processes

MDPI

Article

Impact of Frying and Storage on Sensory, Cognitive, and Consumer Perception of Chayote Chips Using Static and Dynamic Sensometric Techniques

Adán Cabal-Prieto [1,*], Ana Laura Piña-Martínez [1], Lucía Sánchez-Arellano [1], Lorena Guadalupe Ramón-Canul [2], Víctor Manuel Herrera-Morales [1], Rosa Isela Castillo-Zamudio [3,*], Galdy Hernández-Zárate [3], Erika María Gasperín-García [4], Susana Isabel Castillo-Martinez [5], Alejandro Llaguno-Aguiñaga [5], José Manuel Sánchez-Orea [5] and Oliver Salas-Valdez [5]

1 Tecnológico Nacional de México, Instituto Tecnológico Superior de Huatusco, Av. 25 Poniente No. 100, Colonia Reserva Territorial, Huatusco 94106, Veracruz, Mexico; apinam@huatusco.tecnm.mx (A.L.P.-M.); lsancheza@huatusco.tecnm.mx (L.S.-A.); m223z2018@alum.huatusco.tecnm.mx (V.M.H.-M.)
2 Tecnológico Nacional de México, Instituto Tecnológico de Chiná-División de Estudios de Posgrado e Investigación. C. 11, Cementerio, San Francisco de Campeche 24520, Campeche, Mexico; lorena.rc@china.tecnm.mx
3 Colegio de Postgraduados, Campus Veracruz, Km 88.5 Carretera Federal Xalapa-Veracruz, Manlio Fabio Altamirano 91700, Veracruz, Mexico; hernandez.galdy@colpos.mx
4 Universidad Politécnica de Huatusco, Calle 22 sur, Colonia Reserva Territorial, Huatusco 94106, Veracruz, Mexico; mtra.erika.gasperin104@uphuatusco.edu.mx
5 Tecnológico Nacional de México, Instituto Tecnológico Superior de Zongolica, Zongolica 95005, Veracruz, Mexico; susana_castillo@zongolica.tecnm.mx (S.I.C.-M.); alejandrollaguno@yahoo.com.mx (A.L.-A.); jose_ige@zongolica.tecnm.mx (J.M.S.-O.); 236w0855@zongolica.tecnm.mx (O.S.-V.)
* Correspondence: acabalp@huatusco.tecnm.mx (A.C.-P.); rosychely@colpos.mx (R.I.C.-Z.)

Abstract

The objective of this research was to apply static and dynamic sensometric techniques to determine the impact of processing factors (dehydration time, frying exposure time) and storage duration on the sensory and cognitive characteristics, as well as consumer preference, of chayote chips. A total of 18 types of chips were prepared (using a combination of three frying temperatures [140, 150, 160 °C], two exposure times [5 and 10 s], and three periods of storage [0, 30, and 60 days]). A panel of 100 consumers was formed to evaluate sensory and cognitive attributes (emotions and memories) as well as overall liking, using static techniques such as Rate-All-That-Apply (RATA), Check-All-That-Apply (CATA), and a hedonic scale. Finally, the temporal dominance of sensations (TDS) dynamic technique was used to study the behavior of chips with higher levels of preference. The results of the sensory techniques indicated that the storage day factor influenced the sensory results. The samples prepared on the same day were perceived with high intensities of typical attributes of this type of food (bitter-BT, Fried-A, Sweet-A, Potato-A, Toasted-A, Chayote-A, Potato-F, Crunchy, Chayote-F, and Sweet-BT) while evoking positive emotions and memories in consumers (active, enthusiastic, free, good, good nature, happy, interested, satisfied, traditional food, family, summer, party, and mild weather). In terms of preference, consumers selected the chip samples with 0 days of storage. The TDS curves determined that the dominant attributes of the chayote chips with 0 days of storage were chayote flavor, sweet, and fried (with a dominance t = 5–20 s). Regarding the cognitive aspect, these chayote chips evoke positive dominant emotions (good, satisfied, and happy from t = 8–20 s) as well as dominant positive memories of childhood (t = 9–20 s), traditional food (t = 11–20 s), and friendship (t = 11–20 s).

check for updates

Academic Editor: Chi-Fai Chau

Received: 12 August 2025
Revised: 5 September 2025
Accepted: 11 September 2025
Published: 22 September 2025

Citation: Cabal-Prieto, A.; Piña-Martínez, A.L.; Sánchez-Arellano, L.; Ramón-Canul, L.G.; Herrera-Morales, V.M.; Castillo-Zamudio, R.I.; Hernández-Zárate, G.; Gasperín-García, E.M.; Castillo-Martinez, S.I.; Llaguno-Aguiñaga, A.; et al. Impact of Frying and Storage on Sensory, Cognitive, and Consumer Perception of Chayote Chips Using Static and Dynamic Sensometric Techniques. *Processes* **2025**, *13*, 3023. https://doi.org/10.3390/pr13093023

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Keywords: chayote chips; frying process; storage time; consumer preference; sensory evaluation

1. Introduction

Global chayote production is estimated at approximately 366,955 tons, of which Mexico represents 53% of that proportion [1]; in 2023, national production reached 194,487 tons, with Veracruz being the main producing state with 164,255 tons, representing 84% of national production [2]. The fruit is recognized for its high content of water, fiber, vitamins, and minerals, making it a nutritious and versatile food [3]. However, overproduction and the lack of marketing strategies have caused the price of chayote to fluctuate between MXN 15 and MXN 80 per kilogram [4]. This has caused producers to give away their produce, generating economic losses and difficulties in placing their product in national and international markets. On the other hand, the high perishability of chayote contributes to post-harvest losses that are estimated at 30% of total production [5]. These losses limit its potential as a raw material and restrict its use in the food industry. In Mexico, there are programs such as "Vida Saludable" that aim to promote healthy eating habits in the Mexican population by including nutritious foods [6]. However, the sale of potato chips is common in the market. They enjoy high acceptance by consumers due to their convenience and sensory appeal. They contain high levels of fat, sodium, and calories, which are associated with the development of metabolic diseases such as obesity, type 2 diabetes, and high blood pressure [7–11]. Therefore, an alternative to the use of chayote is the development of innovative products in the form of chips in order to add value to this food and avoid post-harvest losses. Several studies have shown that the use of canola oil contributes to a reduction in plasma cholesterol and helps consumers meet dietary fat recommendations, which may improve hypercholesterolemia [12,13]. This alternative could obtain the following benefits: (1) promotion of the consumption of local products; (2) well-being of the Mexican population; and (3) strengthening of rural economies, consolidating the role of chayote as a strategic resource. However, the technological process for the production of chip-type snacks and the factors of dehydration and exposure time to frying are essential for the development of sensory characteristics and to extend their use to different storage times [14]. Therefore, analyzing the impact of the mentioned processes from a sensometry perspective will allow us to explain the possible defects generated in this type of snack. In this sense, the field of sensometry includes a variety of static sensory techniques, such as Check-All-That-Apply (CATA) and Rate-All-That-Apply (RATA), among others, which have experienced significant growth in recent years and are widely used to characterize foods, including snacks [15–19]. However, dynamic techniques such as the temporal dominance of sensations [20] are an important tool to analyze the sensory behavior of samples during consumption in real time. Additionally, the use of the aforementioned sensory techniques for characterization purposes is also important to analyze the cognitive aspects of the consumer based on emotions (EsSense25) [21] and memories (MemVOC) [22]. This statement is supported by Jiang et al. (2014) [23] and Cabal-Prieto et al. (2022) [22], who reported that emotions and memories play an important role in consumer acceptance or rejection of food. This study aimed to evaluate the impact of frying and storage on the sensory, cognitive, and preference attributes of chayote chips using static and dynamic sensometric techniques.

2. Materials and Methods

2.1. Chip Sample Preparation and Experimental Conditions

The fruit was purchased directly from the market in Huatusco, Veracruz, Mexico, which is supplied by local chayote producers. The fruits were fresh, harvested at horticultural maturity [1], uniform in size, free of visible damage, had a moisture content of 91.89 ± 0.01 g per 100 g (wet basis), and weighed 210 ± 10 g (mean ± standard deviation). The fruits were washed under running water and the peel, apical (crown), and basal (base) sections were removed manually. Subsequently, the chayotes were cut transversely to obtain 2 mm thick samples. The samples were dehydrated using industrial equipment (FD-20, MIGSA®, Estado de Mexico, Mexico) at 70 °C for a period of 3 h. After dehydration, the samples were stored in sterile containers to avoid contamination until the oil frying step. Subsequently, the samples were fried with canola oil (Crisco, Pure Canola Oil, Parsippany, NJ, USA) at three different temperatures, namely 140 °C, 150 °C, and 160 °C, with different exposure times of 5 and 10 s, generating a total of 18 runs based on a completely randomized experimental design (Table 1). The samples were not seasoned with any type of spice or salt in order to avoid altering their sensory properties during the analysis.

