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Effect of heat treatment on nutritional and anti-nutritional compounds of unconventional food plants (PANC)

Efeito do tratamento térmico nos compostos nutricionais e anti-nutricionais de plantas alimentícias não convencionais (PANC)

Efecto del tratamiento térmico sobre compuestos nutricionales y antinutricionales de plantas alimenticias no convencionales (PANC)

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Abstract
Unconventional Food Plants (PANC) is a strategy for valuing biodiversity, food sources and nutritional resources. For there to be a correct consumption, studies on PANC are necessary. Bio accessibility has been used for analyzes on the mineral content present in certain foods, and if a high content of these components in THE PANC is proven, they may emerge as an alternative to supply the mineral deficiencies present in part of the population. The aim of this study was to evaluate the contents and bioaccessibility of macro and micronutrients of four unconventional food plants used in the Amazonian gastronomy. The PANC sums used were: holy grass, Amazonian spinach, macuco beans and ora-pro-nóbis. The nutritional analyzes performed were: Humidity; Ashes; Lipids; Proteins; Carbohydrates; Total fibers; Minerals; pH; Titratable acidity; Color reflected; Ascorbic acid and bioaccessibility. The holy grass showed significant nutritional values in the contents of lipids, carbohydrates, fibers, sodium and vitamin C. Spinach Amazonian in natura showed significant values for protein and fiber. When bleached it showed higher values for moisture and protein. Macuco beans stood out in ash, fibers and vitamin C. Ora-pro-nobis in natura showed higher values for proteins, moisture, manganese, calcium, potassium, magnesium and vitamin C. When bleached, it showed significant results for carbohydrate, iron and zinc. In the titratable acidity only two samples suffered significant variations in heat treatment, holy grass with fresh sample, bleached sample and Amazonian spinach, with fresh sample and bleached sample. At pH, bleached Amazonian spinach was determined as the sample with lower acid character, none of the samples presented an acidic character, the one with the lowest value being bleached macuco beans. In the results, the PANC showed high nutritional values mainly in micronutrients and are a good alternative for insertion in the diet of the local population because they are cheap and easily accessible.
Keywords: Biodiversity; Resources; Food; Nutritional values.

Resumo
As Plantas Alimentícias Não Convencionais (PANC) são uma estratégia de valorização da biodiversidade, fonte de alimentação e de recursos nutricionais. Para que haja um consumo feito de forma correta, estudos sobre as PANC são necessários. A bioacessibilidade tem sido utilizada para análises sobre o teor de minerais presentes em determinados alimentos, e se comprovado alto teor desses componentes nas PANC, elas podem surgir como uma alternativa para suprir as deficiências de minerais presentes em parte da população. O objetivo do estudo foi avaliar os teores e a bioacessibilidade de macro e micronutrientes de oito plantas alimentícias não convencionais utilizadas na gastronomia amazônica. As PANC utilizadas foram: capim-santo, espinafre amazônico, feijão-macuco, ora-pró-nóbis, taioba, capeba, cariru e capim alho. As análises nutricionais realizadas foram: Umidade; Cinzas; Lipídeos; Proteínas; Carboidratos; Fibras totais; Minerais; pH; Acidez titulável; Cor refletida; Ácido ascórbico e Bioacessibilidade. O capim santo apresentou valores nutricionais significativos nos teores de lipídios, carboidratos, fibras, sódio e vitamina C. Espinafre Amazônico *in natura* mostrou valores significativos para proteína e fibra. Já quando branqueado mostrou maiores valores para umidade e proteína. O feijão macuco se destacou nas cinzas, fibras e vitamina C. Ora-pró-nobis *in natura* apresentou maiores valores para proteínas, umidade, manganês, cálcio, potássio, magnésio e vitamina C. Quando branqueado apresentou resultados significativos para carboidrato, ferro e zinco. Na acidez titulável apenas duas amostras sofreram variações significativas no tratamento térmico, capim santo com amostra *in natura* e amostra branqueada e o espinafre amazônico, com amostra *in natura* e amostra branqueada. No pH foi determinado como amostra com menor caráter ácido o espinafre amazônico branqueado, nenhuma das amostras apresentou caráter ácido, sendo o de menor valor o feijão macuco branqueado. Nos resultados, as PANC demonstraram altos valores nutricionais principalmente em micronutrientes e são uma boa alternativa para inserção na dieta da população local por serem baratas e de fácil acesso.
Palavras-chave: Biodiversidade; Recursos; Alimentação; Valores nutricionais.

