The Use of Edible Flowers in Human Food: Sensory Analysis of Preparations

Natália K. Simoni, Fernanda F. Santos, Thainá A. Andrade, Anna Lúcia C. H. Villavicencio and Maria Elisabeth M. Pinto-e-Silva
University of São Paulo, São Paulo, Brazil
Email: {na.simoni, santos.fernandaferreira, thatsandrade, annalucia.villavicencio, mmachadops}@gmail.com

***Abstract*—Considering edible flower's various uses in culinary, health benefits, and its low consumption, is essential to evaluate the sensorial aspects of preparations with it to verify the acceptance of these ingredients. Were used three samples of salads with leaves and flowers, which were evaluated by thirty-five volunteers who analyzed it according to hedonic characteristics and indicated their preference. Attributes as color, texture, aroma and overall aspects, in all samples, obtained scores that characterized acceptance of the preparations, while attributes as flavor showed a higher number of rejection or indifference. Between the samples analyzed, the one that presented minor rejection over flavor was the sample with higher degree of irradiation, perhaps by present sweeter flavor, because of higher irradiation exposure. This study shows that population is receptive to consume edible flowers, but it needs to improve disclosure and alternative recipes to attract the consumers.**

***Index Terms*—plants, edible, sensory evaluation, consumer behavior**

I. Introduction

In Brazil, edible flower consumption is reduced, despite of antioxidant benefits they provide, yet, with the increase on the use of these by renowned *chefs* from gastronomic market, the presence of this ingredient on menu become more common [1]-[3].

Edible flowers could be used in culinary preparations with the aim to improve color, flavor, texture and aroma; besides providing important bioactive compounds such as antioxidants, relevant for neutralizing free radicals responsible for cell oxidative stress, preventing chronic diseases, as cancer. Despite of being a factor that positively influences consumption, edible plants are still little known and consumed by population. As well as other ingredients, edible flowers requires care about sanitation, manipulation and conservation that ensure its nutritional and biological quality, among the most promising flower conservation methods stands out irradiation process, which although showing effective conservation and elimination of insects and microorganisms is a factor that could contribute to the low consumption of this ingredient [2]-[4].

Considering the various uses, health benefits and the low consumption of edible flowers, many are the alternatives that can be considered to stimulate curiosity and consumptions of this ingredient. However, it is essential to evaluate the sensorial aspects of preparations with edible flowers to verify the acceptance and rejection of these ingredients, because it is known the despite of food quality, if it does not have good acceptance in its sensorial characteristics, the food will not have a good response from consumers [5].

II. Objective

Evaluate the acceptance of preparations with edible flowers on samples from public servers, students and college's employees.

III. Methods

Were performed different recipe tests with edible flowers from the type *Bauhinia variegate* and, due to subtle mixing and visual difference almost imperceptible between the flowers and lettuce leaves, the chosen recipe for the sensorial analysis was a salad made with lettuce and flowers seasoned with lemon sauce, olive oil and salt. All the samples were made with 1 gram of each principal ingredient and half-coffee spoon of the seasoning, this technique was use to confuse the appearance of the ingredients and avoid confusion with the flavor of the flowers and the seasoning. The figure below (Fig. 1) shows the average final visual characteristic of the samples.

The flowers used in sensorial analyses were previously irradiated with gamma radiation at the Institute of Energy and Nuclear Research (IPEN/USP), with doses of 0,5 º and 1.0 ℅Gy. This method was previously tasted and its security confirmed by the researches of IPEN/USP [3].

Figure 1. Examples of the average final visual characteristic of the samples using in the analysis.

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The volunteers were invited to taste three sample of salads (according to the irradiation used on its conservation – 0.0 ℞Gray, 0.5 ℞Gray and 1.0 ℞Gray), and analyze hedonic aspects, such as color, flavor, texture and scent. All the aspect were evaluated according to a scale that varies from 1 through 9 (being one greatly dislike and nine greatly like) and by the end them all were asked to ordinate the samples according to their preference (to the sample they like less to the one the like the most).

The three samples were served to all the participants randomly, accompanied by a glass of filtered water, and the analyses occurred from 8h30 to 10h30 am, in a modulated environment with adequate light, where it was not allowed communication between participants (as it can be seen in the Fig. 2 and Fig. 3).

