0003

[9] ZÜGE, L.C.B. *et al*. Use of avocado phospholipids as emulsifier. LWT - Food Science and Technology, 79, 2017, p. 42–51. doi: https://doi.org/10.1016/j.lwt.2017.01.013

[10] MARULANDA, A., RUIZ-RUIZ, M.P. and CORTES-RODRIGUEZ, M. Influence of spray drying process on the quality of avocado powder: a functional food with great industrial potential. Vitae 25(1), 2018, p. 37-48. doi: http://dx.doi.org/10.17533/udea.vitae.v25n1a05

[11] INSTITUTO COLOMBIANO DE NORMAS TÉCNICAS (ICONTEC). Norma Técnica Colombiana (NTC) 3501, Análisis sensorial. Vocabulario. Bogotá (Colombia): 2012, 24 p.

[12] INSTITUTO COLOMBIANO DE NORMAS TÉCNICAS (ICONTEC). Guía técnica colombiana (GTC) 226, Análisis sensorial. Guía general para el diseño de cuartos de prueba. Bogotá (Colombia): 2012, 21 p.

[13] INSTITUTO COLOMBIANO DE NORMAS TÉCNICAS (ICONTEC). Norma Técnica Colombiana (NTC) 3930. Análisis sensorial. Metodología. Ordenamiento de acuerdo con un criterio específico (ranking). Bogotá (Colombia): 2015, 24 p.

[14] INSTITUTO COLOMBIANO DE NORMAS TÉCNICAS (ICONTEC). Norma Técnica Colombiana (NTC) 2680. Análisis sensorial. Metodología. Prueba de comparación pareada. Bogotá (Colombia): 2013, 27 p.

[15] INSTITUTO COLOMBIANO DE NORMAS TÉCNICAS (ICONTEC). Norma Técnica Colombiana (NTC) 3932. Análisis sensorial. Identificación y selección de descriptores para establecer un perfil sensorial por una aproximación multidimensional. Bogotá (Colombia): 1996, 31 p.

[16] HURTADO-FERNÁNDEZ, E., FERNÁNDEZ-GUTIÉRREZ, A. and CARRASCO-PANCORBO, A. En: Exotic Fruits. Avocado fruit— Persea americana. 1 ed. Amsterdam (Netherlands): Elsevier Inc., 2018, p. 37–48. doi: https://doi.org/10.1016/B978-0-12-803138-4.00001-0

[17] ORTIZ-VIEDMA, J. *et al*. Textural, flow and viscoelastic properties of Hass avocado (*Persea americana* Mill.) during ripening under refrigeration conditions. Journal of Food Engineering, 219, 2018, p. 62–70. doi: https://doi.org/10.1016/j.jfoodeng.2017.09.014

[18] DANTAS, D. *et al*. Influence of spray drying conditions on the properties of avocado powder drink. Food Chemistry, 266, 2018, p. 284–291. doi: https://doi.org/10.1016/j.foodchem.2018.06.016

[19] APPELQVIST, I.A.M. *et al*. Impact of model fat emulsions on sensory perception using repeated spoon to spoon ingestion. Physiology & Behavior, 160, 2016, p. 80-86. doi: doi:10.1016/j.physbeh.2016.03.035

[20] FUENTES-CAMPO, A. *et al*. In vitro and in vivo inhibition of Hass avocado polyphenol oxidase enzymatic browning by paeonol, β-cyclodextrin, and paeonol:β-cyclodextrin inclusion complex. Journal of Bioscience and Bioengineering, 2018, In Press. doi: https://doi.org/10.1016/j.jbiosc.2018.11.009

[21] GARCÍA-ROJAS, M. *et al.* Biosynthesis of fatty acids-derived volatiles in 'Hass' avocado is modulated by ethylene and storage conditions during ripening. Scientia Horticulturae, 202, 2016, p. 91-98. doi: https://doi.org/10.1016/j.scienta.2016.02.024