Original Article
Food Science and Technology

ISSN 0101-2061 (Print)
ISSN 1678-457X (Online)

DOI: https://doi.org/10.1590/fst.56220

Development and characterization of cookies using passion fruit from the caatinga (*Passiflora cincinnata* Mast.)

Evely Rocha LIMA[1*], Talita Batista MATOS[2], Tamires Reis de SOUSA[2], Ivan de Oliveira PEREIRA[3], Rafael PEREIRA[2], Solange Aparecida de PAULA[1], Maria Patrícia MILAGRES[1]

Abstract

The objective of this study was to use the passion fruit peel *P. cincinnata Mast*., as a viable alternative to produce food (flour and cookies) that is rich in fiber and environmentally sustainable. For this, fruit peels were obtained, which were hygienized, dehydrated and ground in a knife mill in order to develop the flour, which was then used in different concentrations in three formulations of chip cookies (using 10%, 20% and 30% of the flour developed). Analyzes physicochemical and microbiological composition were performed for both flour and for the cookies developed and a sensorial acceptance test was performed for the cookies. It was possible to observe that the flour had an adequate centesimal composition, when it was about quality and safety, as well as health benefits. As for the physicochemical composition, the flour had 5.79 ± 0.11% of ashes; 78.23 ± 0.84% of total carbohydrates; 5.78 ± 0.11% moisture; 4.83 ± 0.00% acidity; 3.74 ± 0.04 pH; 1.66 ± 0.06% lipids; 8.59 ± 0.82% protein and 58,3 g/100g dietary fiber. The study demonstrates its nutritional quality by reducing the lipid content of the final product, by comparing the formulation with 30% of the flour developed to the standard formulation, as well as increasing the ash content and acidity and reducing its pH when compared to the standard formulation, promoting the safety and quality of food. Flour presented promising capacity in the development of functional foods, health promoters, and environmental conservation by avoiding its inappropriate disposal.

Keywords: sustainable development; functional food; food safety.

Practical Application: Passion fruit peel of *P. cincinnata* species can be used as a viable alternative to produce fiber-rich and environmentally sustainable food (flour and cookies).

1 Introduction

In 2015, the United Nations (UN) met in New York to establish the goals for achieving sustainable development (SDG) by 2030. Considering that approximately 1 billion people are still in poverty and do not have enough food, SDG aims at making fundamental changes in the modes of production and consumption of goods and services (Ferranti et al., 2018).

In Brazil, some regions, mainly in the north and northeast, have extreme poverty and food insecurity scenarios (Defante et al., 2015; Pontes et al., 2018). It is possible to observe both malnutrition and obesity due to low consumption of nutritional quality foods and excess consumption of high calorie density foods, A high consumption of flours and cookies, and low consumption of fruit are observed, for example (Claro & Monteiro, 2010; Levy et al., 2012).

Fruits are foods that have high fiber content, important substances since their consumption is related to the regulation of intestinal transit, prevention and aid in the treatment of diseases such as dyslipidemias, diabetes mellitus, colon cancer, cardiovascular diseases and obesity (Ma & Mu, 2016; Macagnan et al., 2016).

The consumption of regional fruit, taking advantage of all its parts, can be a strategy to improve the state of nutrition of families and promote a sustainable agriculture, valuing the local climate, because it favors less intervention for fruit production, and also valuing the regional culture of food (Costa et al., 2016; Umesha et al., 2018).

Researches have been carried out with the use of little used parts of fruits as potential components in the production of functional foods. Among them, we can mention flours developed with quality centesimal composition, high levels of fiber and good sensory acceptance, using food byproducts such as papaya (Santos et al., 2018), *jaboticaba* (Micheletti et al., 2018), *umbu* (Silva et al., 2018) and grapes (Abreu, 2018).