Resumen
Las Plantas Alimentarias No Convencionales (PANC) son una estrategia para valorar la biodiversidad, las fuentes de alimentos y los recursos nutricionales. Para que haya un consumo correcto, son necesarios estudios sobre PANC. La bioaccesibilidad se ha utilizado para análisis sobre el contenido mineral presente en ciertos alimentos, y si se demuestra un alto contenido de estos componentes en EL PANC, pueden surgir como una alternativa para abastecer las deficiencias minerales presentes en parte de la población. El objetivo de este estudio fue evaluar el contenido y la bioaccesibilidad de macro y micronutrientes de cuatro plantas alimenticias no convencionales utilizadas en la gastronomía amazónica. Las sumas de PANC utilizadas fueron: hierba santa, espinacas amazónicas, frijoles macuco y ora-pro-nóbis. Los análisis nutricionales realizados fueron: Humedad; Cenizas; Lípidos; Proteínas; Carbohidratos; Fibras totales; Minerales; pH; Acidez titulable; Color reflejado; Ácido ascórbico y bioaccesibilidad. La hierba sagrada mostró valores nutricionales significativos en el contenido de lípidos, carbohidratos, fibras, sodio y vitamina C. La espinaca amazónica en natura mostró valores significativos para proteínas y fibra. Cuando se blanquearon mostraron valores más altos de humedad y proteínas. Los frijoles macuco se destacaron en cenizas, fibras y vitamina C. Ora-pro-nobis in natura mostró valores más altos de proteínas, humedad, manganeso, calcio, potasio, magnesio y vitamina C. Cuando se blanqueó, mostró resultados significativos para carbohidratos, hierro y zinc. En la acidez titulable solo dos muestras sufrieron variaciones significativas en el tratamiento térmico, la hierba santa con muestra fresca, la muestra blanqueada y la espinaca amazónica, con muestra fresca y muestra blanqueada. A pH, se determinaron las espinacas amazónicas blanqueadas como la muestra con menor carácter ácido, ninguna de las muestras presentó un carácter ácido, siendo la de menor valor la de macuco blanqueada. En los resultados, el PANC mostró altos valores nutricionales principalmente en micronutrientes y son una buena alternativa para la inserción en la dieta de la población local porque son baratos y de fácil acceso.
Palabras clave: Biodiversidad; Recursos; Alimentación; Valores nutricionales.

1. Introduction

The nutrients present in human food are divided into macronutrients and micronutrients. Among which, macronutrients are determined as macromolecules to be used as a source of energy and as a substrate for the synthesis of carbohydrates, fats, and proteins necessary for the maintenance of cellular integrity and metabolism. Micronutrients are also important to maintain cellular and metabolic integrity, but in smaller amounts. An example of micronutrients are minerals and vitamins (Mahan & Escott, 2005).

The use of plants may emerge as an alternative to supply existing nutritional deficiencies in a large part of the population. Therefore, studies have been carried out to analyze the content of minerals present in plants, as well as the bioaccessible fraction, through assays aimed at bioaccessibility. Bioaccessibility refers to the amount of a nutrient present in a food that becomes bioaccessible for absorption by the body. It is an in vitro process where the physiological conditions that occur during digestion in the gastrointestinal tract are simulated. It is divided into three phases: oral, gastric and intestinal. Each stage is composed of gastrointestinal juices made with mineral salts, compounds and organic enzymes similar to those found in our body (Tognon, 2012).

Due to the large population growth, the rural population began to migrate to large urban centers and the increase in social inequality, such as hunger and nutritional deficiencies, has increased. Native and exotic plants can help with food supplementation and can be a source of supplementary income. Thus, there is a great need to give space for these PANC to be studied and commercialized (Kinupp, 2007).

The great challenge of the future is to produce more and more, as the world's population grows too much. So, looking for more variability of species that can replace without denigrating or even improving human and animal feeding is a good and viable option (Souza et al., 2019).

Unconventional food plants are plants that could be part of our daily consumption. However, due to the lack of knowledge by a large part of the population, many of the plants are characterized as weeds, and can be found in abundance in the environment, often considered as "bush", invasive plants, which are ignored by the population (Liberato et al., 2019).

The term PANC was created to identify different plant species, which are not explored in the national context. However, it does not mean that panc's were generated only from the creation of the term, because the species have always been present in nature, just did not know their usefulness until now (Casemiro & Vendramini, 2021).

PANC (Unconventional Food Plants) are characterized by being native, exotic, spontaneous, wild or cultivated edible species, and are traditionally consumed or used therapeutically in certain regions and cultures. Although few studies have been conducted to assess the nutritional composition and effects of PANC on human health, existing publications show high nutritional value and promising therapeutic actions (Paschoal et al., 2015).