Table 1. Experimental conditions for obtaining chayote chips.

Sample	Frying Temperature °C	Exposure Time (s)	Storage Time (Days)
S1	140	5	0
S2	150	5	0
S3	160	5	0
S4	140	10	0
S5	150	10	0
S6	160	10	0
S1	140	5	30
S2	150	5	30
S3	160	5	30
S4	140	10	30
S5	150	10	30
S6	160	10	30
S1	140	5	60
S2	150	5	60
S3	160	5	60
S4	140	10	60
S5	150	10	60
S6	160	10	60

S = sample.

The temperature and exposure time conditions were determined according to the following criteria: (1) preliminary tests that allowed us to obtain chips suitable for sensory evaluation and consumption; (2) temperature and exposure time are parameters that have been analyzed for the development of different foods [14,24–26]. The frying process was carried out using electronic equipment with temperature control (Chefman, model RJ07-45-SS-MX, Hangzhou, China) with a capacity of 4.2 L. Subsequently, the chips were packed in heat-sealable, pillow-type metallized bags (Costalym SA de CV, Cuernavaca, Mexico) and labeled for storage at 0, 30, and 60 days under ambient conditions (average ambient temperature was 22.5 °C and average relative humidity was 66%), since within this range, the chips maintain their quality and overall acceptance without significant changes [14].

2.2. Formation of the Consumer Panel

The panel consisted of 100 participants, of whom 38 were men and 62 were women, with an age range of 18–46 years, all affiliated with the Instituto Tecnológico Superior de Huatusco, Veracruz, Mexico. None of the participants received prior training in sensory evaluation. Consumers were selected according to several criteria, such as the availability of time to participate in the sensory tests, willingness, and consumption of products or by-products derived from chayote [27,28]. The statistical power of the test was 0.99 for a moderate effect size (n = 100, d = 0.80, sig.level = 0.05). In this study, age was not a factor of interest. For the purposes of this research, the consumer panel size was larger than those in previous studies [29–32], which included 10, 20, 98, and 49 consumers, respectively. All individuals considered in this study gave their consent and were informed about aspects related to the product under evaluation (process, ingredients, etc.). The evaluation sessions were conducted at the Teaching, Research, and Service Laboratory (LADISER) of the Tecnológico Nacional de México, Campus Huatusco. The samples were presented whole on white disposable plates and were coded with three random digits. Participants were instructed to taste the first sample and proceed with the evaluation according to the provided instructions.

2.3. Static Sensory Techniques: Sensory and Cognitive Profile

The following sensory attributes were evaluated: Sweet-BT, Chayote-F, Oil-F, Salty-BT, Crunchy, Bitter-BT, Potato-F, and Rancid-F. These sensory attributes were previously defined by a group of trained panelists. Consumers rated the intensity of the samples based on the sensory attributes using the Rate-All-That-Apply (RATA) technique in the following steps: (1) two sessions (60 min per session) were conducted to familiarize consumers with the RATA technique; then, (2) each consumer subsequently rated the samples using a 9-point scale (low and high intensity). This scale was used because it improves discrimination [33]. Subsequently, consumers used the Check-All-That-Apply (CATA) technique for sample evaluation [15] and to develop the cognitive profile based on the EsSense25 [21] and MemVOC [22] emotion and memory vocabularies. Regarding emotions and memories, there is evidence that both vocabularies have been used in the Mexican context; for example, the emotion vocabulary has been validated with tortilla consumers in Mexico [34], and the memory vocabulary has also been developed and validated in the same context [22]. Chip samples were presented in randomized order according to a Latin square experimental design [35]. A 10 min break was given between sample evaluations, during which participants cleansed their palates with water and white bread to minimize carryover effects. The data were collected in separate matrices: intensity data, generated using the RATA technique, were recorded in the corresponding intensity matrix, while emotion and memory responses were collected in binary matrices (1 = presence; 0 = absence). Statistical analysis was performed using XLSTAT version 2020 [36].

2.4. Liking Determination and Dynamic Technique for Real-Time Consumption Analysis

Consumers used a nine-point hedonic scale (1 = extremely dislike; 9 = extremely like) to evaluate how much they liked each chayote chip sample [37]. A Latin square experimental design was used to obtain the randomized order in which the samples were served to each consumer [35]. The sensory behavior of the samples was subsequently analyzed in real time during consumption, and only those most preferred by the consumer were selected. For this purpose, consumers used the dynamic temporal dominance of sensations (TDS) technique proposed by Pineau et al. (2009) [20], which was developed in the steps described below and in different sessions to evaluate sensory attributes, emotions, and memories (Table 2).

Table 2. Sensory attributes, emotions, and memories considered for the TDS test.

Sensory Attributes	Emotions	Memories
Chayote	Happy	Childhood
Oil	Good	Traditional Food
Burnt	Satisfied	Friendship
Sweet	Pleasant	Rainy weather
Potato	Disgusted	Obesity
Fried	Bored	Stench
Rancid	Nostalgic	Interpersonal conflict
Toasted	Worried	Poverty

Initially, training was conducted, consisting of the following steps: (1) explaining to the consumers the definition of dominance for attributes, emotions, or memories and (2) subsequently teaching them how to use the SensoMaker software version 1.92 [38]. Once this training was completed, each consumer performed the TDS test as follows: first, the consumer took a chayote chip sample, placed it in their mouth, and then clicked the "Start" button. Second, each consumer evaluated each sample for a period of 20 s. It is worth noting that the attributes, emotions, and memories were selected by consensus through a focus group (FDG) at the Tecnológico Nacional de México, Huatusco Campus. The FDG procedure was as follows: during an initial individual phase (15–20 min), participants reflected on and recorded the emotions and memories evoked by the evaluated samples. This was followed by a group discussion (60 min), encouraging discussion and collective analysis to reach a consensus and obtain the final listing. For the attributes, only flavor aspects were evaluated, as the principle of the TDS technique is to assess this type of attribute [20]. Regarding the sample amount provided to the consumers, for static sensory techniques (RATA, CATA, and Liking), whole chip samples up to 20 g were offered, while for the dynamic test, only one sample was served since it was a single TDS test and not multiple TDS tests. Finally, the sensory tests were conducted in separate sessions, scheduled with three-day intervals to avoid sensory fatigue; therefore, the methods were not applied concurrently. The evaluation began with an intensity assessment using RATA; after three days, the cognitive tests (emotions and memories) were performed; and finally, the dynamic evaluation was carried out using TDS.

2.5. Statistical Analysis

2.5.1. Static Sensory Techniques

For the techniques, the following statistical strategy was used: (1) the data derived from the RATA technique were collected in a matrix of dimensions ($J * I * E$) K, where J = 6 samples, I = 100 consumers, E = three storage times, and K = 16 sensory attributes = 28,800 data points were evaluated using a two-factor analysis of variance (ANOVA) model (sample and storage day) with interaction (sample * storage day), and the sensory profile was generated via principal component analysis (PCA). (2) The data from the CATA technique were collected in a matrix with dimensions ($J * I * E$) K, where J = 6 samples, I = 100 consumers, E = three storage times, and K = 25 (emotions or memories) = 45,000 data points were evaluated using the Cochran Q technique, and the representation of the cognitive profile (emotions and memories) was generated via correspondence analysis (CA). The sensory and cognitive profiles were constructed using sensory attributes, emotions, and memories ($p < 0.05$), as shown in the ANOVA and Cochran's Q tests.

2.5.2. Liking Determination and Dynamic Technique for Real-Time Consumption Analysis

For this part, the data were analyzed in different stages. (1) The results of the hedonic scale were analyzed using a two-factor ANOVA model (sample and storage day) with

interaction to determine the most important factor or factors. (2) Prior to generating the TDS curves, an ANOVA model was applied to analyze real-time consumption based on the important factors indicated in the previous step. (3) TDS curves were constructed according to Pineau et al. (2009) [20] to identify the dominant attributes, emotions, and memories at specific time points during the TDS test. The binomial approach was used to determine the level of significance according to Pineau et al. (2009) [20]:

$$Ps = Po + 1.645\sqrt{\frac{Po\ (1 - Po)}{n}}$$

where P is the lowest significant proportion value at some point in time on the curve for TDS; $Po = 1/p$, where p is the number of sensory attributes, emotions, and memories; and n is the number of consumers. TDS data were organized into a matrix ($J * I * E$) K, where J = 3 samples, I = 100 consumers, E = three storage times, and K = 8 (attributes, emotions or memories) = 2400 data points. An ANOVA and Cochran's Q test were performed with the software XLSTAT version 2020 [36]. TDS curves were generated using SensoMaker version 1.92 [39].

3. Results and Discussion

3.1. Static Sensory Techniques: Sensory and Cognitive Profile

The results of the two-way ANOVA with interaction applied to the sensory data are shown in Table 3 (Table S1). It was observed that for the sample factor and the interaction (sample * day), no significant differences ($p > 0.05$) were found in any sensory attribute evaluated. In the case of the storage day factor, it was observed that all sensory attributes, with the exception of Burnt-A, were significant ($p < 0.05$).