The yellow passion fruit peel has been highlighted in research that uses little used parts of the fruit for the development of flours with increased fiber content (Fogagnoli & Seravalli, 2014; Padilha & Basso, 2016), and authors such as Macagnan et al. (2015) and Marques et al. (2016) observed beneficial changes in clinical parameters, in rats and in patients hospitalized with HIV lipodystrophy, respectively, which were supplemented with

Received 06 Oct., 2020
Accepted 08 Mar., 2021
[1]*Departamento de Ciências e Tecnologias, Universidade Estadual do Sudoeste da Bahia – UESB, Jequié, BA, Brasil*
[2]*Programa de Pós-graduação em Enfermagem e Saúde, Universidade Estadual do Sudoeste da Bahia – UESB, Jequié, BA, Brasil*
[3]*Instituto Federal de Educação, Ciência e Tecnologia Baiano – IF Baiano, Uruçuca, BA, Brasil*
*Corresponding author: evely.rl@gmail.com

passion fruit peel flour. However, work with other passion fruit species, such as *Passiflora cincinnata Mast*. are scarcer.

The *P. cincinnata* Mast., species of passion fruit common in the *Caatinga* region, popularly known as bush passion fruit or *Caatinga* passion fruit, is a species that has different characteristics from the yellow passion fruit, such as taste and colors of the juice, flower and fruit (Oliveira & Ruggiero, 2005).

In this sense, this study aimed to use passion fruit peel *P. cincinnata Mast*., as a viable alternative to produce food (flour and cookie) rich in fiber.

2 Material and methods

2.1 Study location

Passiflora cincinnata Mast. flour was produced at the Food Technology Center of the Federal Institute of Education, Science and Technology of Bahia - IFBAIANO, Uruçuca Campus. The physical-chemical characterization was performed at the Food Laboratory, located at the State University of Southwest Bahia - UESB, Jequié campus and at the Laboratory of Mineral Nutrition of Plants, Federal Rural University of Rio de Janeiro, Seropédica campus. The acceptance test of cookies was conducted at the Food Laboratory of the UESB in Jequié.

2.2 Obtaining the residue

The passion fruit residues were obtained from rural suppliers in the city of Lagedo do Tabocal - Ba, considering early stages of ripening. The material was stored under refrigeration at 5 °C, according to Ferreira & Pena (2010) and sanitized according to Pita (2012).

It is worth mentioning that the access to genetic heritage was registered in the National System of Genetic Heritage Management under the number ABFF15A.

2.3 Development of Caatinga passion fruit peel flour

The flour production was carried out according to a methodology adapted from Costa (2012), being used industrial dehydrator at 60 °C, for 24 hours, for the drying of the residues. It is worth mentioning that the yield of passion fruit peel flour was calculated through the ratio between the weight of dehydrated powdered peel and the weight of the peel in its natural form.

2.4 Cookie development

The development of the cookie formulations was carried out according to the standard cookie formulation presented in the 10-50D method of the American Association of Cereal Chemists (2000). Three formulations were developed with 10% (formulation 1), 20% (formulation 2) and 30% (formulation 3) of partial replacement of wheat flour by passion fruit peel flour of the species *P. cincinnata* Mast. (Table 1), based on studies conducted by Aquino et al. (2010) and Fasolin et al. (2007). It is worth noting that in order to compare the products developed, a standard formulation of cookies was used, using wheat flour.

2.5 Physical-chemical analysis

The passion fruit peel flour and cookie formulations developed were characterized in the physicochemical scope, following the Adolfo Lutz Institute's Manual of Analytical Standards (Instituto Adolfo Lutz, 2008). Analysis of ashes, humidity, pH, acidity, lipids and total soluble and insoluble dietary fiber were performed. The determination of proteins was performed by the Dumas method, according to Ribeiro (2010) and the Total Carbohydrates by difference, according to RDC nº 360/2003 (Brasil, 2003).

2.6 Microbiological analysis

They were performed according to Ferreira & Pena (2010), following the recommendations of RDC nº 12/2001 of ANVISA, performing total count of mesophilic aerobes, coliforms at 45 °C/g, *Staf.coag.positive/g* and *Salmonella sp*/25 g (Brasil, 2001).

