



Cookies based on apple pomace (*Malus domestica* Borkh) and rice flour (*Oryza sativa* L.)

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ABSTRACT: In apple juice production, a pomace, rich in fibers and technological properties such as thickening, gelling, and stabilizing capacities, is generated. Considering economic and environmental factors, utilizing this residue is advantageous, presenting an opportunity to add value and enhance the nutritional content of products. Biscuits are widely accepted bakery products with high demand, standing out in the development of food products with enhanced nutritional value. Therefore, this research aimed to develop gluten-free biscuit formulations based on the use of apple pomace and rice flour. To achieve this, apple pomace obtained after juice extraction was dried and milled to reduce its particle size, producing a flour that underwent physicochemical analysis for characterization. Subsequently, three biscuit formulations were prepared: a control formulation with 100% rice flour, one with 25% substitution by apple pomace flour, and one with 50% substitution. The biscuits were analyzed for their growth and subjected to sensory analysis. The apple pomace flour exhibited physicochemical characteristics within standards, being classified as fine, indicating its potential in the enrichment of bakery products. Among the produced biscuits, the formulation with 25% apple pomace flour substitution stood out positively in the sensory evaluation. Additionally, it is recorded higher preference in terms of texture, odor, flavor, and overall evaluation, revealing a notably higher acceptance by consumers. Thus, it is evident that the 25% apple pomace formulation has considerable market potential, securing consumer approval. The incorporation of apple pomace flour proved to be a promising alternative for enriching gluten-free biscuits.

Key words: apple pomace, gluten-free cookies, waste utilization.

Cookie a base de bagaço de maçã (*Malus domestica* Borkh) e farinha de arroz (*Oryza sativa* L.)

RESUMO: Na produção de suco de maçã, é gerado um bagaço rico em fibras e com propriedades tecnológicas, como capacidade espessante, geleificante e estabilizante. Considerando fatores econômicos e ambientais, se torna interessante o aproveitamento deste resíduo, além de ser uma oportunidade de agregar valor e proporcionar o enriquecimento nutricional de produtos. Os biscoitos são produtos de panificação amplamente aceitos e com demanda elevada, se destacando no cenário de desenvolvimento de alimentos com valor nutricional incrementado. Diante disso, a presente pesquisa teve como objetivo o desenvolvimento de formulações de biscoitos sem glúten, baseada no uso de bagaço de maçã e farinha de arroz. Para tanto, foi realizada a secagem do bagaço de maçã, obtido após a extração do suco, seguida de trituração para diminuir a granulometria, obtendo-se assim, uma farinha, que foi submetida a análises físico-químicas para a sua caracterização. Posteriormente, foram elaborados uma formulação controle, com 100% de farinha de arroz; uma com substituição de 25% por farinha de bagaço de maçã; e uma com substituição de 50%. Os biscoitos elaborados foram analisados quanto ao seu crescimento e submetidos a análise sensorial. A farinha do bagaço de maçã apresentou características físico-químicas dentro dos padrões, sendo classificada como fina, demonstrando o seu potencial no enriquecimento de produtos de panificação. Dentre os biscoitos produzidos, a formulação que incluiu a substituição de 25% da farinha de arroz pela farinha proveniente do bagaço de maçã destacou-se positivamente na avaliação sensorial. Além disso, registrou uma preferência superior nos aspectos de textura, odor, sabor e avaliação global, revelando uma aceitação notavelmente maior pelos consumidores. Assim, evidencia-se que a formulação com 25% do bagaço de maçã possui considerável potencial de mercado, conquistando a aprovação do público consumidor. A incorporação da farinha do bagaço de maçã demonstrou ser uma alternativa promissora para enriquecer biscoitos sem glúten.

Palavras-chave: bagaço de maçã, biscoito sem glúten, aproveitamento de resíduos.

INTRODUCTION

Brazil is a significant producer of fruits, with apples standing out as a variety of great economic interest due to their global cultivation and consumption. The production chain of apples has experienced

substantial evolution between 2011 and 2019, driven by modernization and technological innovation, particularly in the Southern region of the country. This transformation enabled Brazil to shift from being an importer to an exporter, exporting approximately 15% of its production (BUENO et al., 2021).

According to the Brazilian Institute of Geography and Statistics (IBGE, 2021), the quantity produced in the country was approximately 1.29 million tons, with a production value of approximately R\$ 2.34 billion. A significant portion of the consumption is of the fresh fruit itself, but the increase in production has favored its use in the juice industry. Apple juice is extracted through a pressing process, producing a residue composed of peels, peduncles, leaves, seeds, and pulp, known as apple pomace. It is estimated that between 30% and 40% of this residue is generated, with more than 90% consisting of peel and pulp (GEUS et al., 2014; ZHANG et al., 2021).

