

## SENSORY ANALYSIS OF RAW AND TOASTED PECAN NUTS<sup>1</sup>

### *ANÁLISE SENSORIAL DE NOZ PECAN CRUA E TOSTADA*

**Marcelo de Carvalho Santos<sup>2</sup>, Silvana Maria Michelin Bertagnolli<sup>3</sup>,  
Neila Silvia Pereira dos Santos Richards<sup>4</sup> e Cristiana Basso<sup>5</sup>**

#### ABSTRACT

Nuts are nutritious and well-accepted by the general population, which has increased their consumption. This study analyzed the sensorial characteristics of raw and toasted pecan nuts. In the pre-preparation, the nuts were toasted in an electric oven and air fryer at 180 °C for 5 and 10 min, stirring every 2.5 min. Sensory analysis was performed using an affective acceptability test using a 9-point hedonic scale, evaluating appearance, odor, texture, and flavor attributes. A higher acceptability average was noticed for pecan nuts toasted for 5 min in the air fryer, followed by roasting for 5 min in an electric oven. However, all samples showed a satisfactory acceptability index above 70%.

**Keywords:** Acceptability, *Carya illinoensis*, Consumer preference.

#### RESUMO

*As nozes, por serem nutritivas e bem aceitas pela população em geral, têm aumentado seu consumo. O objetivo deste estudo foi analisar sensorialmente noz pecan crua e tostada. No pré-preparo as nozes foram tostadas em forno elétrico e fritadeira a ar (air fryer), ambos em temperatura de 180 °C, por 5 e 10 minutos, sendo revolvidas a cada 2,5 minutos. A análise sensorial foi realizada por teste afetivo de aceitabilidade, com uso de escala hedônica de 9 pontos, avaliando os atributos de aparência, odor, textura e sabor. Percebeu-se média de aceitabilidade superior para noz pecan tostada por 5 minutos na air fryer, seguida da tostada por 5 minutos no forno elétrico, embora todas as amostras tenham apresentado um índice de aceitabilidade satisfatório, ou seja, acima de 70%.*

**Palavras-chave:** Aceitabilidade, *Carya ilinoensis*, Preferência do consumidor.

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1 Trabalho resultante de TFG.

2 Autor, acadêmico de Nutrição da Universidade Franciscana (UFN), SM/RS/BR. ORCID: <https://orcid.org/0000-0002-8332-0610>. E-mail: [marcelocarvalho@ufn.edu.br](mailto:marcelocarvalho@ufn.edu.br)

3 Coorientadora, Doutora em Ciência e Tecnologia de Alimentos, docente da Universidade Franciscana (UFN), SM/RS/BR. ORCID: <https://orcid.org/0000-0003-4024-8505>. E-mail: [silvibert@ufn.edu.br](mailto:silvibert@ufn.edu.br)

4 Coorientadora, Doutora em Tecnologia Bioquímica Farmacêutica, docente da Universidade Federal de Santa Maria (UFSM), SM/RS/BR. ORCID: <https://orcid.org/0000-0001-6610-5567>. E-mail: [neilarichardsprof@gmail.com](mailto:neilarichardsprof@gmail.com)

5 Orientadora, Doutoranda em Ciência e Tecnologia de Alimentos, docente da Universidade Franciscana (UFN), SM/RS/BR. ORCID: <https://orcid.org/0000-0003-2001-0110>. E-mail: [cristiana@ufn.edu.br](mailto:cristiana@ufn.edu.br)

## INTRODUCTION

The pecan tree (*Carya ilinoensis*) is a species that adapts well to a temperate climate (POLETTO *et al.*, 2020), with deciduous leaves and a tall height (CARVALHO, 2021). It is widely produced and sold worldwide, especially in the United States, which produced the most pecans in 2019 (i.e., 126,000 t). In contrast, Brazil produced 3,500 t, occupying fifth place (POLMANN, 2019), with cultivation being mainly in São Paulo State, followed by Minas Gerais and Rio Grande do Sul States (RUBERT, 2021).

The market is promising and production continues to increase as it is an activity with good remuneration and diversification of the agricultural sector (SUMMIT AGRO, 2020), in addition to presenting high nutritional value and good acceptance by the population (NOGARA, 2018). Regarding its nutritional value, the pecan nut is characterized by its high lipid content (52.70-78.07%), low humidity (2.13-6.36%), relatively low carbohydrate (4.92-17.74%) and sugar content (3.27-5.31%); its fiber content can reach 15.94%, and the protein content ranges from 6.00 to 17.84% and ash content from 1.10 to 1.79% (SIEBENEICHLER *et al.*, 2023).

Ribeiro *et al.* (2020) analyzed the chemical composition of pecans of 11 cultivars produced in southern Brazil and found moisture content ranging from 4.56 to 5.50 g/100 g, ash content between 1.10 and 1.69 g/100 g, the average protein content of all cultivars was 8.0 g/100 g. However, the 'Barton' cultivar, which is the most cultivated in the region, had the highest protein content (9.26 g/100 g) and did not differ statistically ( $p > 0.05$ ) from 'Moneymaker' (9.2 g/100 g), 'Success,' and 'Chickasaw'; the average dietary fiber content was 10.8 g/100 g. As for the main constituent, lipid content ranged from 52.69 to 69.76 g/100 g, and carbohydrates ranged from 4.92 to 17.33 g/100 g.