2.7 Statistical analyses

For the analysis of physical-chemical parameters the data distribution was tested using the Kolmogorov-Smirnov test, and its normal distribution was evaluated. Uniformissive ANOVA was performed, followed by Bonferroni's post hoc test, to compare the means between the groups, always adopting the significance level $p < 0.05$.

For all statistical analyses of the data obtained, the Statistical Package for Social Sciences (SPSS), version 21.0 was used.

Table 1. Formulations of cookies developed with passion fruit flour from the caatinga. September 2018, Jequié, BA, Brazil.

COMPONENTS (%)	FORMULATION			
	Standard	Formulation 1	Formulation 2	Formulation 3
Wheat flour	53.7	48.3	43.0	37.6
Passion fruit flour	-	5.4	10.7	16.1
Sugar	24.1	24.1	24.1	24.1
Margarine	16.2	16.2	16.2	16.2
Baking powder	1.2	1.2	1.2	1.2
Water	4.3	4.3	4.3	4.3
Salt	0.5	0.5	0.5	0.5

3 Results and discussion

The developed flour presented a yield of 19.5%, considered high when compared to that found for melon peel flour (8.81%) by Vieira et al. (2017), as well as for pequi peel flour (12.6%) obtained by Costa et al. (2017).

Table 2 presents the results for descriptive analysis of the physical-chemical parameters evaluated for the flour developed and compared to wheat and cassava flour, as described in the Brazilian Table of Food Composition - *TACO* (Universidade Estadual de Campinas, 2011).

The flour developed in this research can be a healthier alternative for the diet of these families, since, when comparing its composition with wheat and cassava flours, it is observed that the flour developed had higher ash content. As for the carbohydrate content, the developed flour presented similar amounts in relation to wheat and cassava flours. This result may be related to the large amount of total fibers present in its composition, where it is possible to observe a total dietary fiber content about 25 and ninr times higher in the flour developed compared to wheat flour and cassava, respectively.

A similar result was observed by Felisberto et al. (2019) when adding bamboo thatch flour in cookie formulation, finding that the fiber content was higher compared to the fiber content found in wheat flour, which contributed to the development of fiber-rich cookies. In the study conducted by Brites et al. (2019) it is observed that the replacement of wheat flour by alternative flours, such as buckwheat flour and chia seeds, in cookie formulations, contribute to the improvement of their nutritional quality, since according to Ciudad-Mulero et al. (2019), fiber consumption is associated with several health benefits, such as regulation of intestinal functioning, preventing colorectal diseases, among others.

Another parameter that stands out in the comparison between the flours is the humidity, which was lower for the developed flour, being in accordance with the current legislation, the RDC nº 263/2005 (Brasil, 2005), which determines a maximum value of 15% humidity for flours. This result can be considered an advantage, since the humidity of a food is directly related to its quality and safety, since high water levels propitiate microbiological contamination (Picanço et al., 2018).

Table 2. Centesimal composition of flour developed compared to wheat and manioc flour. September 2018, Jequié, BA, Brazil.

Evaluated parameter	Developed Flour*	Wheat Flour**	Cassava flour**
Ash (%)	5.79 ± 0.11	0.8	0.9
Total carbohydrates (%)	78.23 ± 0.84	75.1	87.9
Humidity (%)	5.78 ± 0.11	13.0	9.4
Acidity (%)	4.83 ± 0.00	NA	NA
Ph	3.74 ± 0.04	NA	NA
Total Lipids (%)	1.66 ± 0.06	1.4	0.3
Total Proteins (%)	8.59 ± 0.82	9.8	1.6
Total dietary fiber (g/100 g)	58.30	2.3	6.4
Soluble dietary fiber (g/100 g)	12.30	NA	NA
Insoluble dietary fiber (g/100 g)	46.00	NA	NA

**P. cincinnata* peel flour; **According to the Brazilian Table of Food Composition - TACO (Universidade Estadual de Campinas, 2011). NA: not evaluated.