Figure 2. Examples of the samples served to the volunteers. The numbers were randomized by the software FizzBiosystemes®.

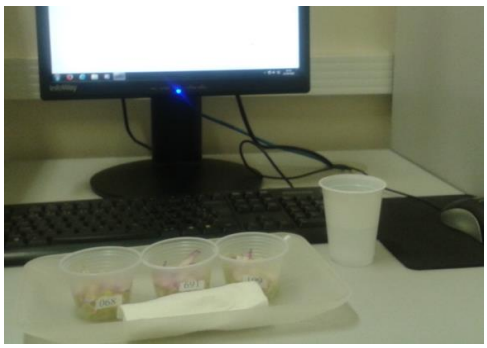

Figure 3. Image of the individual cabin used to perform the sensory analysis.

All volunteers were informed about the sample ingredients and irradiation conservation before the beginning of the test. The ones who accepted to participate were guided by a member of the sensorial analyses team, to prove the samples in the sequence presented and to drink a sip of water between one sample and another, to clean the buccal cavity and avoid any that could cause a misinterpretation. A member of sensorial analyses team stood in the local during all the experimental process to help with questions and orient all the participants similarly [6].

To accomplish the sensorial analyses, consumption acceptability and statistical analyses was used the software FizzBiosystemes®. The statistical analyses were made by comparing the averages differences between the volunteers answers (Tukey 5%). Were considered as rejection the scores below 5 (variates levels of dislike and indifferent) and as acceptance the answers with scores 6 or more.

IV. Results and Discussion

Participated of the sensorial analyses thirty-five taster volunteers, without any health problem that could compromise the experiment, such as cold, or food allergies. All the volunteers proved the three samples of lettuce and flower seasoned salad in the order they were delivered by a member of the sensorial analyses team. The individuals who participated in the experiment were mostly employees or students from the university where the study was conducted.

The sample that obtained the highest preference was the one with zero dose of irradiation (91.4% the scores of global evaluation 6 or above), the other two samples have the same scores of approval and rejection (85.7% of the scores of global evaluation 5 or less). According to the participants two aspects contributed to the higher scores in global evaluation, which were color and texture. The control sample (0.0 ℞Gy) obtained 8.6% of rejection in both aspects, while the other samples obtained 11.4% each.

Despite of the control sample achieve the higher scores on attributes of color and texture, this sample was the one with the lowest scores for flavor attribute (only 65.7% of the volunteers gave scores of acceptance, against 71.4% for the sample with 1.0 ℞Gy).

Between all hedonic aspects, the flavor was the one with higher scores of rejection. The percentage of the flavor rejection ranged 28.6% in the 1.0 ℞Gy sample to 34.29% in the control sample.

The Fig. 4-Fig. 6 shows all distribution's scores for control and irradiation samples used in the sensorial analyses (0.0, 0.5 and 1.0 ℞Gy, respectively), according to the number of participants and its score.

As it can be seen in the Fig. 4- Fig. 6, most tasters did not indicate rejection to the samples (score higher than 5 - indifferent) when analyzing attributes as color, texture and aroma. However, for the flavor attribute twelve tasters of non-irradiated sample, twelve tasters of 0.5 ℞Gy's sample and ten 1 ℞Gy's sample, indicated rejection or indifference (grades lower than 6).

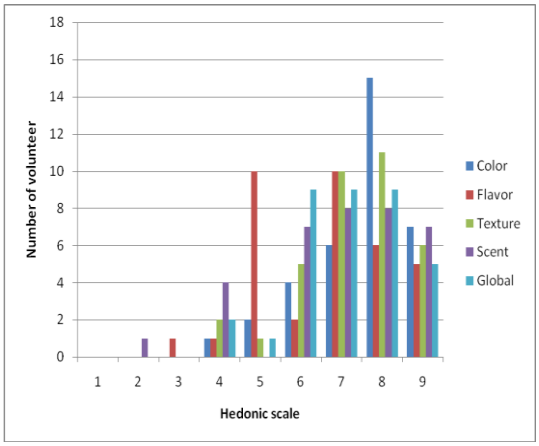

Figure 4. Tasters' scores distribution related to attributes of color, flavor, texture, scent and global assessment on a sample without irradiation.