Table 3. Probability values of the two-way ANOVA model with interaction.

Attribute	Sample *p*-Value	Day *p*-Value	Sample * Day *p*-Value	Attribute	Sample *p*-Value	Day *p*-Value	Sample * Day *p*-Value
Sweet-BT	0.90	<0.0001	0.72	Chayote-A	0.708	0.010	0.77
Chayote-F	0.45	<0.0001	0.85	Oil-A	0.723	<0.0001	0.93
Oil-F	0.19	<0.0001	0.72	Burnt-A	0.885	0.626	0.94
Salty-BT	0.88	<0.0001	0.57	Sweet-A	0.588	0.010	1.00
Crunchy	0.46	<0.0001	0.93	Potato-A	0.435	<0.0001	0.91
Bitter-BT	0.08	0.010	0.94	Fried-A	0.613	<0.0001	0.99
Potato-F	0.76	<0.0001	0.84	Toasted-A	0.622	<0.0001	0.74
Rancid-F	0.92	<0.0001	0.85	Rancid-A	0.822	<0.0001	0.77

BT = basic taste; F = flavor; A = aroma.

Figure 1 presents the sensory profile obtained using the RATA technique. The confidence ellipses (95%) indicate that the chayote chip samples were perceived as different depending on the day of storage (Figure 1A). For example, the chayote chip samples with 0 days of storage were determined to have high intensities in Bitter-BT, Fried-A, Sweet-A, Potato-A, Toasted-A, Chayote-A, Potato-F, Crunchy, Chayote-F, and Sweet-BT (Figure 1B). However, samples with storage days of 30 and 60 days were perceived as samples with high intensities of Oil-F, Rancid-F (flavor and aroma), and Salty-BT (Figure 1B). The predominance of the chayote aroma and sweet taste attributes could be explained by the presence or increase in volatile organic compounds with sweet and herbal notes, which enhance these sensory perceptions [40].

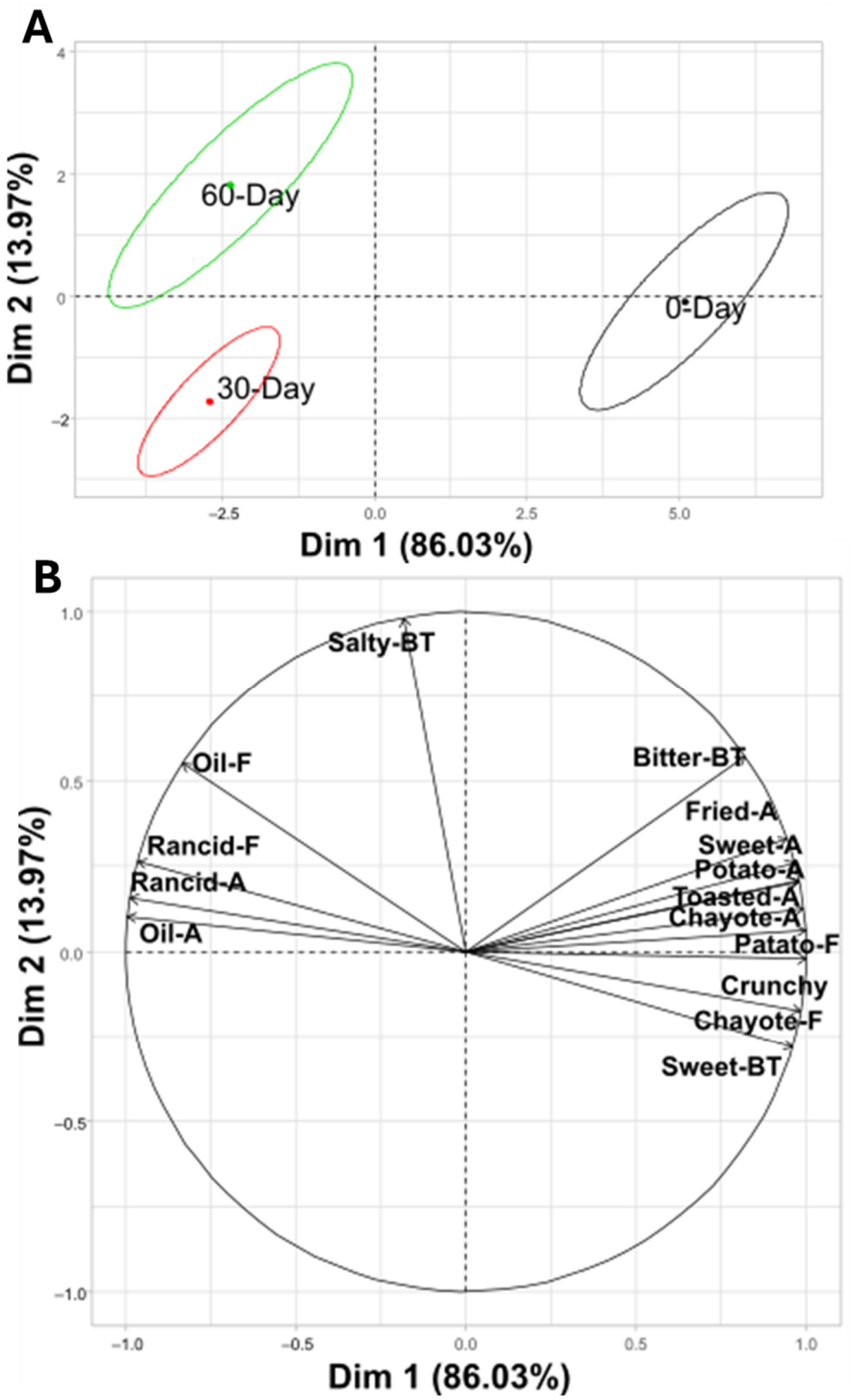

Figure 1. Sensory profile via the Rate-All-That-Apply technique; (**A**) 95% confidence ellipses; (**B**) sensory attributes ($p < 0.05$). 0 = 0 days of storage; 30 = 30 days of storage; 60 = 60 days of storage.

The Cochran Q test probability values for the emotion profile are shown in Table 4. It shows that 15 emotions (eight positive emotions and seven negative emotions) were significantly evoked ($p < 0.05$) in consumers. These results are consistent with previous studies [41], which evaluated potato chips prepared with different oils and reported that the samples made with 100% vegetable oil were associated with positive emotions such as satisfied, calm, happy, well, and enthusiastic. In the case of memories, only 13 memories (seven positive and six negative) were significantly evoked ($p < 0.05$) in consumers. The number of emotions and memories evoked ($p < 0.05$) allowed the samples to be differ-

entiated based on the day of storage, which was formed by the 95% confidence ellipse technique (Figure 2).

Table 4. Probability values of the Cochran Q test of the cognitive profile.

Emotion	*p*-Value	Emotion	*p*-Value	Memory	*p*-Value	Memory	*p*-Value
Active	<0.0001	Satisfied	<0.0001	Traditional food	<0.0001	Cold weather	0.47
Adventurous	0.26	Secure	0.65	Party	<0.0001	Hot weather	0.95
Calm	0.83	Tame	0.26	Family	<0.0001	Mild weather	0.007
Enthusiastic	<0.0001	Understanding	0.41	Birthplace	0.89	Disease (-)	<0.0001
Fres	<0.0001	Warm	0.58	Childhood	0.93	Pain (-)	0.03
Good	<0.0001	Aggressive (-)	<0.0001	Friendship	0.89	Hurt (-)	0.61
Good nature	<0.0001	Bored (-)	<0.0001	Sport	<0.0001	Obesity (-)	<0.0001
Happy	<0.0001	Disgusted (-)	<0.0001	Alive	0.65	Stench (-)	<0.0001
Interested	0.002	Guilty (-)	<0.0001	Gift	0.54	Addiction (-)	0.004
Joyful	1	Nostalgic (-)	<0.0001	Spring	<0.0001	Poverty (-)	0.84
Loving	0.42	Wild (-)	<0.0001	Fall	0.36	Death (-)	0.002
Mild	0.13	Worried (-)	<0.0001	Summer	0.002	Interpersonal conflict (-)	0.58
Pleasant	0.69			Winter	0.44	Accident (-)	0.83
				Rainy weather	0.03		

(-) Negative emotion or negative memory.

The ellipses for emotions and memories revealed that the chayote chip samples with 0 days of storage were differentiated from the rest of the samples with 30 and 60 days of storage (Figure 2A,C). In the case of emotions, the chayote chip samples with 0 days of storage evoked only positive emotions (active, enthusiastic, free, good, good nature, happy, interested, and satisfied), and the chayote chip samples from 30 and 60 days of storage evoked negative emotions (aggressive, bored, disgusted, guilty, nostalgic, wild, and worried) (Figure 2B). This finding highlights that storage strongly compromises consumer acceptance by generating negative emotional responses. This same trend was observed in the case of memories, where samples of chayote chips with 0 days of storage evoked positive memories (traditional food, family, summer, party, and mild weather) compared to samples with 30 and 60 days of storage, where mostly negative memories were evoked (pain, death, stench, obesity, addiction, and disease) and only two positive memories were evoked (rainy weather and sport).