It is observed a high level of acidity presented by the flour developed and, in the same way, it is possible to verify an acid pH, characteristic of the *P. cincinnata* species, providing greater stability to the product and its better conservation. The lipid and protein content of the developed flour was similar when compared to wheat flour.

Besides being a positive alternative, helping in the consumption of higher fiber contents, promoting benefits to the families' health, the use of *P. cincinnata* flour can contribute to sustainable agriculture, since this species is commonly found in the semi-arid region, especially in the northeast of Brazil and still underused (Carmo et al., 2017). Likewise, the use of the peel of this fruit in the production of flour further contributes to sustainable development, considering that its disposal into the environment is now reduced.

The flour developed was used in concentrations of 10%, 20% and 30% (g/g) to replace wheat flour in three cookie formulations. The physical and chemical composition of the formulations developed, as well as the comparison of the averages between the groups, are presented in Table 3.

Evaluating the results of the comparisons, it is possible to observe that there was a significant difference for the physical-chemical parameters. However, considering Bonferroni's post hoc test, it can be observed that there was a significant difference between the standard formulation and the formulations containing the flour developed.

Likewise, a significant difference was observed between formulations 1 and 2 (p= 0.00) and 1 and 3 (p= 0.00), with formulation 1 showing lower humidity among all. This difference can be explained by the variation in concentrations of *P.cincinnata* flour added to the formulation. Between formulations 2 and 3 (p= 1.00), there was no significant difference. The moisture content is directly related to the useful life of the product, since the water present provides microbiological development. Thus, the formulations developed present less risk of microbiological contamination.

When analyzing the ash content in the developed products, there was a significant difference between the standard formulations and 3 (p= 0.00), formulations 1 and 3 (p= 0.00) and formulations 2 and 3 (p= 0.02), noting that among all the formulations developed, the one with 30% of flour developed was the one with the highest ash content. Such results reveal the highest content of minerals in the formulation with the highest content of flour developed.

As for the total acidity, a significant difference was found between the standard formulation when compared to formulations 1, 2 and 3 (p= 0.01; p= 0.00; p= 0.00), noting that the standard formulation had the lowest acidity compared to cookies enriched with flour developed. There was a significant difference between formulations 1 and 2 (p= 0.02) and 1 and 3 (p= 0.00), being verified that by increasing the concentration of flour in the formulation, there was an increase of its acidity.

Table 3. Descriptive analysis of the physical-chemical parameters of the cookies developed. September 2018, Jequié, BA, Brazil.

Evaluated parameter	Standard Formulation*	Formulation 1*	Formulation 2*	Formulation 3*	ANOVA (p<0.05)
Humidity (%)	5.81 ± 0.58[a]	4.40 ± 0.13[bc]	7.67 ± 0.26	7.42 ± 0.24	0.00
Ash (%)	2.09 ± 0.15[e]	2.04 ± 0.03[c]	2.28 ± 0.04[d]	2.65 ± 0.10	0.00
Acidity (%)	2.08 ± 0.46[a]	5.26 ± 0.20[bc]	8.21 ± 0.48	9.3 ± 0.69	0.00
pH	5.68 ± 0.16[a]	4.62 ± 0.16[bc]	3.76 ± 0.97[d]	3.38 ± 0.05	0.00
Total lipids (%)	15.13 ± 0.08[f]	16.01 ± 0.09[bc]	15.23 ± 0.03[d]	14.62 ± 0.12	0.00
Total Proteins (%)	5.19 ± 0.42[g]	4.28 ± 0.52	3.92 ± 0.31	4.14 ± 0.33	0.00
Total carbohydrates (%)	71.93 ± 0.65	73.56 ± 0.83	71.13 ± 0.56	71.96 ± 0.85	0.00

*Standard formulation: developed with wheat flour, without partial replacement by *P. cincinnata* flour; Formulation 1: developed with 10% *P.cincinnata* flour; Formulation 2: developed with 20%; Formulation 3: developed with 30%. [a]difference between standard formulation and 1, 2 and 3; [b]difference between formulation 1 and 2; [c]difference between formulation 1 and 3; [d]difference between formulation 2 and 3; [e]difference between standard formulation and 3; [f]difference between standard formulation and 1 and 3; [g]difference between standard formulation and 2 and 3.