Apple pomace has a high fiber content with thickening, gelling, and stabilizing properties. Additionally, it contains phenolic compounds with antioxidant activity and phytochemicals associated with the inhibition of cancer cell proliferation, lipid oxidation, and cholesterol level reduction (KOŁODZIEJCZYK et al., 2007; SAQUETI et al., 2019).

Considering numerous economic and environmental factors, the utilization of by-products in the food industry is necessary. As a residue, apple pomace is a perishable material due to its high moisture content and nutrient concentration, which fosters microorganism growth. Inadequate disposal can become a severe environmental problem and waste a valuable resource. Thus, its utilization contributes to sustainability and adds value by leveraging its excellent nutritional characteristics (GEUS et al., 2014; GOŁĘBIEWSKA, et al., 2022; PUTRA et al., 2023).

According to LYU et al. (2020), the addition of apple pomace in food formulations can increase the fiber and polyphenol content of the product while having a significant sugar concentration. Hence, this residue has great potential as a functional ingredient in food formulations. Building on this potential, an interesting application of apple pomace is in the production of nutrient-rich flours, which facilitate its incorporation into a variety of foods.

Such flours can be used in cookies, replacing part of the wheat flour, reducing costs, and enhancing the nutritional value of the product (MARTÍNEZ et al., 2022). Cookies, in particular, offer a promising avenue for incorporating these flours due to their widespread commercial appeal and long shelf life.

Among various types of cookies, cookies garner considerable commercial interest due to their durability and broad acceptance. Additionally, compared to other types of cookies, they are known to be less sensitive to the gluten network structure. This

makes them advantageous for formulations replacing wheat flour, resulting in products with reduced gluten content (XU et al., 2020).

Thus, the addition or substitution of wheat flour with mixed flour can increase nutrient content and produce gluten-free products valuable for celiacs. These flours might even involve using fruits and vegetables, not only boosting nutrient content but also utilizing the entire plant, including typically discarded parts such as peels, stems, and leaves. It is essential to always check the sensory acceptance of these products, as there could be changes in color, flavor, and texture (DOURADO et al., 2014; CULETU et al., 2021; MORAES & SILVA, 2023).

Given the above considerations, the present research aimed to develop a new biscuit formulation using apple pomace and rice flour, enabling celiac consumers to enjoy a tasty and nutritious biscuit.

MATERIALS AND METHODS

Drying of apple pomace

The apple pomace was obtained from the juice extraction of the fruit performed at the Beverage and Bioengineering Laboratory of the Centro Federal de Educação Tecnológica Celso Suckow da Fonseca (CEFET/RJ) Valença Campus. The apples were selected, washed to remove impurities, and sanitized in a 200 ppm sodium hypochlorite solution. The apple pomace was distributed in the fruit dryer trays in layers of approximately 1 cm and was dried at a temperature of 60 °C for 24 hours at the Laboratory of Plant-Origin Products of CEFET/RJ Valença Campus. Then, the dried pomace was ground in a blender to reduce its particle size, resulting in material more similar to traditional flour.

Physico-chemical analyses of apple pomace flour

The determinations of proteins, carbohydrates, lipids, ash, and moisture were carried out in triplicates, according to the methods recommended by the INSTITUTO ADOLFO LUTZ (2008). The analyses were conducted in the Physical-Chemistry Laboratory of CEFET/RJ Valença Campus.

Granulometric analysis

The granulometric analysis was conducted using a shaker table from Bertel Indústria Metalúrgica LTDA, with ten sieves from TPL - Tamis Produtos Laboratoriais®, of different openings, at the Experimental Physics Laboratory of CEFET/RJ Valença Campus. The shaking was performed for 10 minutes. After the shaking, the retained materials,

those that passed through the sieves, and the bottom were weighed to proceed with the data analysis.

Cookie preparation

The preparation of the cookies was carried out at the Laboratory of Plant-Origin Products of CEFET/RJ Valença Campus. The formulation used is described in table 1, detailing the quantity of each ingredient. Three formulations were tested: a traditional formulation (standard) with 100% rice flour, one formulation with 25% apple pomace flour, and one with 50% apple pomace flour.