However, the bioavailability of its nutrients can be compromised by the presence of anti-nutritional factors, a term used to compromise chemical compounds that can cause adverse physiological effects and interfere with the bioavailability, digestibility and absorption of nutrients or be toxic, depending on the amount they are consumed (Naves et al., 2010). For this reason, studies on the nutritional composition and possible anti-nutritional factors involving these plants are extremely relevant. With the growing search for a healthy diet and the increase in food syndromes, there is a demand for alternative foods capable of meeting energy and nutritional needs, which are easily accessible to the local population and at low cost.

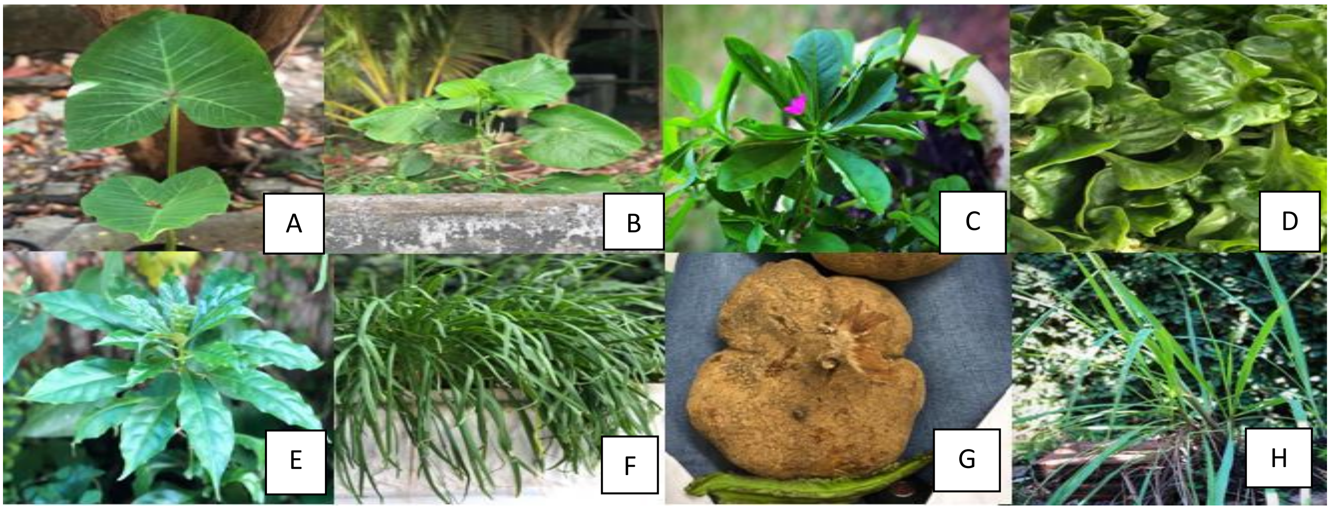
The consumption of vegetables in general, conventional or non-conventional, brings some benefits to consumers, among the improvements to health are the proper functioning of the intestine, are light and easy to digest, aid in satiety, provide few calories, are high in fiber, contains carbohydrates, minerals, vitamins and water, important nutrients for the proper functioning of the body, among other advantages for consumers (Brasil, 2010).

2. Methodology

The materials were acquired at fairs of organic products located in the city of Manaus (AM). Eight species were used for the experiment (Figure 1): taioba (Xanthosama sagittifolium), capeba (Piper umbellatum L.), cariru (Talinum fruticosum), Amazonian spinach (Alternanthera sp), ora-pro-nóbis (Pereskia bleo), grass garlic (Nothoscordum bivalve), cowpea (Pachyrrhizus tuberosus) and lemongrass (Cymbopogon citratus). The analyzes were carried out on fresh and bleached samples, as these are the most consumed forms of the plants. After the previous selection, the edible part of the PANC were washed in running water, then passed through the bleaching process with a temperature around 74°C, the analyses. After the process, the material was stored in plastic bags, cleaned with paper towels and subsequently refrigerated.

Among the nutritional factors determined are the values for moisture, ash, lipids, crude protein (AOAC, 2016); Carbohydrate (by difference); Total fibers (enzymatic-gravimetric method); Soluble and insoluble fibers (enzymatic-gravimetric method); Minerals (atomic absorption spectrometry); Hydrogen potential (pH) and total itratable acidity (Karastogianni et al., 2016); Reflected color (spectrophotometry); Ascorbic acid (HPLC). The anti-nutritional agent (oxalic acid) was determined by the method of Libert (1981).