Table 4. Microbiological evaluation of flour and cookies developed. 2018, Itabuna, BA, Brazil.

Parameter	Developed Flour	Formulation 1***	Formulation 2***	Formulation 3***	MVA*
Total count (UFC/mL)	2.3 x 10^2	1.6 x 10^1	1.8 x 10^1	1.4 x 10^1	-
Coliforms 45 °C (NMP/g)	< 3.6	3.6	3.6	< 3.6	100
Staphylococcus auerus posit. coag. (UFC/g)	1.2 x 10^1	1.0 x 10^1	1.3 x 10^1	1.1 x 10^1	5 x10^2
Salmonella sp.	Absent	Absent	Absent	Absent	Absent 25g

*VMP: Maximum value allowed; ***Formulation 1: developed with 10% P.*cincinnata* flour, formulation 2: developed with 20% and formulation 3: developed with 30%.

Likewise, in agreement with the acidity content, the standard formulation presented a significant difference compared to cookies enriched with the flour developed (p= 0.00), presenting the highest pH of the formulations. There was a significant difference between formulations 1 and 2 (p= 0.00), 1 and 3 (p= 0.00) and 2 and 3 (p= 0.02), and by increasing the concentration of flour developed in the formulation, the lower was the pH value of the final product. This result is directly related to the acidity content found in the developed flour.

The high levels of acidity accompanied by low pH values can be explained by the characteristic acidity of the P. *cincinnata* species (Oliveira & Mapeli, 2015). Such results reveal the flour developed as an alternative of industrial interest, since it reduces the need for additives with acidifying properties, used with the aim of providing quality and safety to the food, increasing the shelf life of the product (Costa, 2012; Oliveira & Mapeli, 2015).

When observing the lipid content, there was a significant difference between the standard formulation compared to formulations 1 and 3 (p= 0.00; p= 0.02), with the exception of formulation 2 (p= 1.00). Considering the formulations enriched with the flour developed, all differed significantly among themselves, noting that the lipid content followed a significant downward trend, from the concentration of 30% of the flour in the formulation.

In relation to protein content, the standard formulation showed significant differences when compared to formulations 2 and 3 (p= 0.00; p= 0.02), revealing higher amounts of protein compared to formulations prepared with the flour developed. However, the protein content did not differ significantly when comparing standard formulations and 1 (p= 0.05). In the same way, there was no significant difference between the protein averages of formulations 1 and 2 (p= 1.00), 1 and 3 (p= 1.00) and 2 and 3 (p= 1.00), revealing that the protein content was not altered by varying the concentration of flour developed in the formulation. The same was observed regarding the carbohydrate content in the developed cookies, not being found a significant difference when comparing this parameter among all the developed formulations.

As for the microbiological evaluation of the developed cookies, it was possible to observe that both the flour and the developed cookies were in accordance with the legislation in force, the ANVISA RDC nº 12/2001 (Table 4).

The microbiological results corroborate the results found for the moisture, acidity and pH levels of the developed products, which are related to the longer shelf life of the food and lower risk of microorganism development. Thus, it is observed that the developed foods are safe, with regard to microbiological evaluation, for human consumption.

According to the POF 2008-2009, the annual household consumption of cookies in Brazil is 4.79 kg and 5.62 kg in the northeast region. Considering that such food is related to *trans*-fat, sugars and poor fiber intake, the addition of flours to its composition, such as that of *P. cincinnata* peel, may be an alternative to improve fiber consumption, providing the health benefits related to this component in foods.

4 Conclusions

It was possible to observe that passion fruit peel of *P. cincinnata* species can be used as a viable alternative to produce food (flour and cookies) rich in fiber and environmentally sustainable. Since it presented promising capacity in the development of functional foods, health promoters, besides taking advantage of a product of wide production in the region, but many times underused. However, it is necessary to conduct studies that characterize the flour as to its functional components, as well as toxicological tests, in addition to clinical trials that highlight its properties for health promotion.