Initially, the ingredients were weighed according to the formulations presented in table 1. Subsequently, refined sugar, brown sugar, eggs, and margarine were added and mixed in an Arno Deluxe Inox 600W industrial mixer for about one minute. Next, the flours were incorporated according to each formulation and mixed for another two minutes until a homogeneous dough was formed. Then, the baking powder was gently mixed in to incorporate it into the dough. The cookies were then shaped using a mold to ensure uniform size. At this stage, chocolate chips were manually added to the surface of the shaped cookies. The cookies were then baked in a Venâncio 485W industrial gas turbo oven at 170 °C for about six minutes. They were cooled on an aluminum suspended grid and vacuum-packed to maintain their characteristics.

Growth analysis of cookies

To evaluate the impact of the total replacement of wheat flour with rice flour on the growth of the cookies, the expansion capacity was assessed by measuring the diameter (mm) and thickness (mm) of the samples using calipers. Measurements were taken before and after baking.

Sensory analysis

The sensory analysis was conducted at the Sensory Analysis Laboratory of CEFET/RJ Valença campus. A hundred untrained consumers participated in the acceptance tests, comprising 60 females and 40 males. Before the sensory analysis, all consumers read and signed the Informed Consent Form (TCLE), approved by the Human Research Ethics Committee - CCAE- 11447119.4.0000.5237. The three cookie formulations were coded with a three-digit number and individually served with a sensory sheet, pencil, eraser, and a glass of water. The presentation order of the samples followed a randomized complete block design to avoid any influence on the results. Consumers were asked to observe and taste the samples and then respond to the sensory acceptance sheet, utilizing a structured verbal hedonic scale ranging from “disliked extremely” (1) to “liked extremely” (9), concerning attributes of appearance, color, odor, texture, flavor, and overall evaluation. Consumers were also asked to complete another sheet regarding their purchase intent of the product, using a five-point scale: 5 “Certainly would buy”, 4 “Probably would buy”, 3 “Might or might not buy”, 2 “Probably would not buy”, and 1 “Certainly would not buy”. The results obtained were statistically analyzed using analysis of variance (ANOVA) and comparison of means using Tukey’s test at a 5% significance level. The calculations were performed using Excel’s data tool.

RESULTS AND DISCUSSION

In table 2, the results obtained from the physicochemical analyses of apple pomace flour are expressed. Approximate results for moisture, ash,

Table 1 - Cookies formulations analyzed.

Ingredient	Formulations		
	Standard (P)	Subst. 25% (F1)	Subst. 50% (F2)
Rice flour (g)	400	300	200
Apple pomace flour (g)	0	100	200
Starch (g)	80	80	80
Refined Sugar (g)	160	160	160
Brown sugar (g)	160	160	160
Egg (un)	2	2	2
Baking powder (g)	6	6	6
Margarine (g)	200	200	200
Chocolate Chips	50	50	50

Table 2 - Results of physico-chemical analyses of apple pomace flour.

Analyses	Apple pomace flour	Pezini et al. (2023)	Duarte et al. (2021)
Moisture (%)	4.71 ± 0.09	5.91 ± 0.06	4.21
Ash (%)	1.55 ± 0.03	1.22 ± 0.03	2.04
Lipids (%)	3.27 ± 0.28	2.22 ± 0.15	1.89
Proteins (%)	0.54 ± 0.02	11.50 ± 1.14	6.50
Carbohydrates (%)	96.90 ± 0.22	79.14 ± 0.90	85.35

lipids, and carbohydrates were found by DUARTE et al. (2021) and PEZINI et al. (2023). However, the protein content found was lower than that reported by these authors. According to DUARTE et al. (2021), the protein content in fruit peels is linked to cultivation conditions, such as soil type and fertilization practices, especially those related to nitrogen. Although, fruits themselves are not traditionally recognized as protein sources, flours derived from fruit residues have the potential to become excellent sources of this component. Fruit peel flours, which have higher protein concentrations, can be strategically incorporated into various food products to enhance protein content, a practice particularly relevant in nutritionally deficient communities.

According to the Resolution of the Collegiate Board - RDC No. 263, dated September 22, 2005, from the National Health Surveillance Agency (ANVISA), which approves the Technical Regulation for Cereal, Starch, Flour, and Bran Products, the maximum moisture content for flours

is 15% m/m. Thus, apple pomace flour met the regulatory standards (BRASIL, 2005).