Both the positive and negative emotions and memories found in this research have also been identified in various products such as honey, with different degrees of adulteration [42–47].

3.2. Liking Determination and Analysis of Chayote Chip Consumption in Real Time

The results of the two-factor ANOVA (sample and storage day) with interaction (sample * storage day) are shown in Table 5. It is observed that only the storage day factor was significant ($p < 0.0001$), in which it is observed that the chayote chip samples with 0 days of storage had the highest preference values (6.1 ± 0.07), placing them in the region of the hedonic scale "I like it slightly" compared to the samples stored for 30 and 60 days. which reached similar average scores (2.8 and 2.6, respectively) and which were located near the region on the hedonic scale that indicates "I dislike it moderately". The decrease in acceptability of the samples stored for 30 and 60 days can be explained by the increase in hydroperoxides, which contribute to the formation of undesirable flavors such as rancidity caused by aldehydes and ketones [48,49]. Based on the aforementioned results, the TDS curves were analyzed based on the storage day factor and time analysis during the real-time test. The probability results of the ANOVA of the aforementioned factors are shown in Table 6. It can be observed that in all attributes, emotions and memories were

highly significant ($p < 0.0001$), indicating that consumers perceived significant differences in attributes and evoked different emotions and memories during the real-time test.

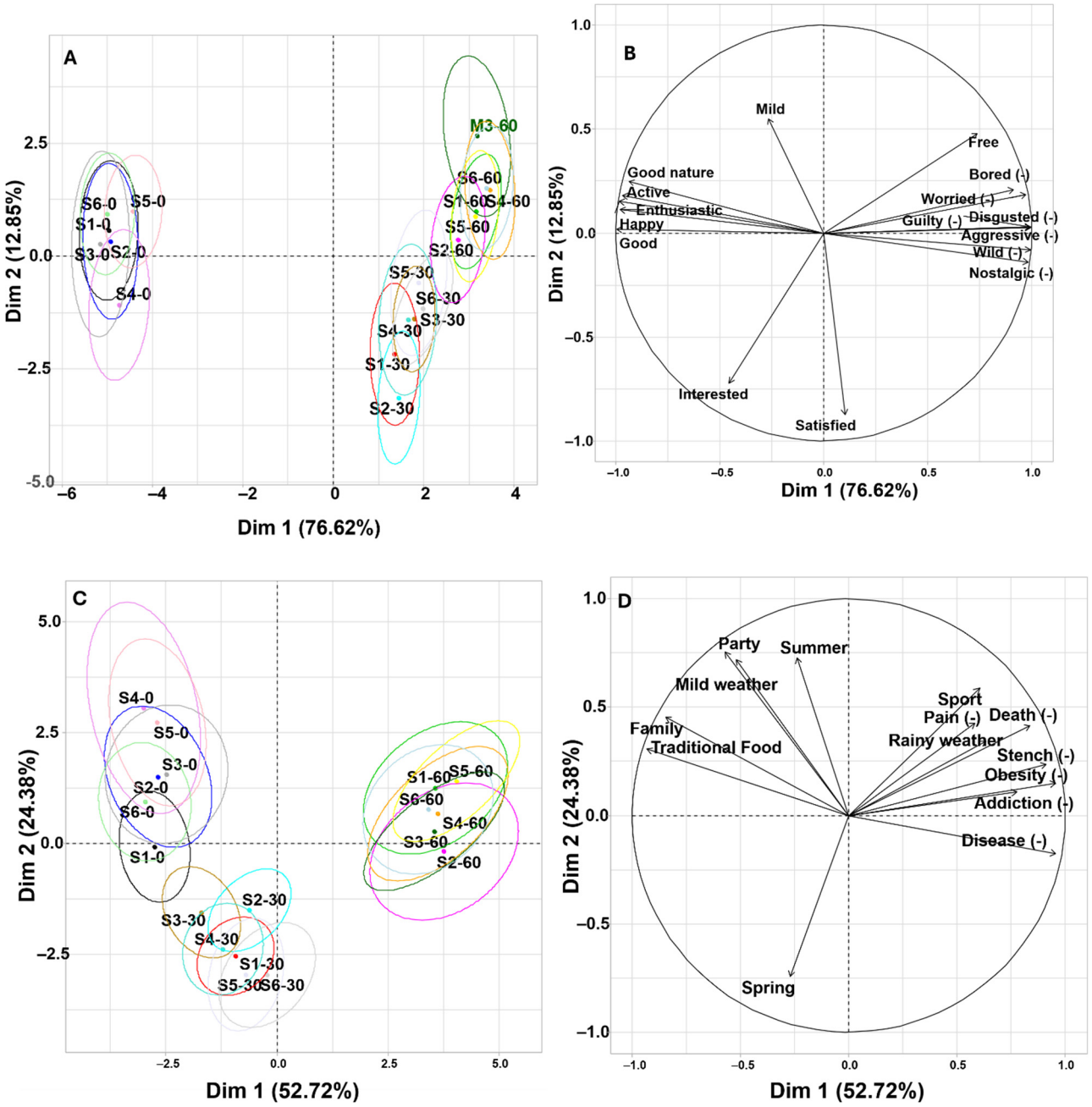

Figure 2. Cognitive profile. (**A**) Confidence ellipses (95%) with emotion data. (**B**) Significant emotions ($p < 0.05$). (**C**) Confidence ellipses (95%) with memory data. (**D**) Significant memories ($p < 0.05$). (-) Negative emotion or negative memory. S1-0 = 140 °C with 5 S of frying and 0 days of storage; S2-0 = 150 °C with 5 S of frying and 0 days of storage; S3-0 = 160 °C with 5 S of frying and 0 days of storage; S4-0 = 140 °C with 10 S of frying and 0 days of storage; S5-0 = 150 °C with 10 S of frying and 0 days of storage; S6-0 = 160 °C with 10 S of frying and 0 days of storage; S1-30 = 140 °C with 5 S of frying and 30 days of storage; S2-30 = 150 °C with 5 S of frying and 30 days of storage; S3-30 = 160 °C with 5 S of frying and 30 days of storage; S4-30 = 140 °C with 10 S of frying and 30 days of storage; S5-30 = 150 °C with 10 S of frying and 30 days of storage; S6-30 = 160 °C with 10 S of frying and 30 days of storage; S1-60 = 140 °C with 5 S of frying and 60 days of storage; S2-60 = 150 °C with 5 S of frying and 60 days of storage; S3-60 = 160 °C with 5 s of frying and 60 s of storage; S4-60 = 140 °C with 10 s of frying and 60 s of storage; S5-60 = 150 °C with 10 s of frying and 60 s of storage; S6-60 = 160 °C with 10 s of frying and 60 s of storage.

Table 5. Average (mean ± SD) values and probability of the two-way ANOVA with interaction for the preference data.

Factor: Sample (*p*-Value = 0.19)		**Interaction (Sample * Day) *p*-Value = 0.18**			
S1	4.11 ± 0.10 [a]	0 * S1	6.46 ± 0.18 [a]	30 * S5	3.0 ± 0.18 [a]
S2	3.9 ± 0.10 [a]	0 * S2	6.23 ± 0.18 [a]	30 * S6	3.0 ± 0.18 [a]
S3	3.7 ± 0.10 [a]	0 * S3	6.3 ± 0.18 [a]	60 * S1	3.1 ± 0.18 [a]
S4	3.8 ± 0.10 [a]	0 * S4	6.0 ± 0.18 [a]	60 * S2	2.5 ± 0.18 [a]
S5	3.8 ± 0.10 [a]	0 * S5	6.0 ± 0.18 [a]	60 * S3	2.4 ± 0.18 [a]
S6	3.9 ± 0.10 [a]	0 * S6	6.2 ± 0.18 [a]	60 * S4	2.7 ± 0.18 [a]
Factor: Day (*p*-Value ≤ 0.0001)		30 * S1	2.7 ± 0.18 [a]	60 * S5	2.5 ± 0.18 [a]
0 days	6.1 ± 0.07 [a]	30 * S2	2.9 ± 0.18 [a]	60 * S6	2.5 ± 0.18 [a]
30 days	2.8 ± 0.07 [b]	30 * S3	2.5 ± 0.18 [a]		
60 days	2.6 ± 0.07 [b]	30 * S4	2.6 ± 0.18 [a]		

± = standard error; different letters in the column and by factor indicate significant differences ($p < 0.05$); S = sample.

Table 6. Probability values of the two-way ANOVA with interaction for TDS data.