Figure 1. Species worked on (A) taioba (Xanthosama sagittifolium), (B) capeba (Piper umbellatum L.), (C) cariru (Talinum fruticosum), (D) Amazonian spinach (Alternanthera *sp*.), (E) ora-pro-nóbis (Pereskia bleo), (F) garlic grass (Nothoscordum bivalve), (G) Cowpea (Pachyrrhizus tuberosus) and (H) Holy grass (Cymbopogon citratus).



Source: Marques (2021).

3. Results and Discussion

It was observed that in relation to protein contents (Table 1) the samples of bleached capeba (4.63%), bleached cariru (4.70%) and fresh garlic grass (4.33%) showed higher values. A study carried out by Orting et al., (1996) and Balbin et al., (2005) proved that the macuco bean presents in the chemical composition in its dry roots the levels of proteins in which it can vary from 10 to 18%, being able to be consumed cooked in natura, or as animal feed.

Regarding the lipid values, the lemongrass samples both in natura and bleached (0.8%) stood out from the other samples. Rocha et al. (2008) suggests the use of P. aculeata in lipid-restricted diets, due to the low content of the nutrient.

As most vegetables, PANC also did not present high levels of carbohydrates, the highest portion was found in the blanched ora-pro-nóbis samples (9.73%), in natura taioba (9.97%), blanched cariru (9.95%) and bleached lemongrass (10.96%). According to Martinevski (2011), leafy vegetables in general are not great sources of carbohydrates, a fact that is consistent with the findings of this study, in the case of the bertalha which presented 28.70% of this nutrient and the ora-pro-nóbis 24.80%.

The moisture content in natura that stands out are in the samples of fresh garlic grass (94.13%) and bleached Amazonian spinach (93.23%). In comparison to the data found in the literature, the values are similar. The moisture value of the ora-pro-nóbis leaf was 86.81%, lower than that of Regina lettuce (95.47%) and Vera lettuce (95.58%) (Ohse et al, 2009).

In the case of ashes, it is possible to observe that the samples of in natura (4.56%) and blanched (4.95%) beans are evident. According to Pereira et al. (2003), the ash content refers to the total amount of minerals present in the plants, with bertalha 19.81% (± 0.4) and ora-pro-nóbis a lower value, 13.80 (±0. 16), both in a dry sample. However, when compared with other vegetables, these PANC's can be considered more efficient in the supply of minerals, presenting the carrot leaf 10.50%

(±0.33) of ash for example.

Regarding the fiber values, the samples of cariru (10.50%) and capim santo (27.60%) were the ones that stood out from the others. These values are close to those determined for fruit peels, which are well known to be rich in this component. Gondin et al. (2005) reported the proximate analysis of the composition of seven different fruits, among the fruits studied was banana, which presented 18.90% of fiber, a lower value when compared to that found in lemongrass, thus corroborating the data discussed here.

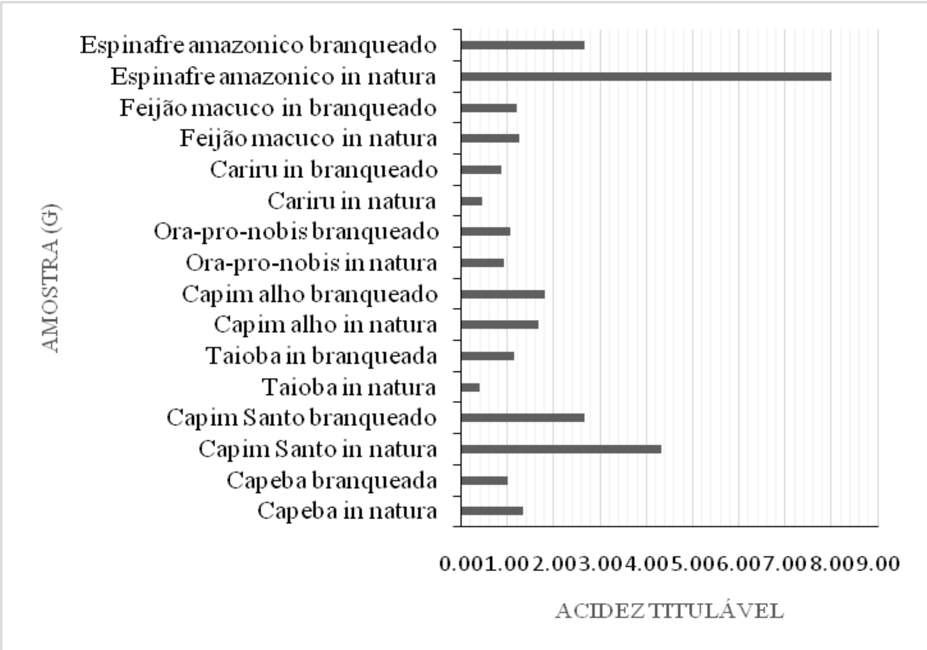
Table 1. Proximal composition of values in percentage of eight species of PANC: Capeba in natura and capeba bleached; Ora-pro-nóbis in natura and ora-pro-nóbis bleached; In natura taioba and bleached taioba; Raw macuco beans and blanched macuco beans; Fresh cariru and bleached cariru; Fresh garlic grass and bleached garlic grass; Fresh lemongrass and bleached lemongrass; Fresh spinach and blanched spinach. With evaluation of eight variables moisture, ash, protein, lipid, carbohydrate, insoluble fiber (FI), soluble fiber (FS), total fiber (FT).