According to FORSIDO et al. (2021), moisture significantly influences the storage, packaging, and processing of flours, ensuring that maintaining ideal levels of this index preserves sensory and nutritional characteristics, prevents problems such as lump formation, microbiological deterioration, and changes in physical properties. Therefore, controlling flour moisture is of paramount importance as it contributes to ensuring preservation throughout the entire production chain.

The identified ash content totaled 1.55%. It is important to note that the ash composition reflects the amount of mineral substances contained in foods. Thus, when flours reveal significant concentrations of these minerals, their incorporation into food products can contribute to improving nutritional value (STORCK et al., 2015; MARCON, 2021).

The flour exhibited a high carbohydrate content, around 96%, which is related to the significant amount of fiber that residues like apple peel contain. Besides aspects related to its composition, it is also important to highlight the potential use of fruit pomace flour as coatings for fruits, like waxes, increasing the shelf life of fruits (DUARTE et al., 2021; PEZINI et al., 2023).

Table 3 shows the results of the particle size analysis, the mesh openings of the shaker table sieves, their respective diameters, the mass, and the percentage retained. It also presents the Accumulated Coarse Fractions (ACF) and the Accumulated Fine Fractions (AFF) of the flour. The fraction retained in the sieves was characterized by the particle size

Table 3 - Granulometric analysis results.

Opening (mm)	Sieves nº (Mesh-Tyler)	Retained dough (g)	Fraction retained (X _i)	D _i (mm)	ACF (%)	AFF (%)
1.700	10	0.41	0.0008	1.850	0.08	99.92
1.200	12	0.69	0.0013	1.450	0.21	99.79
1.180	14	1.06	0.0020	1.190	0.40	99.60
1.000	16	46.16	0.0864	1.090	9.04	90.96
0.850	20	35.16	0.0658	0.925	15.62	84.38
0.600	28	124.68	0.2333	0.725	38.95	61.05
0.500	32	46.47	0.0869	0.550	47.64	53.36
0.425	35	46.79	0.0875	0.463	56.40	43.60
0.300	60	54.01	0.1011	0.363	66.50	33.50
0.250	60	43.44	0.0813	0.275	74.63	25.37
Botto	-	135.6	0.2537	0.231	100.00	0.00

fraction D_p, which is the arithmetic mean of the mesh openings of sieves *i* and *i*-1. It can be observed that the largest quantity of apple pomace flour particles (25.37%) was retained at the bottom of the sieve set, indicating that this portion of the sample had particle sizes smaller than 0.275 mm. A significant percentage (23.33%) was retained in the sieve with a 0.600 mm opening, with a diameter smaller than 0.925 mm. These results differed from those found by STORCK et al. (2015) for apple residue flour, where 37% had a particle size greater than or equal to 0.600 mm and 24% less than or equal to 250 µm.

The quantity of flour retained at the bottom can be classified as fine flour. In their research on jabuticaba peel flour, ALMEIDA et al. (2020) observed that the largest quantity of particles was retained in the 32 mesh Tyler sieve (0.500 mm), with a value of 21.17%. This analysis allowed the separation of fine and coarse particle sizes, considering the material that is retained or passes through the 60 mesh (250 µm) sieve as fine particle size flour.

The cookie ingredients have specific roles in the dough formation process, which are related to the product quality. Wheat flour is a crucial ingredient, providing unique characteristics such as the high formation of the gluten network, which retains gases during fermentation. To entirely or partially replace this ingredient, it is necessary to assess its impact on the product. To understand how the cookies would rise and whether apple pomace flour could interfere, a growth analysis of the cookies was conducted. Table 4 shows the values of circumferences and weights before and after baking for the three formulations.

According to the results obtained from the sensory analysis, the control formulation and the one with 25% apple pomace were well accepted, with hedonic scores averaging between 6 and 7, corresponding to "slightly liked" and "moderately liked." Table 5 presents the sensory acceptance

results of cookie-type biscuits, considering attributes such as appearance, color, texture, odor, flavor, and overall evaluation.

For the appearance attribute, it was observed that the F2 sample showed a significant difference compared to the others, being the least accepted. However, its acceptance index was between 6 and 7, equivalent to slightly liked and moderately liked, respectively. Thus, despite having lower acceptance, it still presented a regular acceptance among tasters. The P and F1 samples did not significantly differ from each other and had higher acceptance in this attribute, indicating that the substitution of 25% rice flour with apple pomace flour does not influence the perception of the cookies appearance by the tasters, whereas the 50% substitution causes significant changes. It was noted that the shape of the cookies with the substitution of rice flour by apple pomace flour was less uniform, with a more brittle and irregular aspect, which may have influenced the appearance acceptance results. A justification for this again lies in the absence of the gluten network, which affects texture and other characteristics like extensibility, elasticity, and dough viscosity. Furthermore, when replacing rice flour with the residue, the starch concentration decreases, which is also important for the product's structure and texture (USMAN et al., 2020; ZLATANOVIĆ et al., 2019).