Attribute	**Day**	**Time (s)**	**Memory**	**Day**	**Time (s)**	**Emotion**	**Day**	**Time (s)**
Chayote	<0.0001	<0.0001	Childhood	<0.0001	<0.0001	Happy	<0.0001	<0.0001
Oil	<0.0001	<0.0001	Traditional food	<0.0001	<0.0001	Good	<0.0001	<0.0001
Burnt	<0.0001	<0.0001	Friendship	<0.0001	<0.0001	Satisfied	<0.0001	<0.0001
Sweet	<0.0001	<0.0001	Rainy weather	<0.0001	<0.0001	Pleasant	<0.0001	<0.0001
Potato	<0.0001	<0.0001	Obesity	<0.0001	<0.0001	Disgusted	<0.0001	<0.0001
Fried	<0.0001	<0.0001	Stench	<0.0001	<0.0001	Bored	<0.0001	<0.0001
Rancid	<0.0001	<0.0001	Interpersonal conflict	<0.0001	<0.0001	Nostalgic	<0.0001	<0.0001
Toasted	<0.0001	0.001	Poverty	<0.0001	<0.0001	Worried	<0.0001	<0.0001

Figure 3 shows the TDS curves for the case of sensory attributes, where it is observed that for samples with 0 days of storage (Figure 3A), the dominant attributes were chayote flavor, sweet, and fried, which began to be perceived after five seconds until the end of the test (t = 20 s). In the case of the samples with 30 days of storage (Figure 3B), it was possible to identify that the dominant attributes were chayote flavor, oil, rancid, and fried, in which the chayote flavor was perceived as dominant from t = 5 s to t = 15 s. The oil flavor was initially perceived at t = 5 s until the end of the test (t = 20 s), while the rancid flavor was perceived at t = 7 s and increased its dominance and remained constant throughout the test. The fried flavor was dominant from t = 15 s until the end of the test (t = 20 s). However, the dominant attribute perceived in the samples with 60 days of storage (Figure 3B) was rancid flavor, which emerged at t = 7 s and persisted until the end of the test (t = 20 s).

Figure 4 shows the TDS curves for the case of emotions. It is observed that the samples with storage times of 0 days (Figure 4A) evoked the positive emotion good from t = 8 s until the end, and the positive emotions satisfied and happy were evoked from t = 12 s until the end of the test (t = 20 s). Samples with 30 days of storage time (Figure 4B) evoked dominant negative emotions such as disgusted (t = 6 s to t = 20 s) and bored (t = 11 s to t = 20 s), and samples with 60 days of storage (Figure 4C) evoked the aforementioned negative emotions, but their evocation time was longer because it started at t = 3 s until the end of the test at t = 20 s.

The TDS curves for the evocation of memories are shown in Figure 5. It is observed that the samples with 0 days of storage (Figure 5A) evoked positive memories such as childhood (t = 9 s to t = 20 s), traditional food (t = 11 s to t = 20 s), and friendship as dominant (t = 11 s to t = 20 s). However, samples with 30 days of storage (Figure 5B) still evoked the positive memories of traditional food (t = 6 s to t = 20 s) and childhood (t = 15 s to t = 20 s) as dominant, but the samples were also associated with the negative memory of obesity (t = 15 s to t = 20 s). Samples with 60 days of storage (Figure 5C), although they

continued to evoke the positive memories of traditional food and childhood (t = 7 s to t = 20 s), initially evoked the negative memory of stench (t = 6 s to t = 12 s).

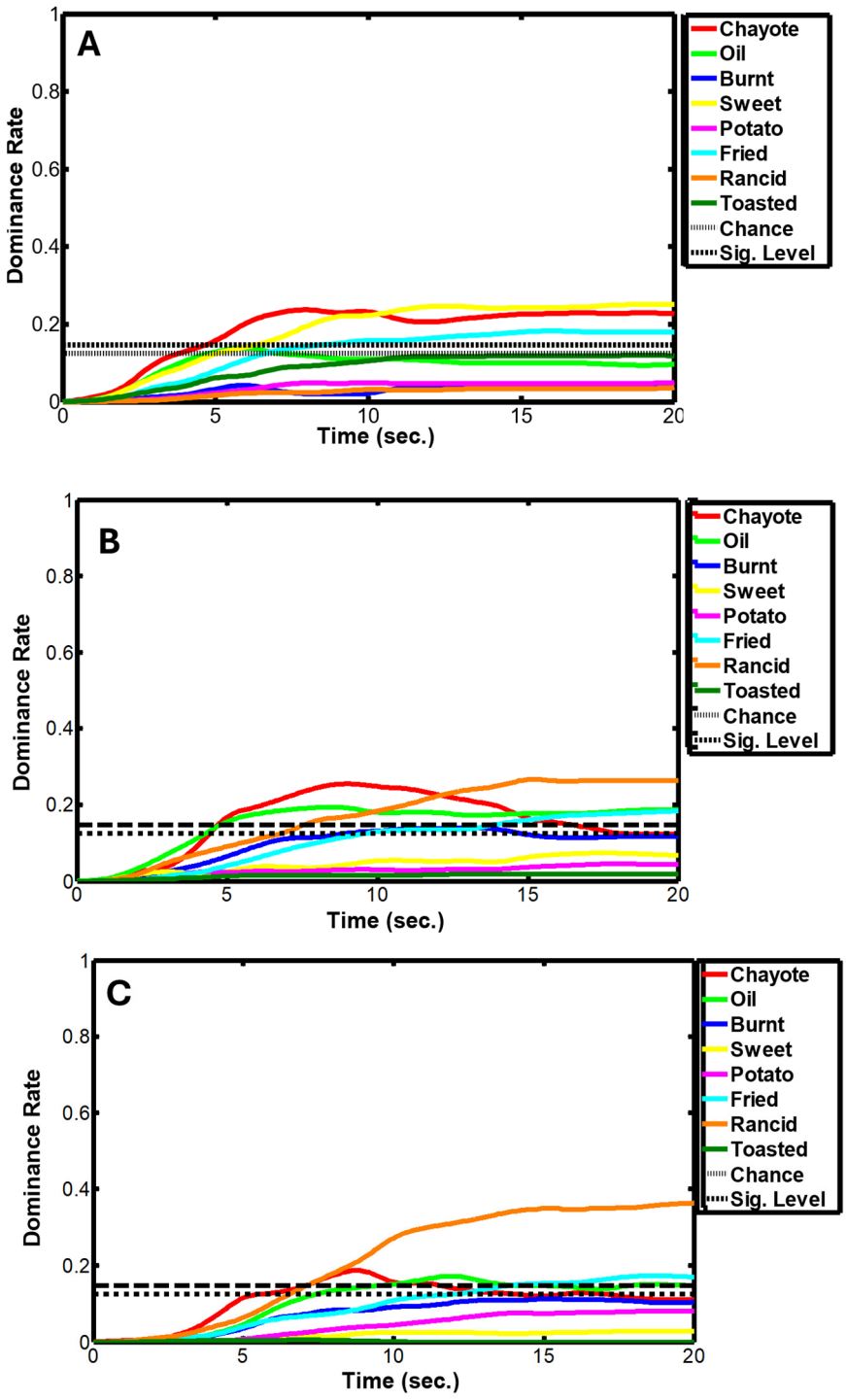

Figure 3. TDS curves for sensory attributes (100 consumers * 3 samples * 3 storage times = 1800 data points). (**A**) Samples stored for 0 days; (**B**) samples stored for 30 days; (**C**) samples stored for 60 days. The first dotted line (bottom up) indicates the dominance rate that an attribute may have by chance, and the second dotted line indicates the "significance level", which is the minimum value to which the dominance rate must be equal to be considered significant [20].

