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Technological and sensory potential of creole cowpea: a study for consumption appreciation

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ABSTRACT

Creole grains come from seed selected by farmers, therefore, such seed show rusticity and high genetic variability, which suggests their ability to adapt to local conditions, allowing of farmers´autonomy. The objective of this work was to evaluate cowpea creole grains for their physicochemical, technological, and sensory properties, besides seeking the rescue and the consumption appreciation of these grains because of their importance combined with the search for healthy foods. The accessions of cowpea 'Argentino 148' and 'Mamoninha 79' were grown in an experimental area of Embrapa Clima Temperado, in Rio Grande do Sul state, Brazil. 'Mamoninha 79' can be considered a high protein food which shows rapid hydration. 'Argentino 148' shows six-minute cooking time and less hardness, which is a very important parameter for texture and for consumer acceptance. The samples of 'Argentino 148' showed higher averages for sensory attributes of softness, tegument rupture, a sweet and characteristic taste, and uniform color and broth viscosity. Therefore, creole grains are a promising alternative to increase the supply of bioactive compounds for human diet, besides showing positive sensory characteristics, such as displaying a pleasant taste to the palate and soft texture.

Index terms: agrobiodiversity, appreciation, grains.

Ideias centrais

- Valorização do consumo de acessos de feijão crioulo.
- Feijão crioulo de rápida cocção.
- Alternativa promissora de compostos bioativos.
- "Mamoninha 79" alto teor de proteínas.

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Potencial tecnológico e sensorial de feijão-caupi crioulo: um estudo para a valorização do consumo

RESUMO

Os grãos crioulos são oriundos de sementes selecionadas pelos agricultores, as quais devido à rusticidade e ampla variabilidade genética mostram capacidade de adaptação às condições locais, o que torna possível a autonomia dos agricultores. O objetivo deste trabalho foi avaliar o feijão-caupi crioulo quanto às propriedades físico-químicas, tecnológicas e sensoriais, buscando o resgate e a valorização do consumo desses grãos. Os acessos de feijão-caupi 'Argentino 148' e 'Mamoninha 79' foram cultivados em área

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experimental da Embrapa Clima Temperado, no estado do Rio Grande do Sul, Brasil. O 'Mamoninha 79' pode ser considerado um alimento rico em proteína que mostra uma rápida hidratação. O 'Argentino 148' mostra um tempo de cocção de seis minutos e menor dureza, parâmetro muito importante quanto à textura e quanto à aceitação pelo consumidor. As amostras do 'Argentino 148' apresenta maiores médias quanto aos atributos sensoriais de maciez, ruptura do tegumento, gosto adocicado e característico, cor uniforme e viscosidade do caldo. Assim, os grãos crioulos são uma alternativa promissora para aumentar o fornecimento de compostos bioativos na dieta humana, além de mostrar características sensoriais positivas, como sabor agradável ao paladar e textura macia.

Termos para indexação: agrobiodiversidade, valorização, grãos.

INTRODUCTION

Family-based agriculture that practices agroecology, or technologies in agroecological transition, has proved to be an important tool for the conservation of the genetic heritage of the main food crops, besides developing sustainable agriculture (Altieri, 2002). The agroecological/organic production systems are based on processes of valorization of the biodiversity represented by the creole plants – traditional varieties conserved and selected by the farmers –, which due to rusticity and wide genetic variability have the ability to adapt to local conditions, making it possible the autonomy of the farmers (Bevilaqua et al., 2009).

The discussion that has been taking place worldwide on the need to conserve genetic resources, and more particularly on creole varieties, has attracted the attention of the academic world and of world organizations, such as FAO. The agrobiodiversity is threatened and it forms the basis of food for rural populations, notably for low-income people in several countries (Santilli, 2012).

Creole plant populations are important materials for the genetic improvement, due to their high potential for adaptation to specific environmental conditions (Bevilaqua et al., 2014). Since they are a source of genetic variability, the creole plants can be exploited in the search for tolerant and/or resistant genes to biotic and abiotic factors (Araújo & Nass, 2002).

Creole varieties have much of their production carried out on small farms which use a wide variety of genotypes adapted to their economic, environmental, and social conditions, a reason that leads farmers to plant their crops with seed produced over the years. Over the generations, these grains are kept by farmers and are known as 'creole seed'. These seed guarantee the maintenance of ecosystem variability, besides being a strategic option for organic food production and commercialization in specific fairs and markets (Coelho et al., 2010).