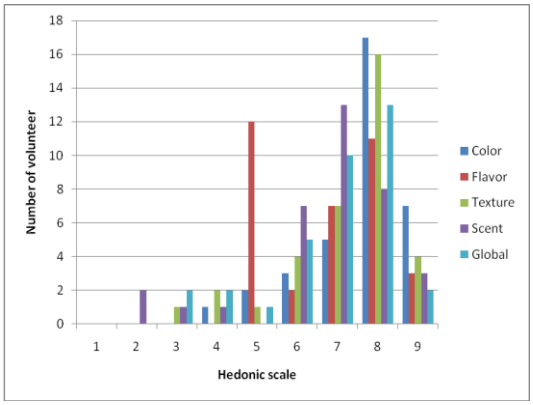

Figure 5. Tasters' scores distribution related to attributes of color, flavor, texture, scent and global assessment on a sample with 0.5 ℞Gy of irradiation.

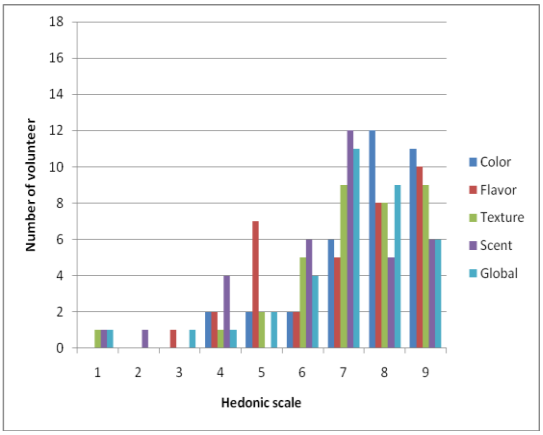

Figure 6. Tasters' scores distribution related to attributes of color, flavor, texture, scent and global assessment on a sample with 1.0 ℞Gy of irradiation.

Table I shows the comparison of averages and standards deviation of all three samples and the attributes analyzed in the experimental.

TABLE I. DISTRIBUTION AND COMPARISON OF AVERAGE AND STANDARD DEVIATION FOR THE THREE SAMPLES.

℞Gy	Color	Flavor	Texture	Scent	Global
0.0	7.51 ± 1.27 [a]	6.63 ± 1.61 [b]	7.29 ± 1.32 [a]	6.94 ± 1.75 [ab]	7.06 ± 1.33 [ab]
0.5	7.60 ± 1.24 [a]	6.74 ± 1.44 [b]	7.23 ± 1.46 [ab]	6.71 ± 1.71 [b]	6.89 ± 1.53 [b]
1.0	7.63 ± 1.44 [a]	7.06 ± 1.81 [ab]	7.23 ± 1.72 [ab]	6.66 ± 1.94 [b]	7.00 ± 1.77 [b]

Note: abc. Averages followed by distinct letters, in the same line, are significantly different (P<0.05) by Tukey test.

The table shows that the most difference between the attributes occurs specially in the two characteristics: color and flavor.

As explained by Kelley [7], the color is the most attractive attribute for flower consumption, the more colorful the flower or the dish with the flower, the bigger the chance to please the consumer. On flowers and fruits salad preparation, two flowers coloration were used, but when mixing with lettuce leaves, the white petals had become almost imperceptible to less attentive eyes. It was the researchers' choice that the flowers blend evenly into lettuce leaves to avoid the initial impact that could be cause.

Nowadays it is knew that flowers, as other food, have flavors that vary widely between species, being that the taste that pleases more the consumer taste use to be the sweet. In this study, the preparation sample that had the higher score about flavor attribute was the one that went through 1kGray irradiation. This occurs mostly likely because of the interaction between irradiation and glycosides linkages of sucrose molecules, the first breaks the molecules of the second and in the process releases glucose and fructose, which are characteristics of sweet flavor. [8], [9].

The sample preparation contained *in nature* flowers, in other words, there were no kind of cooking that could change, even slightly significantly, its chemical characteristics. This was researchers options to maintain the fundamental characteristics of the petals and avoid any degradation of bioactive components. However, care was taken when buying flowers a few days in advance, as well as manipulating the ingredients, to avoid visual differences that could be perceptible between irradiated and no irradiated flowers. In other work that also used edible flowers in common preparations, as cake, there was not the use of this manipulation strategy, once the flowers were used previously the cooking process [10]-[12].