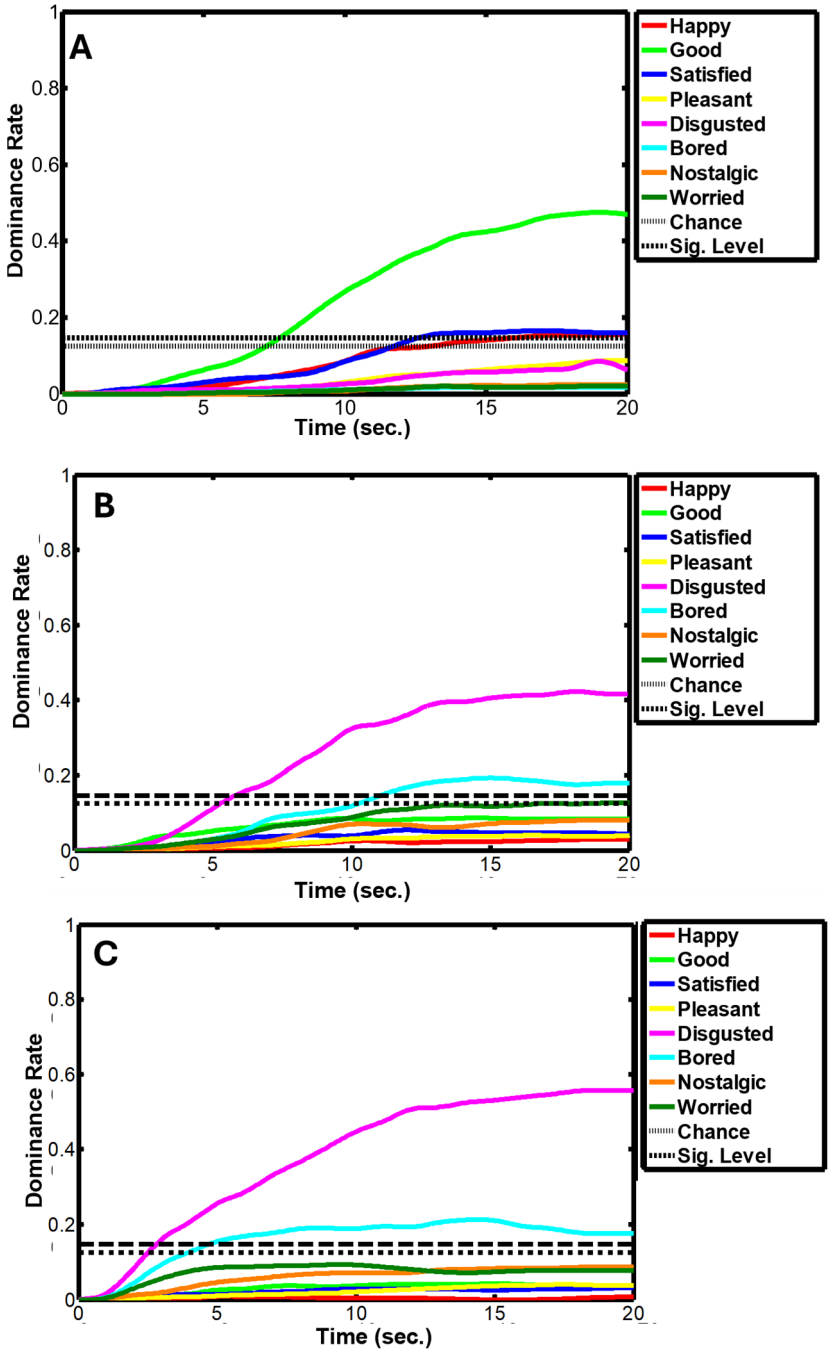

Figure 4. TDS curves for emotions (100 consumers * 6 samples * 3 storage times = 1800 data points). (**A**) Samples stored for 0 days; (**B**) samples stored for 30 days; (**C**) samples stored for 60 days. The first dotted line (bottom up) indicates the dominance rate that an attribute may have by chance, and the second dotted line indicates the "significance level", which is the minimum value to which the dominance rate must be equal to be considered significant [20].

In general, the following several aspects could be identified with both types of sensometric techniques: (1) only the storage day factor had a significant effect on the intensity and evocation of emotions, memories, and consumer preference; (2) chips with more storage days showed the generation of sensory attributes that can be considered negative and that are related to oil, fat, and rancidity; and (3) in the cognitive aspect, it could be identified that consumers evoked only positive emotions and memories, as well as high preference values only in samples with 0 days of storage.

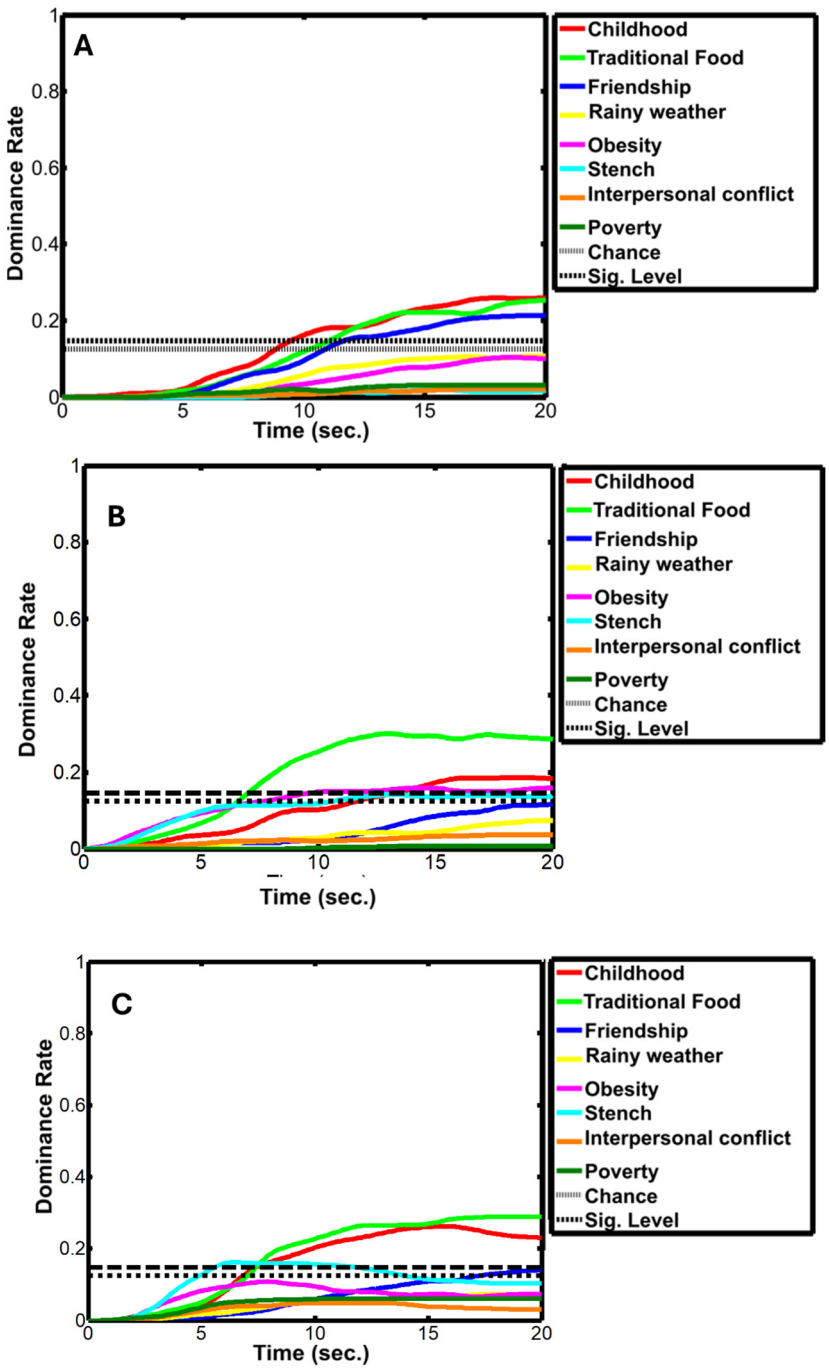

Figure 5. TDS curves for memories (100 consumers * 6 samples * 3 storage times = 1800 data points). (**A**) Samples stored for 0 days; (**B**) samples stored for 30 days; (**C**) samples stored for 60 days. The first dotted line (bottom up) indicates the dominance rate that an attribute may have by chance, and the second dotted line indicates the "significance level", which is the minimum value to which the dominance rate must be equal to be considered significant [20].

Research Limitations

This research presents the findings of the use of sensometric techniques to study the impact of the production process and storage time of chayote chips. However, further research should be performed involving the use of analytical techniques such as chromatography, Fourier transform infrared spectroscopy (FTIR), and inductively coupled plasma atomic emission spectroscopy (ICP-OES), among others, to determine the volatile compounds, fingerprint, and mineral content that may be present in this food. Conducting further research on the nutritional aspects (proximate profile, minerals, lipid profile) of

the samples and their impact on consumer health is crucial. Likewise, research should be involved that allows for establishing relationships between agronomic management and environmental aspects in the quality of the chayote used for the production of this snack.

4. Conclusions

The use of sensometric techniques allowed us to analyze the impact of the manufacturing process factors and the storage time. This led us to conclude that the storage time was the only factor that influenced the sensory, cognitive, and preference reactions. It was observed that samples prepared on the same day were perceived with high intensities of typical attributes of this type of food (Bitter-BT, Fried-A, Sweet-A, Potato-A, Toasted-A, Chayote-A, Potato-F, Crunchy, Chayote-F, and Sweet-BT), while they evoke only positive emotions and memories in chip consumers (active, enthusiastic, free, good, good nature, happy, interested, satisfied, traditional food, family, summer, party, and mild weather). In terms of preference, consumers chose the chip samples with 0 days of storage and in this sense, it is also concluded that with the TDS curves, it was possible to show that the dominant attributes of the chayote chips with 0 days of storage were chayote flavor, sweet, and fried, and its dominance starts at five seconds until the end of the test (t = 20 s). For the cognitive aspect, these chayote chips evoke positive dominant emotions (good, satisfied, and happy from t = 8 s until the end of the test) as well as positive dominant memories of childhood (t = 9 s to t = 20 s), including traditional food (t = 11 s to t = 20 s) and friendship (t = 11 s to t = 20 s). The results from CATA and TDS highlight the key sensory attributes that drive consumer preference. This information can help the food industry optimize product formulations and storage to better meet consumer expectations and improve market acceptance. These findings provide practical implications for sensory scientists, food technologists, and the agro-industrial sector.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/pr13093023/s1, Table S1: F-test values and probabilities for the factors sample, day, and sample × day interaction.