PANC	Moisture	Grey	Protein	lipid	Carbohydrate	*FI	**FS	**FT
Capeba in natura	87.55	2.35	3.77	0.59	2.02	6.76	1.03	7.79
bleached cape	90.36	1.10	4.63	0.59	2.02	5.34	0.65	5.99
Ora-pro-nóbis in natura	91.39	2.15	3.25	0.41	2.80	0	0	0
Bleached Ora-Pro-Nobis	87.83	0.91	1.12	0.41	9.73	0	0	0
fresh taioba	84.76	1.81	3.38	0.08	9.97	0	0	0
bleached taioba	89.64	2.38	2.68	0.08	5.22	0	0	0
raw macuco beans	85.88	4.57	0.92	0.10	0.42	8.95	0.00	8.95
blanched kidney beans	88.29	4.95	0.52	0.10	2.81	5.76	0.00	5.76
Cariru in natura	90.85	1.61	3.29	0.43	6.68	10.50	0.00	10.50
bleached cariru	92.81	1.51	4.70	0.43	9.95	7.35	0.00	7.35
fresh garlic grass	94.13	0.89	4.33	0.53	0.12	0	0	0
bleached garlic grass	92.67	0.62	2.63	0.53	3.55	0	0	0
fresh lemongrass	74.84	1.86	2.86	0.81	7.97	26.64	0.96	27.60
bleached holy grass	84.29	0.92	2.34	0.81	10.96	24.38	0.73	25.11
Amazonian spinach in natura	89.52	1.51	3.48	0.49	2.18	6.54	0.00	6.54
Blanched Amazonian Spinach	93.23	0.89	3.29	0.49	3.76	4.76	0.00	4.76

*FI= Insoluble Fiber, **FS= Soluble Fiber, *** FT= Total Fiber. Source: Authors (2021).

Regarding titratable acidity (Graph 1) most of the samples did not suffer significant variations between samples with and without heat treatment, however, two plants showed significant values compared to the others. The holy grass presented 4.33 while the bleached fell to 2.67. In natura Amazonian spinach, in turn, had a value of 8.00 and blanched 2.67. In terms of pH values, bleached Amazonian spinach (8.27) was determined as the sample with the lowest acidity, none of the samples showed acidic character, and the lowest value was the cariru in natura (5.77).

Graph 1. Determination of titratable acidity of samples.



Source: Authors (2021).

Color analysis (Table 2) was performed for both fresh and bleached samples. In general, there were no significant changes about the treatment of the samples, and the values remained very approximate for both in natura and bleached samples. The taioba in natura sample, however, showed a decrease in the values of a**, the bleached cariru suffered an increase in the values of b*** and the samples of beans, both in natura and blanched, an increase in the values of b** *.