References

Abreu, J. P. D. (2018). *Efeitos da adição de farinha de casca de uva orgânica (Vitis labrusca) sobre as características físicas, químicas e sensoriais no desenvolvimento de biscoito tipo cookie com alegação funcional* (Dissertação de mestrado). Universidade Federal do Rio de Janeiro, Rio de Janeiro.

American Association of Cereal Chemists – AACC. (2000). *Approved methods of the American Association of Cereal Chemists* (Vol. 54). Washington.

Aquino, A. C. M., Móes, R. S., Leão, K. M. M., Figueiredo, A. V. D., & Castro, A. A. (2010). Avaliação físico-química e aceitação sensorial de biscoitos tipo cookies elaborados com farinha de resíduos de acerola. *Revista do Instituto Adolfo Lutz*, 69(3), 379-386.

Brasil, Agência Nacional de Vigilância Sanitária – ANVISA. (2001, January 10). Regulamento técnico sobre padrões microbiológicos para alimentos (Resolução RDC nº 12, de 2 de janeiro de 2001). *Diário Oficial [da] República Federativa do Brasil*.

Brasil, Agência Nacional de Vigilância Sanitária – ANVISA. (2003, December 26). Aprova regulamento técnico sobre rotulagem nutricional de alimentos embalados, tornando obrigatória a rotulagem nutricional (Resolução nº 360, de 23 de dezembro de 2003). *Diário Oficial [da] República Federativa do Brasil*, seção 1.

Brasil, Agência Nacional de Vigilância Sanitária – ANVISA. (2005, September 22). Regulamento técnico para produtos cereais, amidos, farinhas e farelos (Resolução nº 263, de 22 de setembro de 2005). *Diário Oficial [da] República Federativa do Brasil*, seção 1.

Brites, L. T. G. F., Ortolan, F., Silva, D. W. D., Bueno, F. R., Rocha, T. D. S., Chang, Y. K., & Steel, C. J. (2019). Gluten-free cookies elaborated with buckwheat flour, millet flour and chia seeds. *Food Science and Technology*, 39(2), 458-466. http://dx.doi.org/10.1590/fst.30416.

Carmo, T. V. B. D., Martins, L. S. S., Musser, R. D. S., Silva, M. M. D., & Santos, J. P. O. (2017). Diversidade genética em acessos de *Passiflora cincinnata* Mast. baseada em descritores morfoagronômicos e marcadores moleculares. *Revista Caatinga*, 30(1), 68-77. http://dx.doi.org/10.1590/1983-21252017v30n108rc.

Ciudad-Mulero, M., Fernández-Ruiz, V., Matallana-González, M. C., & Morales, P. (2019). Dietary fiber sources and human benefits: the case study of cereal and pseudocereals. *Advances in Food and Nutrition Research*, 90, 83-134. http://dx.doi.org/10.1016/bs.afnr.2019.02.002. PMid:31445601.

Claro, R. M., & Monteiro, C. A. (2010). Renda familiar, preço de alimentos e aquisição domiciliar de frutas e hortaliças no Brasil. *Revista de Saúde Pública*, 44(6), 1014-1020. http://dx.doi.org/10.1590/S0034-89102010000600005. PMid:21107500.

Costa, A. P., Pinto, E., & Soares, D. (2017). Obtenção de farinha do mesocarpo de pequi. *Agrarian*, 10(38), 349-354. http://dx.doi.org/10.30612/agrarian.v10i38.7051.

Costa, F. I. B. (2012). *Caracterização e avaliação da atividade antioxidante de farinhas produzidas a partir dos resíduos de Umbu (Spondias tuberosa Arruda Cam.) e Maracujá do Mato (Passiflora cincinnata Mast.)* (Dissertação de mestrado). Universidade Estadual do Sudoeste da Bahia, Itapetinga.