Probably due to their chemical constitution, Costa (2011) noted that nuts can contribute to delaying premature aging and stimulate the immune system, favoring protection against heart disease and different types of cancer. They help reduce LDL cholesterol and total cholesterol, according to Tomazelli *et al.* (2013), Maciel (2021), and Barroncas (2020), decreasing triglyceride levels and the occurrence of diabetes mellitus (GROSSO *et al.*, 2015). According to Ortiz (2000), arginine present in pecan nuts, due to nitric oxide, plays the role of vasodilator, reducing fatty plaques. Linolenic acid acts by reducing heart diseases given its antithrombotic and antiarrhythmic action. Other authors also agree that an adequate lipid profile and fiber consumption reduce stroke, acute myocardial infarction, and other heart diseases (SALAS-SALVADÓ *et al.*, 2008; ESTRUCH *et al.*, 2013).

Nuts have excellent nutritional quality; they are presented in numerous ways and can be consumed raw, toasted, salted, caramelized with sugar and honey, or even as ingredients in preparations, deserving special attention in sensory analysis. According to Dutcosky (2019), the functionality and quality of a product perceived and valued by the consumer are achieved when using an appropriate sensory method. In addition to all these consumption possibilities, Santos (2020) reported that there

is a large production of waste generated due to the harvest and processing that can be used, especially the shell and broken/cracked nuts in culinary preparations such as pies, cakes, cookies, and ice cream, among others (TOMAZELLI *et al.*, 2013; MACIEL, 2021).

As for processing, this is commonly done in an air fryer or electric oven. An air fryer is an apparatus that circulates hot air at high speed, providing food with a crisp outer layer (SHAKER, 2014). It has an evenly distributed fan with hot air, minimizing temperature variations (DE FREITAS, 2019), which can be adjusted up to 200 °C (ARAÚJO *et al.*, 2021). As a result of the poor diet of the population with excessive consumption of fats and consequently increases in chronic degenerative diseases, the technology of air fryers came to try to change this perspective, not to produce toxic compounds and to preserve sensory attributes (FADAIRO, 2021). In this context, this study aimed to evaluate the acceptability of untrained tasters for raw or toasted nuts in an electric oven and air fryer.

## **METHODOLOGY**

This study was quantitative as it dealt with tests, which are instruments used to obtain data that allow measuring the performance, frequency, capacity, or behavior of individuals (LAKATOS; MARCONI, 1986). Research was performed between August and October 2022, with samples of pecan nuts kindly provided by Agroindústria Santa Leocádia Ltda (Santa Maria/RS/BR). The pecans underwent a drying process until they reached between 4 and 5% moisture content, then were stored in a cold room at a temperature of up to 10 °C until the time of analysis to delay oxidation. Samples to be toasted were placed in metal molds and toasted at 180 °C for 5 and 10 min, agitated every 2.5 min, in an electric oven and air fryer. Right after toasting, the nuts were kept at room temperature ( $\pm 23^{\circ}\text{C}$ ) to cool down, being stored in plastic pots with lids until the moment of analysis.

Sensory analysis was carried out by affective acceptability test, in which volunteers participated, composed of academics, professors, and other employees of a higher education institution, of both genders, aged between 18 and 50 years. Acceptability was performed using a hedonic scale after approval by the ethics and research committee (CAAE no. 87072418.6.0000.5346). The analysis was conducted in the laboratory of dietary technique and the sensory analysis room of a higher education institution, in individual booths, under fluorescent light, with untrained evaluators, who received five samples coded with three digits selected in the random number table (half raw nut, half roasted nut 5 min in an air fryer, half toasted nuts 10 min in an air fryer, half a nut toasted for 5 min in an electric oven, and half a nut toasted for 10 min in an electric oven), all provided at room temperature and on a white porcelain plate. The participants also received a glass of water to clean their palate sample tastings, a paper napkin, a pen, and a sensory evaluation form containing a 9-point hedonic scale, ranging from “extremely liked” to “extremely disliked”; two copies of an informed consent form was also provided.

The acceptability index (AI) was calculated according to the highest score achieved, with an average of %. According to Dutcosky (2013), the product is accepted when it exceeds the minimum of 70%. To calculate the AI of the product, we employed  $AI (\%) = A \times 100/B$ , in which A = average score obtained for the product and B = maximum score given to the product (MONTEIRO, 1984). For data analysis, data were organized in an electronic spreadsheet (Microsoft Excel®) and analyzed using the IBM SPSS® software (version 2.5). Descriptive analysis with median, mean, and standard deviation was performed. The inferential part took place with a significance level of 5% for all tests, the Shapiro-Wilk test was used to verify the prerequisite of normality, and the comparison of means was conducted using the Kruskal-Wallis test.