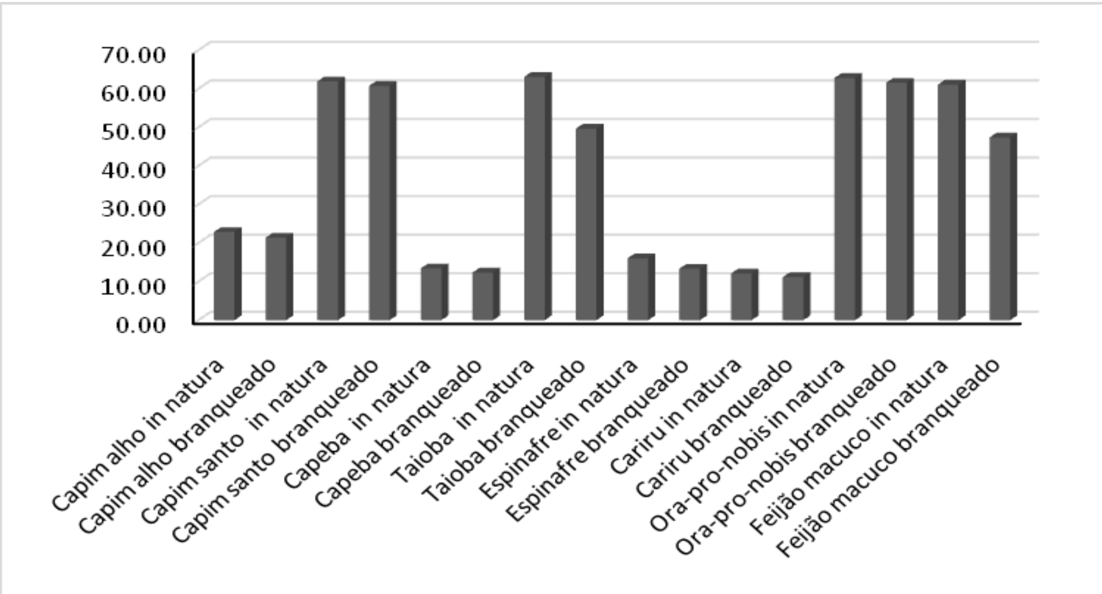
Table 2. Color analysis of eight species of PANC (in natura and bleached).

Sample	L*	a**	b***
fresh garlic grass	29.38	-4.27	4.96
bleached garlic grass	39.16	-2.01	3.45
fresh lemongrass	42.09	-8.2	14.97
bleached holy grass	46.62	-2.94	4.84
Capeba in natura	32.99	-6.89	11.41
bleached capeba	37.64	-1.97	3.06
fresh taioba	27.71	-11.68	20.24
bleached taioba	35.27	-6.04	11.43
fresh spinach	37.27	-0.35	2.38
blanched spinach	34.15	-1.2	8.26
Cariru in natura	32.58	-3.68	7.48
bleached cariru	43.52	2.18	11.87
Ora-pro-nobis in natura	38.75	-10.81	21.01
Ora-pro-nobis bleached	32.63	-12.56	5.36
raw macuco beans	76.43	0.51	14.18
blanched kidney beans	72.39	0.51	17.53

Parameter = L*, Parameter = a **, Parameter = b***. Source: Authors (2021).

Vitamin C contents vary between 11.17 and 63.07 mg of ascorbic acid in 100 g of sample. There were no significant losses of ascorbic acid during the processing of PANC, but the sample with the greatest loss of this nutrient was taioba and macuco bean.

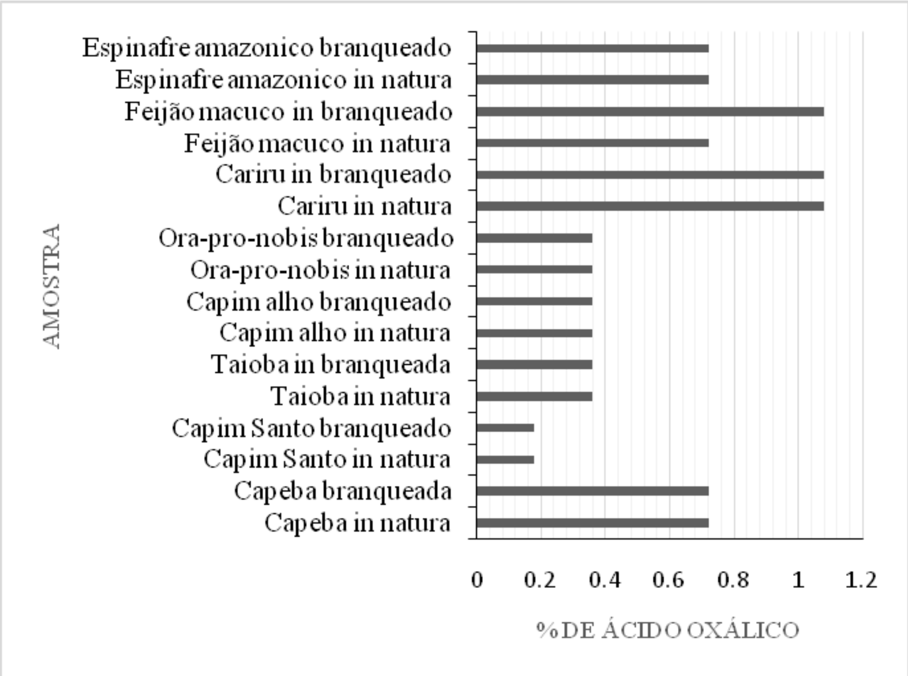
Graph 2. Vitamin C contents of the eight PANC species.Source: Authors (2021).