Author Contributions: Conceptualization, A.C.-P., R.I.C.-Z. and A.L.P.-M.; methodology A.C.-P., A.L.P.-M., R.I.C.-Z., L.S.-A., V.M.H.-M., L.G.R.-C., G.H.-Z. and E.M.G.-G.; software, A.C.-P., A.L.P.-M., L.S.-A., V.M.H.-M. and R.I.C.-Z.; validation, L.S.-A., V.M.H.-M., L.G.R.-C., S.I.C.-M. and A.L.-A.; formal analysis, L.G.R.-C., V.M.H.-M., E.M.G.-G., S.I.C.-M., A.L.-A., J.M.S.-O. and O.S.-V.; investigation, A.C.-P., A.L.P.-M., L.G.R.-C., R.I.C.-Z. and L.S.-A.; resources, L.G.R.-C., V.M.H.-M., S.I.C.-M., A.L.-A., J.M.S.-O., G.H.-Z., E.M.G.-G. and O.S.-V.; data curation, L.S.-A., L.G.R.-C., G.H.-Z., E.M.G.-G., S.I.C.-M., A.L.-A. and J.M.S.-O.; writing—original draft preparation, A.C.-P., R.I.C.-Z. and A.L.P.-M.; writing—review and editing, A.C.-P., R.I.C.-Z. and L.S.-A.; visualization, O.S.-V., G.H.-Z. and E.M.G.-G.; supervision, A.C.-P., A.L.P.-M. and R.I.C.-Z.; project administration, A.C.-P. and A.L.P.-M.; funding acquisition, A.C.-P. and A.L.P.-M. All authors have read and agreed to the published version of the manuscript.

Funding: This research and development was financed through resources from the Convocatoria Proyectos de Investigación Científica, Desarrollo Tecnológico e Innovación 2025 under code 22661.25-PD (entitled Deshidratación del chayote para la elaboración de un snack saludable: impacto del tiempo de almacenamiento en las propiedades sensoriales-cognitivas y su aporte a la soberanía alimentaria) of the Tecnológico Nacional de México.

Data Availability Statement: Data is not available.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Ramírez-Rodas, Y.C.; Arévalo-Galarza, M.d.L.; Cadena-Iñiguez, J.; Soto-Hernández, R.M.; Peña-Valdivia, C.B.; Guerrero-Analco, J.A. Chayote Fruit (*Sechium edule* var. *virens levis*) Development and the Effect of Growth Regulators on Seed Germination. *Plants* **2023**, *12*, 108. [CrossRef]
2. Servicio de Información Agroalimentaria y Pesquera. Cierre de la Producción Agrícola por Estado. Available online: https://nube.agricultura.gob.mx/cierre_agricola/ (accessed on 17 July 2025).
3. Vieira, E.F.; Pinho, O.; Ferreira, I.M.P.L.V.O.; Delerue-Matos, C. Chayote (*Sechium edule*): A Review of Nutritional Composition, Bioactivities and Potential Applications. *Food Chem.* **2019**, *275*, 557–568. [CrossRef]
4. INFOBAE. ¿Por qué Subió de Precio el Chayote? Así se Vende por Kilo en Mercados de México. Available online: https://www.infobae.com/mexico/2024/06/25/por-que-subio-de-precio-el-chayote-asi-se-vende-por-kilo-en-mercados-de-mexico/ (accessed on 6 August 2025).
5. Cadena-Iñiguez, J.; Cisneros-Solano, V.M.; Aguíñiga-Sánchez, I.; Arévalo Galarza, M.d.L.; Santiago-Osorio, E.; Soto-Hernández, R.M.; Ruiz-Posadas, L.d.M. Desarrollo y Transferencia de la Variedad vegetal de Chayote [*Sechium edule* (*Jacq*) *Sw.*] var. Amarus Sylvestris "Perla Negra". *Agro Divulg.* **2022**, *2*, 65–81.
6. Vive Saludable, Vive Feliz. Alimentación Saludable. Available online: https://web.archive.org/web/20250901014419/https://vidasaludable.gob.mx/alimentacion-saludable (accessed on 3 September 2025).
7. Secretaria de Salud. Peligro: Alimentos Ultraprocesados. Available online: https://web.archive.org/web/20250903191831/https://www.gob.mx/promosalud/articulos/peligro-alimentos-ultraprocesados (accessed on 3 September 2025).
8. Heidari-Beni, M.; Golshahi, J.; Esmaillzadeh, A.; Azadbakht, L. Potato Consumption as High Glycemic Index Food, Blood Pressure, and Body Mass Index among Iranian Adolescent Girls. *ARYA Atheroscler.* **2015**, *11*, 81–87.
9. American College of Cardiology. Eating Ultra-Processed Foods May Harm Your Health. Available online: https://www.acc.org/About-ACC/Press-Releases/2025/05/08/14/10/Eating-Ultra-Processed-Foods-May-Harm-Your-Health (accessed on 9 August 2025).
10. Swarup, S.; Ahmed, I.; Grigorova, Y.; Zeltser, R. *Metabolic Syndrome*; StatPearls Publishing: Treasure Island, FL, USA, 2024; p. 19.
11. Mehta, A.; Serventi, L.; Kumar, L.; Morton, J.D.; Torrico, D.D. Packaging, Perception, and Acceptability: A Comprehensive Exploration of Extrinsic Attributes and Consumer Behaviours in Novel Food Product Systems. *Int. J. Food Sci. Technol.* **2024**, *59*, 6725–6745. [CrossRef]
12. Lichtenstein, A.H.; Appel, L.J.; Brands, M.; Carnethon, M.; Daniels, S.; Franch, H.A.; Franklin, B.; Kris-Etherton, P.; Harris, W.S.; Howard, B.; et al. Diet and Lifestyle Recommendations Revision 2006: A Scientific Statement from the American Heart Association Nutrition Committee. *Circulation* **2006**, *114*, 82–96. [CrossRef] [PubMed]
13. Lin, L.; Allemekinders, H.; Dansby, A.; Campbell, L.; Durance-Tod, S.; Berger, A.; Jones, P.J. Evidence of health benefits of canola oil. *Nutr. Rev.* **2013**, *71*, 370–385. [CrossRef]
14. Raleng, A.; Singh, N.J.; Sarangi, P.K.; Manojkumar, P.; Wahengbam, A. Standardization of Frying Time-Temperature Strategy for Enhancing the Quality and Storability of Chayote Chips. *Appl. Food Res.* **2022**, *2*, 100167. [CrossRef]
15. Vidal, L.; Ares, G.; Hedderley, D.I.; Meyners, M.; Jaeger, S.R. Comparison of Rate-All-That-Apply (RATA) and Check-All-That-Apply (CATA) Questions across Seven Consumer Studies. *Food Qual. Prefer.* **2018**, *67*, 49–58. [CrossRef]
16. Ares, G.; Bruzzone, F.; Vidal, L.; Cadena, R.S.; Giménez, A.; Pineau, B.; Hunter, D.C.; Paisley, A.G.; Jaeger, S.R. Evaluation of a Rating-Based Variant of Check-All-That-Apply Questions: Rate-All-That-Apply (RATA). *Food Qual. Prefer.* **2014**, *36*, 87–95. [CrossRef]
17. Souza, O.L.; González-Mohino, A.; Estévez, M.; Madruga, M.S.; Ventanas, S. Emotional Response to Healthier Foods: Influence of Culture and Health Consciousness. *J. Food Sci.* **2023**, *88*, 5248–5265. [CrossRef]
18. Oliveira, D.; De Steur, H.; Lagast, S.; Gellynck, X.; Schouteten, J.J. The Impact of Calorie and Physical Activity Labelling on Consumer's Emo-Sensory Perceptions and Food Choices. *Food Res. Int.* **2020**, *133*, 109166. [CrossRef]
19. Yañez, G.; Sotera, T.; Rodriguez, A. Evaluación de La Aceptabilidad de Chips de Pepino Orgánico: Estudio de Mercado y Análisis Sensorial. *Rev. Investig. Agropecu.* **2022**, *48*, 160–166.
20. Pineau, N.; Schlich, P.; Cordelle, S.; Mathonnière, C.; Issanchou, S.; Imbert, A.; Rogeaux, M.; Etiévant, P.; Köster, E. Temporal Dominance of Sensations: Construction of the TDS Curves and Comparison with Time-Intensity. *Food Qual. Prefer.* **2009**, *20*, 450–455. [CrossRef]
21. Nestrud, M.A.; Meiselman, H.L.; King, S.C.; Lesher, L.L.; Cardello, A.V. Development of EsSense25, a Shorter Version of the EsSense Profile®. *Food Qual. Prefer.* **2016**, *48*, 107–117. [CrossRef]
22. Cabal-Prieto, A.; Teodoro-Bernabé, G.; Coria-Rincón, C.; Sánchez-Arellano, L.; Ramón-Canul, L.G.; Rodríguez-Miranda, J.; Prinyawiwatkul, W.; Juárez-Barrientos, J.M.; Herrera-Corredor, J.A.; Ramírez-Rivera, E.D.J. Development of a Memories Vocabulary (MemVOC) for Food Products Using Coffee as Model. *Food Sci. Technol.* **2022**, *42*, e44221. [CrossRef]