Costa, R. B., Arruda, E. J., & Oliveira, L. C. S. (2016). Sistemas agrossilvipastoris como alternativa sustentável para a agricultura familiar. *Interações*, 3(5). http://dx.doi.org/10.20435/interacoes.v3i5.567.

Defante, L. R., Nascimento, L. D. O., & Lima-Filho, D. O. (2015). Comportamento de consumo de alimentos de famílias de baixa renda de pequenas cidades brasileiras: o caso de Mato Grosso do Sul. *Interações*, 16(2), 265-276. http://dx.doi.org/10.1590/151870122015203.

Fasolin, L. H., Almeida, G. D., Castanho, P. S., & Netto-Oliveira, E. R. (2007). Biscoitos produzidos com farinha de banana: avaliações química, física e sensorial. *Ciência e Tecnologia de Alimentos*, 27(3), 524-529. http://doi.org/10.1590/S0101-20612007000300016.

Felisberto, M. H. F., Miyake, P. S. E., Beraldo, A. L., Fukushima, A. R., Leoni, L. A. B., & Clerici, M. T. P. S. (2019). Effect of the addition of young bamboo culm flour as a sugar and/or fat substitute in cookie formulations. *Food Science and Technology*, 39(4), 867-874. http://dx.doi.org/10.1590/fst.12418.

Ferranti, P., Berry, E., & Jock, A. (2018). *Encyclopedia of food security and sustainability*. Oxford: Elsevier.

Ferreira, M. F. P., & Pena, R. S. (2010). Estudo da secagem da casca do maracujá amarelo. *Revista Brasileira de Produtos Agroindustriais*, 12(1), 15-28. http://dx.doi.org/10.15871/1517-8595/rbpa.v12n1p15-28.

Fogagnoli, G., & Seravalli, E. A. G. (2014). Aplicação de farinha de casca de maracujá em massa alimentícia fresca. *Brazilian Journal of Food Technology*, 17(3), 204-212. http://dx.doi.org/10.1590/1981-6723.0614.

Instituto Adolfo Lutz – IAL. (2008). *Métodos físico-químicos para análise de alimentos*. São Paulo.

Levy, R. B., Claro, R. M., Mondini, L., Sichieri, R., & Monteiro, C. A. (2012). Distribuição regional e socioeconômica da disponibilidade domiciliar de alimentos no Brasil em 2008-2009. *Revista de Saúde Pública*, 46(1), 6-15. http://dx.doi.org/10.1590/S0034-89102011005000088. PMid:22183512.

Ma, M., & Mu, T. (2016). Anti-diabetic effects of soluble and insoluble dietary fibre from deoiled cumin in low-dose streptozotocin and high glucose-fat diet-induced type 2 diabetic rats. *Journal of Functional Foods*, 25, 186-196. http://dx.doi.org/10.1016/j.jff.2016.05.011.

Macagnan, F. T., Santos, L. R., Roberto, B. S., Moura, F. A., Bizzani, M., & Silva, L. P. (2015). Biological properties of apple pomace, orange bagasse and passion fruit peel as alternative sources of dietary fibre. *Bioactive Carbohydrates and Dietary Fibre*, 6(1), 1-6. http://dx.doi.org/10.1016/j.bcdf.2015.04.001.

Macagnan, F. T., Silva, L. P., & Hecktheuer, L. H. (2016). Dietary fibre: the scientific search for an ideal definition and methodology of analysis, and its physiological importance as a carrier of bioactive compounds. *Food Research International*, 85, 144-154. http://dx.doi.org/10.1016/j.foodres.2016.04.032. PMid:29544829.