Regarding color, all samples were well accepted, with indices ranging from 7 - moderately liked to 8 - liked very much. It was found that the tone of the cookies intensified as the proportion of apple pomace flour increased. This phenomenon can be explained by the considerable amount of carbohydrates in the formulations, which, when subjected to the baking process, likely went through both caramelization and the Maillard reaction, causing browning. These processes contributed to obtaining a darker color in the products (SILVA et al.,

Table 4 - Growth analysis of cookies results.

Formulations	-----Raw dough-----			-----Baked dough-----			ΔV (mL)	ΔV (%)
	Diameter (mm)	Thickness (mm)	Volume (mL)	Diameter (mm)	Thickness (mm)	Volume (mL)		
P	42.0 ^a ± 0.20	15.0 ^a ± 0.05	20.78 ^a ± 0.13	53.0 ^a ± 0.15	14.0 ^a ± 0.10	30.89 ^a ± 0.05	10.10 ^a ± 0.17	48.62 ^a ± 1.14
F1	32.0 ^b ± 0.25	28.0 ^b ± 0.15	22.52 ^b ± 0.23	51.0 ^b ± 0.20	23.0 ^b ± 0.15	46.98 ^b ± 0.06	24.47 ^b ± 0.17	108.65 ^b ± 1.87
F2	31.0 ^c ± 0.05	20.0 ^c ± 0.05	15.10 ^c ± 0.09	41.0 ^c ± 0.05	9.0 ^c ± 0.05	11.88 ^c ± 0.09	-3.21 ^c ± 0.01	-21.29 ^c ± 0.18

Means followed by equal letters (vertical) do not differ statistically from each other by the Tukey test at 5%.

Table 5 - Sensory analysis results.

Attributes	Formulations		
	Standard (P)	Subst. 25% (F1)	Subst. 50% (F2)
Appearance	7.80 ^a ± 1.23	7.52 ^a ± 1.90	6.48 ^b ± 1.57
Color	7.68 ^a ± 1.25	7.32 ^{ab} ± 1.67	7.08 ^b ± 1.66
Texture	6.78 ^a ± 2.08	7.52 ^b ± 1.82	5.06 ^c ± 1.55
Odor	7.18 ^a ± 1.46	7.79 ^b ± 1.55	6.92 ^a ± 1.16
Flavor	7.28 ^a ± 1.80	7.76 ^a ± 1.58	5.96 ^b ± 1.35
Overall Evaluation	7.28 ^a ± 1.68	7.76 ^a ± 1.40	5.96 ^b ± 1.22
Purchase intention	6.66 ^a ± 2.37	7.06 ^a ± 2.03	4.5 ^b ± 1.96

Means followed by equal letters (horizontal) do not differ statistically from each other by the Tukey test at 5%.

2019). Similar results were observed by DOURADO et al. (2014) when making cookies with 8.5% and 14.2% apple pomace flour, compared to a control formulation without wheat flour replacement.

Another aspect related to appearance is texture, an attribute in which the three formulations statistically differed, with the F1 sample being the best accepted, followed by the control sample and then F2. The F1 and control samples were well accepted, with acceptance averages close to 7 - moderately liked. The F2 sample showed an acceptance average close to 5 - neither liked nor disliked. In LIMA'S (2019) research on the partial replacement of wheat flour with pineapple residue flour, it was found that texture acceptance decreased as the replacement increased, with the least accepted sample being the one with 50% replacement. Thus, the presence of more fibrous material with 50% replacement alters the consistency, deviating from the usual cookies that contain only wheat flour.

The F1 sample statistically differed in odor, being better accepted than the others, while the F2 sample did not differ from the standard sample. The acceptance indices of the three samples ranged from 6 - slightly liked to 8 - liked very much, indicating reasonable acceptance. Given that the F1 sample received superior acceptance, it can be assumed that the aromatic compounds in apple pomace flour have a positive influence on the product's aroma, especially when rice flour is replaced in reduced proportions. Similar results were found by BENDER et al. (2016) in their study with extruded snacks with grape peel flour. The acceptance of the aroma attribute was higher for the product with 5% compared to the sample with 10% and the control sample without grape peel flour, indicating the contribution of grape flour, in small amounts, to increasing product acceptability.