## RESULTS

A total of 101 volunteers participated in the sensory analysis, and one was excluded due to being over 50 years old since individuals above this age can manifest certain desensitization of the sensory organs (IAL, 2008), totaling 100 tasters. The participants were instructed to consider the attributes of appearance, odor, texture, and flavor, regardless of whether the sample was raw or roasted in different ways, and assigned scores greater than 6 (I slightly liked it) on a 9-point hedonic scale, that is, all samples were accepted (Table 1). Nevertheless, the nuts roasted for 5 min in an air fryer had the highest averages in 3 of the 4 attributes (odor, texture, and flavor), including a significant difference for odor and flavor and a higher general AI. The average of the nut sample roasted for 5 min in the electric oven did not differ significantly at 5% probability in relation to the appearance and taste of the raw nut. Only the raw pecan nut appearance attribute achieved a higher average and acceptability index than the toasted ones, unlike the raw pecan nut texture, which obtained a lower average and acceptability than the other samples.

**Table 1** - Mean (M), standard deviation (SD), significance (p), and acceptability index (AI) of raw and toasted pecan nut samples, Santa Maria, 2022.

Samples	Sensory attributes												General AI
	Appearance			Odor			Texture			Flavor			
	M (SD)	p	AI	M (SD)	p	AI	M (SD)	p	AI	M (SD)	p	AI	
Raw	7.57 ± 1.75	-	84%	6.82 ± 1.75	-	76%	6.67 ± 2.04	-	74%	6.89 ± 1.89	-	76%	75.5%
5 min air fryer	6.96 ± 1.77	0.042	77%	6.73 ± 1.60**	0.337	79%	6.93 ± 1.83*	ns	81%	6.23 ± 2.12**	0.006	83%	80%
10 min air fryer	6.40 ± 2.30	0.042	71%	6.51 ± 2.29**	0.42	75%	6.78 ± 2.31	ns	77%	6.84 ± 2.98	0.666	69%	73%
5 min electric oven	7.35 ± 1.76*	0.883	82%	6.51 ± 1.75	0.020	72%	6.78 ± 1.80	ns	75%	6.84 ± 2.94*	0.654	76%	76.25%
10 min electric oven	7.18 ± 1.94	0.882	80%	6.69 ± 1.75	0.612	74%	7.09 ± 1.59*	ns	79%	6.69 ± 1.99	0.546	74%	76.75%

Source: The authors. \*Characteristics do not differ significantly at 5% probability by the Kruskal-Wallis test. \*\*Characteristics differ significantly at 5% probability by the Kruskal-Wallis test. Ns = no significant difference.

## DISCUSSION

Given that only 5 attributes obtained values above 5% of significance, the results were reassessed, and the action taken was to add up the samples that obtained the highest means. Thus, comparing toasted nuts with raw nuts, one can observe that nuts toasted for 5 min in the air fryer was the one received the highest means, followed by those toasted for 5 min in the electric oven since the air sample fryer for 5 min received higher means for odor, texture, and flavor; in the electric oven for 5 min for appearance and flavor. Additionally, when observing the general AI, the preference is 80% for toasted nuts at 5 min in the air fryer. Magnuson *et al.* (2016) corroborate our findings; the authors tested 8 varieties of raw and toasted nuts and observed a predilection for processed ones regarding color, texture, appearance, and flavor. Likewise, Gong *et al.* (2018) concluded that roasting intensified some attributes, affecting the volatile profile of nuts. Erickson *et al.* (1994) offered 11 trained panelists samples of raw and roasted nuts under different humidities to obtain answers regarding crunchiness, aroma, and rancid flavor. They noticed that rancidity scores did not differ significantly, whether raw or roasted, although storage affected the crispness of raw and processed pecan nuts, with those stored at 65% relative humidity having lower scores than those stored at 55% humidity.

In another study, Heaton and Beucha (1980) concluded that the appearance, color, odor, texture, and flavor attributes of pecan nuts were negatively affected by high humidity, suggesting a reduction of 10% or less before submitting to refrigerated storage, coming to meet the routine of the agroindustry from which the nuts were transferred, in which the nuts have their moisture reduced to around 4%. As for the processing of nuts in the air fryer, no similar studies were found, albeit we found studies with microwaves. Jigan *et al.* (2016) subjected fresh nuts to 1, 2.5, 3, and 5 min at 650 W and then stored them at 2°C for up to 120 days. The most recommended treatment was nut exposure for 2.5 min as it significantly delayed crude protein degradation and lipid decrease compared to the untreated control, in addition to significantly inhibiting moisture loss and increasing the total soluble sugar content, maintaining the sensory quality of the fresh nut throughout the period. Zhang *et al.* (2018) suggested microwave drying, although with variable power in stages, proving to be a promising technique since water loss was effective without affecting the composition of the main nutrients and sensory quality.

## CONCLUSION

Pecans toasted for 5 min in the air fryer, followed by toasted for 5 min in an electric oven, were more acceptable. All samples showed a satisfactory acceptability index (i.e., >70%). Nonetheless, further research on the processing of nuts is suggested, especially using the air fryer, as no literature was found on the subject; in addition, physicochemical analyses should be carried out comparing raw nuts with toasted ones and comparing them with sensory analyses.

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