Source: Authors (2021).

The most significant value of oxalic acid found in the studied samples was determined in the samples of in natura and blanched cariru, both with 1.08% and in the blanched macuco bean sample with 1.08%. The results differ from the values found by Germano *et al.*, (2002) who determined oxalic acid in bean samples with the most diverse mixtures. In the analysis of oxalic acid there were no statistically significant differences between the mixtures, but the highest proportions were in the mixtures with spinach.

Graph 3. Quantification of oxalic acid from PANC species (in natura and bleached).



Source: Authors (2021).

Among the minerals (Table 3) the capeba sample showed the highest copper contents, being in natura (1.29 mg/100 g) and bleached (1.03 mg/100 g). Iron in turn had its contents highlighted in the samples of ora-pro-nóbis in natura (12.34 mg/100 g) and bleached (10.46 mg/100 g). Capeba in natura stood out in terms of zinc content (45.95 mg/100 g). In natura ora-pro-nóbis also showed high manganese terrors (9.50 mg/100 g) as well as in natura macuco bean (8.33 mg/100 g). The highest levels of sodium were found in fresh lemongrass (12.12 mg/100 g). Calcium, in turn, was found in greater amounts in the fresh lemongrass sample (213.27). Potassium was determined in greater amounts in fresh beans (427.45 mg/100 g) and blanched beans (384.51 mg/100 g).

Table 3. Concentration of mineral elements (macronutrients and micronutrients) in mg/100g of PANC from Amazon.

PANC	Minerals (mg/100g)							
	Ass	Faith	Zn	Mn	At	Here	K	mg
Capeba in natura	1.29	10.69	4.59	3.65	5.10	133.79	339.07	65.61
bleached cape	1.03	8.47	2.25	2.02	3.12	88.45	283.74	34.12
Ora-pro-nóbis in natura	0.12	12.34	6.40	9.50	5.10	480.71	619.50	88.27
Bleached Ora-Pro-Nóbis	0.07	10.46	7.83	5.84	3.12	388.56	445.16	66.56
fresh taioba	0.14	2.09	0.29	0.55	0.84	152.64	289.50	46.17
bleached taioba	0.10	1.88	0.20	0.37	0.33	127.57	265.76	23.94
raw macuco beans	0.10	2.62	3.75	8.33	2.19	14.16	427.45	28.27
blanched kidney beans	0.07	1.57	2.70	6.59	1.24	10.16	384.51	25.26
Cariru in natura	0.29	7.16	7.22	4.04	8.17	107.01	356.00	164.66
bleached cariru	0.10	5.30	6.45	1.09	6.71	86.69	142.88	114.05
fresh garlic grass	0.28	1.27	0.81	0.93	1.20	19.75	201.35	6.27
bleached garlic grass	0.05	1.14	0.29	0.80	0.85	12.42	179.85	1.01
fresh lemongrass	0.16	1.05	1.27	1.30	12.12	213.27	214.22	43.49
bleached holy grass	0.03	0.13	0.08	0.28	8.26	125.77	130.08	27.77
fresh spinach	0.05	0.84	3.84	4.29	10.76	222.3	336.88	68.77
blanched spinach	0.02	0.61	3.94	2.16	6.70	148.73	186.45	53.80

Source: Authors (2021).

4. Conclusion

The eight species of PANC used in the Amazonian gastronomy in the in natura and Blanchada showed great nutritional potential, mainly of capeba, ora-pro-nóbis, macuco bean, cariru and holy grass, in proteins, carbohydrates, fiber, minerals and vitamin C. bleaching agents, including vitamin C. Regarding the anti-nutritional fact, oxalic acid, macuco bean and cariru stood out from the other species. Thus, it is correct to say that these plants have high nutritional value, especially about micronutrients and that their introduction into the diet of residents would be beneficial.

A more emphatic exploratory study of the potential of these and other PANC species are extremely important for us to really know the chemical composition and benefits of unconventional plants.

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References

A.O.A.C – Official Methods of Analysis of AOAC Internacional (2016). *Journal of the Association of Official Agricultural Chemists*, 20, Maryland, USA.

Balbin, I. O., Vásquez O. D., Carhuanca, K. M., Sørensen, M., & Kvist, L. P. (2005). El cultivo de Chuin (Pachyrhizus tuberosus): una alternativa para la inocuidad alimentaria y la recuperación de suelos degradados en la Amazonía peruana. Instituto de Investigaciones de la Amazonía Peruana (IIAP), 40, Perú.