Regardless of the cultivation system used, the preservation of creole seed becomes essential for the sovereignty of producers. Knowledge and identification of the varieties present in a region are important actions for maintaining the existing cultural diversity (Gomes et al., 2015). Creole varieties show changes in colors, morphology, and uses. The preference for their use is attributed to characteristics such as adaptability, enhancement of customs, taste, and quality of traditional varieties, in addition to the low cost of production (Pelwing et al., 2008).

Cowpea [*Vigna unguiculata* (L.) Walp.] is an annual legume originated from Africa, and it is part of the diet of many people, mainly family farming (Rangel et al., 2004). Varieties such as common beans, kidney beans, and creole corn have great genetic variability and are worth of studies, not only for their chemical and nutritional composition, but also for their sensory characteristics, as well as for the technological potential of their grains.

In Brazil, cowpea is grown mainly for the production of dry or green grains, for human consumption either in natura or in the form of preserved or dehydrated grains. In addition, it is also used as green fodder, hay, silage, flour for animal feed and, as a green manure and soil protection (Ribeiro, 2002).

Cowpea has considerable levels of proteins, carbohydrates, vitamins and minerals, and low levels of fat. According to Giami (2005), the chemical and nutritional compositions of cowpea, as well as its culinary properties, vary according to environmental and genetic factors. Because of this fact, it is necessary to know its nutritional value, and to verify its sensory characteristics, to guarantee its commercialization, consolidating new options for the market to enlarge the consumption of this grain. It is believed that the new accessions of “creole” beans, coming from preserved cultivation by family farming, have high levels of essential nutrients, and technological characteristics that fulfill consumer needs such as rapid hydration, less cooking time, good flavor, and soft texture.

The objective of this work was to characterize the physicochemical, technological, and sensory properties of creole cowpea grains, in order to seek the appreciation of its consumption.

MATERIALS AND METHODS

Samples

‘Argentino 148’ and ‘Mamoninha 79’cowpea cultivars (Figure 1) were grown in Terras Baixas Experimental Station of Embrapa Clima Temperado, in São José do Norte (31º40′47″ S, 52º26′24″ W, at 57 m altitude), in Rio Grande do Sul, and harvested in the 2017/2018. These accessions came from the germplasm bank of Embrapa Clima Temperado, for which they were acquired from seed preservation by family farming.

The experiment was carried out in the Laboratory of Physicochemistry of the Center for Chemical, Pharmaceutical, and Food Sciences, and in the Department of Food Science and Technology, both belonging to the Universidade Federal de Pelotas. Cowpea grains were dried at 13% moisture, and grind for physicochemical analyses, using a hammer mill (Pulverisette 14, Fritsch, England).

Autora da Figura 1: Thauana Heberle.

Figure 1. Accessions of cowpea‘Argentino 148’ (A) and ‘Mamoninha 79’ (B).

Autora da Figura 1: Thauana Heberle.

Chemical characterization

Moisture, ashes content, crude protein, lipids, and fibers (enzymatic method) were determined according to the official method 991.20 indicated by AOAC (Latimer Jr., 2016). Carbohydrate percentage in the samples was obtained by the difference between 100 and the content sum of proteins, lipids, fibers, moisture, and ashes, as described by Anvisa (2003).

The color of the whole and uniform grains was determined using the CR-300colorimeter (Minolta), according to Lawless& Heymann (1998).The hydration coefficient was established according to the method described by Nasar-Abbas et al. (2008). The previously hydrated grains were subjected to the cooking test, using the Mattson (Mattson, 1946).

The texturometric profile of the cooked grains was determined using a single grain at a time (n=10), which was analyzed in a TA.XT plustexturometer (Stable Micro Systems Texture Analysers, England) and subjected to 80% compression with a cylindrical probe of 40 mm diameter and 1 mms^{-1} speed, in two cycles, using a load of 5 kg for calibration.The hardness parameter was determined as described by Bourne (1966).