The three formulations differed statistically in terms of flavor, with formulation F1 being the best accepted, followed by the control sample and then F2. These results are in line with the aroma attribute, indicating that the aroma and flavor compounds from the fruit and; consequently, the pomace flour, contributed to the product's aroma and flavor when the substitution was 25%. However, when this substitution was 50%, the product had lower acceptance, possibly because it differed from what is expected for cookie-type biscuits. These results support those found by DOURADO et al. (2014) concerning the flavor of cookie-type biscuits with 8.5% and 14.2% apple pomace. When analyzing gluten-free cookies with partial replacement of rice flour with orange residue flour, MIRANDA et al. (2021) noted that flavor acceptance decreased as the substitution increased.

Regarding overall evaluation, the three samples showed statistically significant differences, with the F1 sample being the best accepted, with an average close to 8 - liked very much.

Concerning purchase intent, the F1 formulation did not differ from the control sample, with averages close to 7 - would probably buy. The F2 sample had a lower purchase intention, with an average close to 5 - unsure if would buy. This result showed that for formulations with partial replacement of rice flour with apple pomace flour, the F1 formulation has greater market potential, meaning a higher likelihood of being purchased by consumers.

CONCLUSION

The use of flour obtained from apple pomace proved to be an alternative for enriching

cookie-type biscuits. The obtained flour showed good physicochemical and granulometric characteristics, demonstrating its technological potential in the development of baked goods. Among the prepared cookies, the formulation with 25% substitution of rice flour with apple pomace flour obtained the best results in cookie growth and sensory analysis, not showing statistically significant differences from the control sample in the attributes of appearance, color, and purchase intention. Additionally, it had higher acceptance in the attributes of texture, odor, flavor, and overall evaluation. Thus, this formulation showed a greater market potential, being well accepted by consumers. The use of flour obtained from residues in the industry presents itself as value addition, nutritional enrichment, advantages in reducing waste and disposal costs, and sensory improvements, especially in gluten-free baked goods, as observed. Therefore, the positive results indicate the possibility of utilizing apple pomace in the development of gluten-free cookie-type biscuits.

DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTIONS

All authors contributed equally for the conception and writing of the manuscript. All authors critically revised the manuscript and approved of the final version.