Marques, S. D. S. F., Libonati, R. M. F., Sabaa-Srur, A. U. O., Luo, R., Shejwalkar, P., Hara, K., Dobbs, T., & Smith, R. E. (2016). Evaluation of the effects of passion fruit peel flour (*Passiflora edulis* fo. *flavicarpa*) on metabolic changes in HIV patients with lipodystrophy syndrome secondary to antiretroviral therapy. *Revista Brasileira de Farmacognosia*, 26(4), 420-426. http://dx.doi.org/10.1016/j.bjp.2016.03.002

Micheletti, J., Soares, J. M., Franco, B. C., Carvalho, I. R. A. D., Candido, C. J., Santos, E. F. D., & Novello, D. (2018). The addition of jaboticaba skin flour to muffins alters the physicochemical composition and their sensory acceptability by children. *Brazilian Journal of Food Technology*, 21(0), e2017089. http://dx.doi.org/10.1590/1981-6723.08917.

Oliveira, F., & Mapeli, A. M. (2015). Caracterização fisiológica de frutos de maracujá-do-mato coletados em diferentes diâmetros. In *Anais* *do 1º Congresso Brasileiro de Processamento Mínimo e Pós-colheita de Frutas, Flores e Hortaliças*. Aracaju.

Oliveira, J. C., & Ruggiero, C. (2005). Espécies de maracujá com potencial agronômico. In F. G. Faleiro, N. T. V. Junqueira & M. F. Braga (Eds.), *Maracujá: germoplasma e melhoramento genético*. Planaltina: Embrapa Cerrados.

Padilha, T., & Basso, C. (2016). Biscoitos com resíduo de manga, maracujá e jabuticaba. *Disciplinarum Scientia Saúde*, 16(1), 79-88.

Pita, J. S. L. (2012) *Caracterização físico-química e nutricional da polpa e farinha da casca de maracujazeiros do mato e Amarelo* (Dissertação de mestrado). Universidade Estadual do Sudoeste da Bahia, Itapetinga.

Pontes, R. P., Barbosa, M. N., de Oliveira, C. A., & Abdallah, P. R. (2018). Quem passa fome no brasil? Uma análise regional dos determinantes da insegurança alimentar forte nos domicílios brasileiros. *Revista Brasileira de Estudos Regionais e Urbanos*, 12(2), 225-241.

Ribeiro, P. E. A. (2010). *Implementação de análise de nitrogênio total em solo pelo método de Dumas*. Sete Lagoas: Embrapa Milho e Sorgo.

Picanço, Y. D. S., Oliveira, S. S., Almeida, M., Otani, F. S., Pereira, E. J., & Santos, G. C. (2018). Análise de atividade de água e umidade na qualidade do mel produzido em comunidades da reserva extrativista tapajós-arapiuns, Santarém, Pará. *Revista Agroecossistemas*, 10(2), 1-10. http://dx.doi.org/10.18542/ragros.v10i2.5146.

Santos, C. M. D., Rocha, D. A., Madeira, R. A. V., Queiroz, E. D. R., Mendonça, M. M., Pereira, J., & Abreu, C. M. P. D. (2018). Preparation, characterization and sensory analysis of whole bread enriched with papaya byproducts flour. *Brazilian Journal of Food Technology*, 21, e2017120.

Silva, D., Pagani, A., & Souza, R. (2018). Elaboração de cupcake adicionado de farinha de resíduo de umbu cajá: características sensoriais e químicas. *Revista Ciência (In) Cena*, 1(7), 28-46.

Umesha, S., Manukumar, H. M. G., & Chandrasekhar, B. (2018). Sustainable agriculture and food security. In R. L. Singh & S. Mondal (Eds.), *Biotechnology for sustainable agriculture: emerging approaches and strategies* (pp. 67-92). Duxford: Woodhead Publishing.

Universidade Estadual de Campinas – UNICAMP. (2011). *TACO - Tabela Brasileira de Composição de Alimentos* (4. ed.). Campinas: NEPA-UNICAMP.

Vieira, R. F. F. A., Carvalho, C. L. S., Carvalho, I. R. A., Candido, C. J., Santos, E. F., & Novello, D. (2017). Adição de farinha da casca de melão em cupcakes altera a composição físico-química e a aceitabilidade entre crianças. *Conexão Ciência*, 12(2), 22-30. http://dx.doi.org/10.24862/cco.v12i2.611.