Protein digestibility was carried out on bean grain flours following the methodology described by Hsu et al. (1977). For the hydrolysis of the protein solution, an enzymatic solution containing trypsin and pancreatin was employed. The principle of the method is based on the correlation between initial proteolysis speed and digestibility, measured through pH, using an enzymatic solution to digest the sample.

The antioxidant capacity was performed according to the DPPH (2,2-diphenyl-1-picrylhydrazyl) method adapted from Brand-Williams et al. (1995). The determination of total phenols was carried out according toNasar-Abbas et al. (2008). The total tannin content was carried out according to the AOAC officialmethod 991.20 (Latimer Jr., 2016).The amylose content was determined using a colorimetric method with iodine, according to Juliano (1971).

Sensory analysis

The sensory analysis was performed by a trained team of twelve evaluators (professors and students) of both genders, in the Universidade Federal de Pelotas, Brazil, who signed the free and informed consent form and received infomation on the research procedures. The attribute profile test was applied to cooked beans, with a structured nine-point scale. The samples (10 g) were encoded with three random digits (Gularte et al., 2019) and offered on white porcelain plates; testing was performed in individual booths, with white light, free from noise and odors. All the experiments carried out in the present study were approved by the Research Ethics Committee of the Universidade Federal de Pelotas, Brazil, under the number CAAE 76628617.0.0000.5317.

Statistical analysis

The results of the study were subjected to the analysis of variance and to the t-test, at 5% probability, using the software XlStat free version.The relationship between theresults found in the physicochemical and technological parameters of beans were determined by the Pearson´s correlation.

RESULTS AND DISCUSSION

Physicochemical parameters

The studied samples did not differ significantly, at 5% probability, except for protein that varied between 21% and 24% in‘Mamoninha 79’and showed the highest value (Table 1). This grain can be considered a source of protein Anvisa (2012). In a study on cowpea, 32 genotypes were analyzed and 22.95% average protein was observed (Pereira, 2013). The chemical composition of beans can vary according to the cultivar, origin, location, climate, environmental conditions, soil type, nutrition, storage, processing, and genetic modifications, according to Afonso (2010).

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Table 1. Physicochemical and technological parameters of the cowpea accessions 'Argentino 148' and 'Mamoninha 79'.

Variable	Argentino 148	Mamoninha 79
Moisture (%)	15.011±0.8^{ns}	15.65±0.9^{ns}
Lipids (%)	1.27±0.0^{ns}	1.25±0.0^{ns}
Crude protein (%)	21.745±0.6	24.121±0.1
Ashes (%)	3.338±0.0^{ns}	3.382±0.0^{ns}
Fibers (%)	6.2864±0.4^{ns}	5.8596±0.3^{ns}
Carbohydrates (%)	52.361±0.0	49.754±0.0
Hydration coefficient (%)	205.399±0.9	212.19±0.6
Cooking (min)	6	9
Digestibility (%)	76.498±0.0	74.688±0.0
DPPH (**µ**mol L^{-1} Troloxg^{-1})	68.12±1.85	51.48±1.97
Total phenys (mgEAGg^{-1})	11.8±0.21	16.63±1.14
Tannins (mgEAGg^{-1})	19.732±0.1	14.574±0.84
Amylose (%)	16.603±0.73	14.890±10.46
Hardness	88.605±3.0	110.014±1.8
L	34.883±0.6	23.361±7.7
a	18.847±0.8	4.727±0.2
b	10.26±0.2	9.15±0.4

^{ns}Variable has nosignificant effectby the t-test, at 5% probability.

The hydration coefficient and the cooking time were higher in the 'Mamoninha 79' sample. There is a negative correlation between the absorption of water by grains and the cooking time, according to Ntatsi et al. (2018). Thus, beans with longer cooking times tend to absorb less water than those which cook quickly. Cooking time can be a limiting factor in the consumption of beans, as it demands time and energy from the consumer, and beans should be hydrated and cooked to become palatable, according to Bertoldo et al. (2010).

The values found in the present work for protein digestibility were below those found by Souza et al. (2016) in their cowpea sample (83.7%); however, they were higher than those found by Carvalho et al. (2012) (29.39 – 44.05%) in different cowpea genotypes. According to Ntatsi et al. (2018), protein digestibility is a nutritional parameter which seeks the use of a protein source and can be influenced by several factors such as phenolic compounds, protein inhibitors and heat treatment, and its values may be different between bean species and within the same species, which can generate differences from one cultivar to another.