23. Jiang, Y.; King, J.M.; Prinyawiwatkul, W. A Review of Measurement and Relationships between Food, Eating Behavior and Emotion. *Trends Food Sci. Technol.* **2014**, *36*, 15–28. [CrossRef]
24. Ramappa, D.; Kumar, V.K.; GV, M.K.; Kumargouda, V.; Hallad, S.C.; Aruna, T.N.; Ravi, Y.; Murali, P. Standardization of Vacuum Frying Techniques for the Development of Low-Fat Beetroot Finger Chips. *Food Humanit.* **2024**, *3*, 100424. [CrossRef]
25. Tizhe, L.J.; Bhuiyan, M.d.H.R.; Ngadi, M. Advancements in Rapid and Non-Destructive Approaches for Quality Assessment of Fried Foods and Frying Oil. *J. Food Compos. Anal.* **2025**, *145*, 107839. [CrossRef]
26. Mam, S.; Rudra, S.G.; Kundu, A.; Singh, S.; Joshi, A.; Bhardwaj, R.; Kumar, D. Crisps from Red Cabbage: Process Standardization for Nutrients Retention. *Food Humanit.* **2025**, *4*, 100555. [CrossRef]
27. *ISO 8586-1*; Sensory Analysis—General Guidance for the Selection, Training, and Monitoring of Assessors, Part 1—Selected Assessors. International Organization for Standardization: Geneva, Switzerland, 1993.
28. *ISO 11035*; Analyse Sensorielle—Recherche et Sélection de Descripteurs pour L'élaboration d'un Profil Sensoriel par Approche Multidimensionnelle. International Organization for Standardization: Saint-Denis, France, 1994.
29. Thuillier, B.; Valentin, D.; Marchal, R.; Dacremont, C. Pivot© Profile: A New Descriptive Method Based on Free Description. *Food Qual. Prefer.* **2015**, *36*, 15–28. [CrossRef]
30. Miraballes, M.; Hodos, N.; Gámbaro, A. Application of a Pivot Profile Variant Using CATA Questions in the Development of a Whey-Based Fermented Beverage. *Beverages* **2018**, *4*, 11. [CrossRef]
31. Rios-Mera, J.D.; Saldaña, E.; Cruzado-Bravo, M.L.M.; Patinho, I.; Selani, M.M.; Valentin, D.; Contreras-Castillo, C.J. Reducing the Sodium Content without Modifying the Quality of Beef Burgers by Adding Micronized Salt. *Food Res. Int.* **2019**, *121*, 288–295. [CrossRef] [PubMed]
32. Pearson, W.; Schmidtke, L.; Francis, I.L.; Blackman, J.W. An Investigation of the Pivot© Profile Sensory Analysis Method Using Wine Experts: Comparison with Descriptive Analysis and Results from Two Expert Panels. *Food Qual. Prefer.* **2020**, *83*, 103858. [CrossRef]
33. Jaeger, S.R.; Cardello, A.V. Direct and indirect hedonic scaling methods: A comparison of the labeled affective magnitude (LAM) scale and best-worst scaling. *Food Qual. Prefer.* **2009**, *20*, 249–258. [CrossRef]
34. Santiago-Cruz, I.A.; Ramirez-Rivera, E.J.; Lopez-Espindola, M.; Hidalgo-Contreras, J.V.; Prinyawiwatkul, W.; Herrera-Corredor, J.A. Use of online questionnaires to identify emotions elicited by different types of corn tortilla in consumers of different gender and age. *J. Sens. Stud.* **2021**, *36*, e12638. [CrossRef]
35. Macfie, H.J.; Bratchell, N.; Greenhoff, K.; Vallis, L.V. Designs to balance the effect of order of presentation and first-order carry-over effects in hall tests. *J. Sens. Stud.* **1989**, *4*, 129–148. [CrossRef]
36. Addinsoft. XLSTAT Statistial and Data Analysis Solution. Available online: https://www.xlstat.com (accessed on 15 March 2025).
37. Ramírez-Rivera, E.d.J.; Díaz-Rivera, P.; Guadalupe Ramón-Canul, L.; Juárez-Barrientos, J.M.; Rodríguez-Miranda, J.; Herman-Lara, E.; Prinyawiwatkul, W.; Herrera-Corredor, J.A. Comparison of Performance and Quantitative Descriptive Analysis Sensory Profiling and Its Relationship to Consumer Liking between the Artisanal Cheese Producers Panel and the Descriptive Trained Panel. *J. Dairy Sci.* **2018**, *101*, 5851–5864. [CrossRef]
38. Pinheiro, A.C.M.; Nunes, C.A.; Vietoris, V. SensoMaker: A Tool for Sensorial Characterization of Food Products. *Ciência Agrotecnologia* **2013**, *37*, 199–201. [CrossRef]
39. Jariyah; Hidayat, A.W.; Munarko, H. Sensory Profile Characterization of Non-Wheat Flour Biscuits Using Rate-All That-Apply (RATA) and Emotional Sensory Mapping (ESM) Method. *Future Foods* **2024**, *9*, 100281. [CrossRef]
40. Tzompa-Sosa, D.A.; Yi, L.; van Valenberg, H.J.F.; Lakemond, C.M.M. Four Insect Oils as Food Ingredient: Physical and Chemical Characterisation of Insect Oils Obtained by an Aqueous Oil Extraction. *J. Insects Food Feed.* **2019**, *5*, 279–292. [CrossRef]
41. Tzompa-Sosa, D.A.; Dewettinck, K.; Gellynck, X.; Schouteten, J.J. Consumer Acceptance towards Potato Chips Fried in Yellow Mealworm Oil. *Food Qual. Prefer.* **2022**, *97*, 104487. [CrossRef]
42. Rodrigues, S.S.Q.; Dias, L.G.; Teixeira, A. Emerging Methods for the Evaluation of Sensory Quality of Food: Technology at Service. *Curr. Food Sci. Technol. Rep.* **2024**, *2*, 77–90. [CrossRef]
43. Varela, P. Is It the Name, or Is It the Impact? A Sensory and Consumer Science Changing with the Times. *Food Qual. Prefer.* **2025**, *129*, 105408. [CrossRef]
44. Ameca-Veneroso, C.; Sánchez-Arellano, L.; Ramón-Canul, L.G.; Herrera-Corredor, J.A.; Cuervo-Osorio, V.D.; Quetz-Aguirre, E.M.; Rodríguez-Miranda, J.; Cabal-Prieto, A.; Ramírez-Rivera, E.d.J. A Modified Version of the Sensory Pivot Technique as a Possible Tool for the Analysis of Food Adulteration: A Case of Coffee. *J. Sens. Stud.* **2021**, *36*, e12705. [CrossRef]
45. Kumar, R.; Chambers, E.; Chambers, D.H.; Lee, J. Generating New Snack Food Texture Ideas Using Sensory and Consumer Research Tools: A Case Study of the Japanese and South Korean Snack Food Markets. *Foods* **2021**, *10*, 474. [CrossRef]
46. Torrico, D.D. Novel Techniques to Measure the Sensory, Emotional, and Physiological Responses of Consumers toward Foods. *Foods* **2021**, *10*, 2620. [CrossRef]
47. Kaneko, D.; Toet, A.; Brouwer, A.M.; Kallen, V.; van Erp, J.B.F. Methods for Evaluating Emotions Evoked by Food Experiences: A Literature Review. *Front. Psychol.* **2018**, *9*, 911. [CrossRef]

48. Rababah, T.M.; Feng, H.; Yang, W.; Yücel, S. Fortification of Potato Chips with Natural Plant Extracts to Enhance Their Sensory Properties and Storage Stability. *J. Am. Oil Chem. Soc.* **2012**, *89*, 1419–1425. [CrossRef]
49. Takeungwongtrakul, S.; Benjakul, S. Oxidative Stability of Lipids from Hepatopancreas of Pacific White Shrimp (*Litopenaeus vannamei*) as Affected by Essential Oils Incorporation. *Eur. J. Lipid Sci. Technol.* **2014**, *116*, 987–995. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.