The result of this study demonstrates that irradiated edible flowers can be a much-explored product, since there was great acceptance from tasters about hedonic attributes, with a special attention to the one with higher irradiated levels, because of its flavor. Furthermore, the presence of flowers in simple preparations as salads can aggregate flavor, texture and aroma, which make these preparations more attractive to the senses, besides health benefits.

Consume of edible flowers could be stimulated by testing and divulging diversified recipes using this ingredient.

V. CONCLUSION

This study shows that population are receptive to consume edible flowers, especially the ones with sweet flavor, what could be favored by the irradiation process. Nevertheless, it needs to improve disclosure and alternative recipes to attract the consumers who have trouble to accept new foods.

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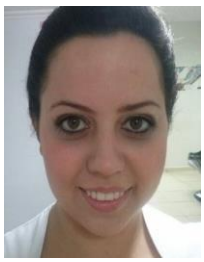
REFERENCES

[1] H. C. Voon, R. Bhat, and G. Rusul, "Flower extract and their essential oils as potential antimicrobial agents for food uses and pharmaceutical applications," *Comp. Rev. Food Sci. F.*, vol. 11, pp. 34-55, 2012.

[2] A. Koike, J. C. Barreira, L. Barros, C. Santos-Buelga, A. L. Villavicencio, and I. C. Ferreira, "Edible flowers of Viola tricolor

L. as a new functional food: Antioxidant activity, individual phenolics and effects of gamma and electron-beam irradiation," *Food Chemistry*, vol. 179, pp. 6-17, 2015.
[3] A. C. R. Koike, "Compostos bioativos em flores comestíveis processadas por radiação," Ph.D. dissertation, Instituto de Pesquisas Energéticas e Nucleares, Universidade de São Paulo, SP, 2015.
[4] A. M. Zimmermann and V. R. Kirsten, "Alimentos com função antioxidante em doenças crônicas: uma abordagem clínica," *DisciplinarumScientia Saúde*, vol. 8, no. 1, pp. 51-68, 2008.
[5] M. C. T. R Vidigal, V. P. R. Minim, N. B. Carvalho, M. P. Milagres, and A. C. A. Gonçalves, "Effect of a health claim on consumer acceptance of exotic Brazilian fruit juices: Açaí (Euterpe oleracea Mart.), Camu-camu (Myrciaria dubia), Cajá (Spondias lutea L.) and Umbu (Spondias tuberosa Arruda)," *Food Research International*, vol. 44, pp. 1988-1996, 2011.
[6] S. D. Dutcosky, *Análise Sensorial de Alimentos*, 4th. ed. Curitiba: Champagnat, 2013, ch. 2, pp. 53-59.
[7] K. M. Kelley, B. K. Behe, J. A. Biernbaum, and K. L. Poff, "Consumer preference for edible-flower color, container size, and price," *HortScience*, vol. 36, no. 4, pp. 801-804, 2001.
[8] P. Podadera and S. F. Sabato. "Estudo dos efeitos da radiação gama nas propriedades físico-químicas do açúcar líquido invertido," in *Proc. INAC–Int Nuclear Atlantic Conf.*, vol. 28, Santos, 2005.
[9] J. Mlcek and O. Rop, "Fresh edible flowers of ornamental plants–A new source of nutraceutical foods," *Trends in Food Science & Technology*, vol. 22, no. 10, pp. 561-569, 2011.
[10] M. Carocho, L. Barros, A. Bento, C. Santos-Buelga, P. Morales, and I. C. Ferreira, "Castanea sativa Mill. flowers amongst the most powerful antioxidant matrices: A phytochemical approach in decoctions and infusions," *BioMed Research International*, vol. 2014, pp. 1-7, 2014.
[11] M. Carocho, J. C. Barreira, L. Barros, A. Bento, M. Câmara, P. Morales, and I. C. Ferreira, "Traditional pastry with chestnut flowers as natural ingredients: An approach of the effects on nutritional value and chemical composition," *Journal of Food Composition and Analysis*, vol. 44, pp. 93-101, 2015.
[12] A. Koike, J. C. Barreira, L. Barros, C. Santos-Buelga, A. L. Villavicencio, and I. C. Ferreira, "Irradiation as a novel approach to improve quality of Tropaeolum majus L. flowers: Benefits in phenolic profiles and antioxidant activity," *Innovative Food Science & Emerging Technologies*, vol. 30, pp. 138-144, 2015.