REFERENCES

- ALMEIDA, R. L. J. et al. Análise granulométrica diferencial da farinha da casca de jabuticaba (*Myrciaria cauliflora* Berg). **Research, Society And Development**, v.9, n.1, p.1-13, 2020. Available from: <<https://dialnet.unirioja.es/servlet/articulo?codigo=7342145>>. Accessed: Nov. 27, 2023. doi: 10.33448/rsd-v9i1.1875.
- BENDER, A. B. B. et al. Obtenção e caracterização de farinha de casca de uva e sua utilização em snack extrusado. **Brazilian Journal of Food Technology**, v.19, p.1-9, 2016. Available from: <<https://www.scielo.br/bjft/a/PRdP5gYfb6VjdxmPCVFGBMt/abstract/?lang=pt>>. Accessed: Nov. 19, 2023. doi: 10.1590/1981-6723.1016.
- BRASIL. **Resolução-RDC n° 263**, de 22 de setembro de 2005. Brasília, DF, Available from: <https://bvsmms.saude.gov.br/bvsm/saudelegis/anvisa/2005/rdc0263_22_09_2005.html>. Accessed: Nov. 27, 2023.
- BUENO, M. P. et al. Analysis of the commercialization of the brazilian apple production chain: production, import and export in the year 2015 to 2019. **Brazilian Journal Of Development**, v.7, n.4, p.34061-34078, 2021. Available from: <<https://ojs.brazilianjournals.com.br/ojs/index.php/BRJD/article/view/27561>>. Accessed: Nov. 12, 2023. doi: 10.34117/bjdv7n4-048.
- CULETU, A. et al. Nutritional and functional properties of gluten-free flours. **Applied Sciences**, v.11, n.14, p.6283, 2021. Available from: <<https://www.mdpi.com/2076-3417/11/14/6283>>. Accessed: Jun. 21, 2024. doi: 10.3390/app11146283.
- DOURADO, C. P. et al. Biscoito Adicionado de Farinha de Bagaço de Maçã: caracterização química e sensorial. **Revista Brasileira de Inovação Tecnológica em Saúde**, p.1-12, 2014. Available from: <<https://periodicos.ufrn.br/reb/article/view/4887>>. Accessed: Nov. 17, 2023. doi: 10.18816/r-bits.v4i1.4887.
- DUARTE, S. G. et al. Biscoito Tipo Cookie com Adição de Farinha de Resíduos de Frutas. **Exatas Online**, v.12, n.1, p.23-37, 2021. Available from: <https://www.researchgate.net/profile/Stephany-Goncalves-Duarte/publication/351105851_BISCOITO_TIPO_COOKIE_COM_ADICAO_DE_FARINHA_DE_RESIDUOS_DE_FRUTAS_COOKIES_PRODUCED_WITH_FRUIT_WASTE_FLOUR/links/60878c04881fa114b42dd6a0/BISCOITO-TIPO-COOKIE-COM-ADICAO-DE-FARINHA-DE-RESIDUOS-DE-FRUTAS-COOKIES-PRODUCED-WITH-FRUIT-WASTE-FLOUR.pdf>. Accessed: Nov. 29, 2023.
- FORSIDO, S. F. et al. Effects of storage temperature and packaging material on physico-chemical, microbial and sensory properties and shelf life of extruded composite baby food flour. **Heliyon**, v.7, n.4, 2021. Available from: <<https://www.sciencedirect.com/science/article/pii/S2405844021009245>>. Accessed Jun. 21, 2024. doi: 10.1016/j.heliyon.2021.e06821.
- GEUS, L. M. M. et al. Caracterização Nutricional de Amostras de Bagaço de Maçã Industrial e Laboratorial. **Scientia Rural**, 9^a ed., 2014. Available from: <https://www.researchgate.net/profile/Alessandro-Nogueira/publication/283403973_CHARACTERIZACAO_NUTRICIONAL_DE_AMOSTRAS_DE_BAGACO_DE_MACA_INDUSTRIAL_E_LABORATORIAL/links/56377c7608aed65d3c42c625/CARACTERIZACAO-NUTRICIONAL-DE-AMOSTRAS-DE-BAGACO-DE-MACA-INDUSTRIAL-E-LABORATORIAL.pdf>. Accessed: Jul. 26, 2023.
- GOLEBIEWSKA, E. et al. Sustainable use of apple pomace (AP) in different industrial sectors. **Materials**, v.15, n. 5, p.1788, 2022. Available from: <<https://www.mdpi.com/1996-1944/15/5/1788>>. Accessed: Jun. 21, 2024. doi: 10.3390/ma15051788.
- INSTITUTO ADOLFO LUTZ. **Normas Analíticas do Instituto Adolfo Lutz. Métodos físico-químicos para análises de alimentos**. 4^a ed. (1^a Edição digital), 2008. 1020 p.
- INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. **Produção de Maçã**. 2021. Available from: <<https://www.ibge.gov.br/explica/producao-agropecuaria/maca/br>>. Accessed: Jul. 24, 2023.
- KOLODZIEJCZYK, K. et al. Apple pomace as a potential source of nutraceutical products. **Polish Journal of Food and Nutrition Sciences**, v.57, n.4[B], p.291-295, 2007. Available from: <<https://journal.pan.olsztyn.pl/pdf-98826-30829?filename=30829.pdf>>. Accessed: Jun. 21, 2024.
- LYU, F. et al. Apple pomace as a functional and healthy ingredient in food products: A review. **Processes**, v.8, n.3, p.319, 2020. Available from: <<https://journal.pan.olsztyn.pl/pdf-98826-30829?filename=30829.pdf>>. Accessed: Jun. 21, 2024. doi: 10.3390/pr8030319.
- LIMA, A. B. M. **Obtenção de Farinha de Abacaxi a Partir da Secagem dos Resíduos Agroindustriais da Fruta para Aplicação**