Brasil - Ministério da Agricultura, Pecuária e Abastecimento (2010). Hortaliças não-convencionais: (tradicionais) / Ministério da Agricultura, Pecuária e Abastecimento (MAPA). Secretaria de Desenvolvimento Agropecuário e Cooperativismo, 52, Brasília (DF), Brasil.

Casemiro, I. P., & Vendramini, A. L. A. (2021). 10 anos de PANC (plantas alimentícias não convencionais) – análise e tendências sobre o tema. Instituto Nacional de Educação, Ciência e Tecnologia (IFAM). Revista Alimentos: Ciência, Tecnologia e Meio Ambiente, 2 (3).

Germano, R. M. A., & Canniatti - Brazaca, S. G. (2002) Importância do ferro na nutrição humana, Nutrire: rev. Soc. Bras. O Alim. O Nutr. J. Brazilian Soc. Food Nutr., 24, 85-104.

Gondim, J. A. M., Moura, M. F. V., Dantas, A. S., Medeiros, R. L. S., & Santos, K. M. (2005). Centesimal and mineral composition in fruit peels. *Food science and technology*, 25(4), 825-827.

Karastogianni, S., Girousi, S., & Sotiropoulos, S. (2016). pH: Principles and measurement. *The Encyclopedia of food and Health*, 4, Oxford: Academic Press, Elsevier Ltd.

Kinupp, V. F. (2007). Plantas alimentícias não convencionais na região metropolitana de Porto Alegre - RS. Tese de doutorado, Faculdade de Agronomia da Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brasil.

Libert, B. O. (1981). Rapid determination of oxalic acid by reversed-phase high-performance liquid chromatography. *J. Chromatogr.*, 210 (3), 540-543.

Liberato, P. S., Lima, D. V. T., & Silva, G. M. B. (2019). Panc´s – Plantas alimentícias não convencionais e seus benefícios nutricionais. *Environmental Smoke,* 2 (2), 102-111.

Mahan, L. K., Escott-Stump, S., & Raymond, J. L. (2015). Krause- Alimentação, Nutrição e Dietoterapia. Elsevier Brasil., 11, 1256, São Paulo.

Martinevski, C. S. (2011). Caracterização de bertalha (Anredera cordifolia (Dez.) Steenis) e ora-pronobis (Moinho Pereskia aculeata.) e seu uso na preparação dos pães. Trabalho de conclusão do curso. Universidade Federal do Rio Grande do Sul - UFRS. Porto Alegre, RS, Brasil.

Naves, L. P., Corrêa, A. D., Santos, C. D., & Abreu, C. M. P. (2010). Componentes antinutricionais e digestibilidade proteica em sementes de abóbora (Cucurbita maxima) submetidos a diferentes processamentos. Science Tech Aliment., 30 (1), 180-184.

Ohse, S., Ramos, D. M. D., Carvalho, S. M., Feet, R., & Oliveira, J. L. B. (2009). Composição centesimal e teor de nitrato em cinco cultivares de alface produzidas sob cultivo hidropônico. Sci. Agri., 58, 407-414.

Orting, B., Gruneberg, W. J., & Sørensen, M. (1996). Ahipa (Pachyrhizus ahipa (Wedd.) Parodi) In Bolivia. *Genetic Resources and Crop Evolution,* 43, 435–446.

Paschoal, V., Gouveia, I., & Souza, N. S. (2015). Plantas Alimentícias Não Convencionais (PANCS): o potencial da biodiversidade brasileira. Revista brasileira de nutrição funcional. 13, Ed. VP, São Paulo.

Pereira, G. I. S., Pereira, R. G. F. A., Barcelos, M. F. P., & Morais, A. R. (2003). Avaliação química da folha de cenoura visando seu uso em alimentos humanos. Ciência. Agrotec., 27 (4), 852-857.

Rocha, D. R. C., Pereira Júnior, G. A., Vieira, G., Pantoja, L., Santos, A. S., & Pinto, N. A. V. D. (2008). Adicionado macarrão de ora-pró-nóbis desidratado (Pereskia aculeata Miller). O Alim. Nutr,19 (4), 459-65.

Souza, A. P. S., Silva, L. S., & Pierre, F. C. (2019). Plantas Alimentícias não convencionais (Panc): Um estudo de caso na cidade de botucatu. *Anais Sintagro,* 11 (1), 368-374.

Tognon, L. A. (2012). Quantificação e avaliação da bioacessibilidade in vitro de micro e macro elementos em frutas, legumes e cerals. Tese do mestre. Universidade de São Paulo, Ribeirão Preto, SP, Brasil.