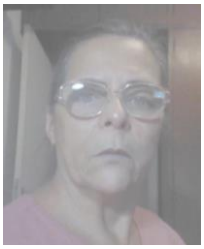


Natália K. Simoni Master student from graduate program in Nutrition and Public Health from Public Health College/USP, acting in the area of characterization, evaluation and formulation of food for nutrition and human public health. CAPES scholarship holder since June/2016. Studied improvement in Nutrition and Public Health at Public Health College (USP) and at Reference Center for the Prevention and Control of Nutrition-Related Diseases (CRNutri), acting in the area of Nutrition Education, supervising internship and groups nutritional assistance. Undergraduate's degree in Nutrition from Public Health College/USP in 2015. CNPq scholarship holder between 2011 and 2012, and FAPES between 2012 and 2013. Have experience in Clinical Nutrition area, ambulatory and Attention to Educational Groups in Nutrition.

Fernanda F. dos Santos Undergraduate student in Nutrition by Public Health College from University of São Paulo. scholarship holder from the Unified Scholarship Program of the University of São Paulo, for the project "Practical Experience in the Laboratory of Dietetic Technique", Academic Director of the Metabolic Syndrome' League of HCFMUSP.

Thainá A. Andrade Undergraduate's degree in gastronomy by Famesp, attended Technology in Gastronomy. Experience gained through internship in renowned restaurant (D.O.M Brazilian Gastronomy) where were performed many activities related to planning, preparation and finalization of the products offered by the establishment.

Anna Lúcia C.H. Villavicencio Undergraduate's degree in Biological Sciences from Santa Úrsula University (1979), Master's degree in Basic Nuclear Technology in the field of Radiobiology by the University of São Paulo, Nuclear and Energy Research Institute (1989); Doctor's degree in Food Science, Bromatology at the Faculty of Pharmaceutical Sciences of the University of São Paulo (1998) and Postdoctoral's degree in Chemistry and Biochemistry Applied from School of Agriculture of the Polytechnic Institute of Bragança, Portugal, CNPq scholarship holder (level 2). Is a full professor at IPEN / USP postgraduate program, directs and teaches disciplines in the Nuclear Technology program of the University of São Paulo (TNA-IPEN / USP), was a member of the Post-Graduation Committee of the Nuclear Technology Program (IPEN / USP, 2013-2015). Technologist of the National Nuclear Energy Commission (CNEN) and researcher at the Nuclear and Energy Research Institute (IPEN-CNEN / SP). Has developed works aiming the Peaceful Application of the use of Nuclear Technology in favor of Food Safety in Food Science and Technology area, with emphasis on Irradiated Foods Analysis, working mainly on the following topics: Food Irradiation, Detection of Irradiated Foods of animal and vegetable origin; Physical-Chemical Analysis, Biochemistry, Microbiological and Nutritional Analysis of Irradiated Foods, Evaluation and Application of Quarantine and Phytosanitary treatment in combination with the irradiation process in agricultural products; Analysis of Natural Biocompounds and Radiation Processing; Sensory Analysis of irradiated foods; Food Security and Public Acceptance Studies of Radiation Processed Foods; National and international legislation on implementation of Radiation in Food and Agricultural Products by ABNT; Detection of Transgenic Foods and Biological Effects of Radiation. Has experience in coordinating national and international projects funded by the International Atomic Energy Agency (IAEA), Vienna, Austria, on the interaction of radiation in food. Participate in commissions and short duration courses on updating the theme related to the irradiation of food and agricultural products.



Maria Elisabeth M. Pinto-e-Silva Undergraduate's degree in Nutrition by Public Health College from University of São Paulo (1975), Master's degree in Food Science from the Faculty of Pharmaceutical Sciences of the University of São Paulo (1990), Doctor degree in Public Health from the School of Public Health of the University of São Paulo (1995) and Habilitation (professorship) from School of Public Health of the University of São Paulo (2016). Nowadays is docent at the University of São Paulo. Experience in Nutrition area, with emphasis in food, acting mainly on the following topics: sensorial analyzes, food experiment, product development, dietary behavior, dietary technique and dietotherapy.