- em **Formulações de Cookies**. 2019. 56 f. TCC (Graduação) - Curso de Engenharia Química, Universidade Federal do Rio Grande do Norte (UFRN), Natal, 2019.
- MARCON, L. S. S. **Elaboração e Caracterização da Farinha de Cascas de Poncã**. 2021. 35 f. Tese (Doutorado) - Curso de Tecnologia em Alimentos, Universidade Tecnológica Federal do Paraná (UTFPR), Londrina, 2021.
- MARTÍNEZ, E. et al. Elaboration of Cookies Using Oils and Flours from Seeds and Nuts: Effects on Technological, Nutritional and Consumer Aspects. **Foods**, v.11, n.15, p.2249, 2022. Available from: <<https://www.mdpi.com/2304-8158/11/15/2249>>. Accessed: Jun. 21, 2024. doi: 10.3390/foods11152249.
- MIRANDA, M. S. et al. Biscoitos tipo cookie sem glúten enriquecido com farinha de resíduos de laranja. **Research, Society And Development**, v.10, n.11, p.1-12, 2021. Available from: <<https://rsdjournal.org/index.php/rsd/article/view/19023>>. Accessed: Nov. 18, 2023. doi: 10.33448/rsd-v10i11.19023.
- MORAES, E. de M.; SILVA, L. H. da. Wheat flour substitutes in the preparation of gluten-free bakery products - a review. **Research, Society and Development**, v.12, n.3, p.e3512328931, 2023. Available from: <<https://rsdjournal.org/index.php/rsd/article/view/28931>>. Accessed: Jun. 21, 2024. doi: 10.33448/rsd-v12i3.28931.
- PEZINI, L. et al. Produção e caracterização de farinhas alimentícias a partir da casca e da polpa da maçã gala. **Rlas: Revista Latino-Americana Ambiente e Saúde**, Lages-SC, v.05, n.03, p.118-123, 2023. Available from: <<https://rlas.uniplaclages.edu.br/index.php/rlas/article/view/80>>. Accessed: Nov. 29, 2023.
- PUTRA, N. R. et al. Waste to wealth of apple pomace valorization by past and current extraction processes: a review. **Sustainability**, v.15, n.1, p.830, 2023. Available from: <<https://www.mdpi.com/2071-1050/15/1/830>>. Accessed: Jun. 21, 2024. doi: 10.3390/su15010830.
- SAQUETI, B. H. F. et al. Efeito da Adição de Farinha de Bagaço da Maçã e Hidrolato da Canela Encapsulado sobre as Propriedades Físico-Químicas, Sensoriais e Reológicas de Bebida Láctea. **Brazilian Journal of Development**, v.5, n.12, p.30036-30054, 2019. Available from: <<https://ojs.brazilianjournals.com.br/ojs/index.php/BRJD/article/view/5312>>. Accessed: Jul. 27, 2023. doi: 10.34117/bjdv5n12-139.
- SILVA, I. G. et al. Elaboração e análise sensorial de biscoito tipo cookie feito a partir da farinha do caroço de abacate. **Brazilian Journal of Food Technology**, v.22, p.1-10, 2019. Available from: <<https://www.scielo.br/j/bjft/a/fJNStYzbRbbvygMSHmZWP4f/?lang=pt>>. Accessed: Nov. 19, 2023. doi: 10.1590/1981-6723.20918.
- STORCK, C. R. et al. Qualidade microbiológica e composição de farinhas de resíduos da produção de suco de frutas em diferentes granulometrias. **Brazilian Journal of Food Technology**, v.18, n.4, p.277-284, 2015. Available from: <<https://www.scielo.br/j/bjft/a/fYhwDbYXN4bTDFZMBw6BR6d/>>. Accessed: Nov. 29, 2023. doi: 10.1590/1981-6723.1615.
- USMAN, M. et al. Effect of apple pomace on nutrition, rheology of dough and cookies quality. **Journal of Food Science and Technology**, v.57, p.3244-3251, 2020. Available from: <<https://www.scielo.br/j/cta/a/CyJm4qtzkKp9FGNjY7BVNPd/>>. Accessed: Jun. 21, 2024. doi: 10.1007/s13197-020-04355-z.
- XU, J. et al. Advanced properties of gluten-free cookies, cakes, and crackers: A review. **Trends in food science & technology**, v.103, p.200-213, 2020. Available from: <<https://www.sciencedirect.com/science/article/abs/pii/S092422442030546X>>. Accessed: Jun. 21, 2024. doi: 10.1016/j.tifs.2020.07.017.
- ZHANG, F. et al. Apple pomace as a potential valuable resource for full-components utilization: A review. **Journal of Cleaner Production**, v.329, p.129676, 2021. Available from: <<https://www.sciencedirect.com/science/article/abs/pii/S0959652621038531>>. Accessed: Jun. 21, 2024. doi: 10.1016/j.jclepro.2021.129676.
- ZLATANOVIĆ, S. et al. Functionality and storability of cookies fortified at the industrial scale with up to 75% of apple pomace flour produced by dehydration. **Foods**, v.8, n.11, p.561, 2019. Available from: <<https://www.mdpi.com/2304-8158/8/11/561>>. Accessed: Jun. 21, 2024.