The results found for both DPPH and total phenolic compounds show differences between 'Mamoninha 79' and 'Argentino 148' beans (Table 1). Despite this fact, these results can be considered as high values, in comparison to those other studies. The consumption of antioxidant substances can produce a protective action against oxidative processes which occur in the body naturally. Sousa et al. (2016) found an average of 37.81 µmol L^{-1} Trolox.g^{-1} in their sample, a value that is lower than that found in the present study. One fact which should be taken into account is the tegument color, as there is a relationship between the color intensity of bean tegument and the content of phenolic compounds present in this legume, and of these with the antioxidant activity. According to Xu & Chang (2008), this variation can be explained by the differences between the studied genotypes, as these variations for the antioxidant potential in seed are determined by the color of the grain and the model of genes of each genotype. In addition, variations of cultivation conditions, such as climate change, ways of planting, high temperatures during the grain filling period, the way post-harvest processing is performed, and the time and storage conditions can affect the interactions between nutrients and enhance or hinder their bioavailability (Ávila, 2014).

The level variation of tannins in the two samples of the present study can be explained according to Acosta-Estrada et al. (2014), who state that it can vary according to the tegument color, in which it can be concentrated about 7 to 11 times more in the tegument than in the rest of the grains. When tannins are present in large quantities, they can decrease the bioavailability of proteins, due to the formation of complexes with polyphenols, which are insoluble and of low digestibility, making the proteins partially unavailable. In addition, higher concentrations of tannins are found in the cooking broth, and lower ones, in the peel and cotyledons; therefore, they are able to interfere with the nutritional value of the legumes (Chávez-Mendoza & Sánchez, 2017), which is in line with the present study, since the largest tannin contents were found in the 'Argentino 148' sample, which had the shortest cooking time,.

The two cowpea samples are considered to have a low amylose content, according to Juliano (1971), who classifies the amylose levels in beans as follows: very low (above 2% to 12%; low (above 12% to 20%); intermediate (above 20% to 25%), and high (above 25% to 33%). In a study on the characteristics of starch in common bean (*Phaseolus vulgaris*) grown in different locations, the authors found that the amylose content was variable according to the origin and the cultivation method of the bean grain (Ovando-Martínez et al., 2011).

As to the hardness parameter, the results show that the 'Mamoninha 79' sample displayed a firmer tegument, which is in agreement with the verified cooking time. The texture can be affected by the place and period of production, by the time and storage conditions, and by the chemical composition, among other factors (Ávila, 2014).

The analysis of the colorimetric profile showed that the luminosity of the 'Argentino 148'sample was greater than that of' Mamoninha 79', as its tegument is clearer and more intense. There is a tendency to establish a relationship between color intensity of the bean coat and the content of phenolic compounds (Paredes, 2017). This fact occurred in the present study, since the sample with the highest luminosity is the one with the highest values for phenolics. For the values of a*, it was observed that the sample of 'Argentino 148' obtained the highest value, since the sample displayed a reddish chroma. For the values found in b*, the two samples showed similar results.

In the Pearson´s correlation coefficient of the two samples, the tegument color is highly related to the contents of phenolic compounds, DPPH, tannins, and amylose, as well as the cooking time, which approaches 1, when correlated with the hydration coefficient (Tables 2 and 3). The hardness of 'Argentino 148' is related to physicochemical parameters, such as lipids, ashes, fibers, and carbohydrates, and to the cooking time, which was shorter than 'Mamoninha 79' (6 min).

Table 2. Pearson's correlation coefficient of 'Mamoninha 79' cowpea accession.

Variable	Moisture	Lipids	rotein	Ashes	Fibers	Carbo-hydrates	Hydration coeficient	Cooking	Digestibility	DPPH	Total phenols	Tannins	Amylose	L	a	b	Hardness
Moisture	—																
Lipids	-0.756	—															
Protein	-0.761	0.149	—														
Ashes	-0.081	0.592	0.708	—													
Fibers	0.544	0.961	0.131	0.792	—												
Carbohydrates	-0.642	0.987	0.010	0.713	0.993	—											
Hydration coeficient	-0.052	0.693	0.609	0.991	-0.866	0.799	—										
Cooking	-0.336	0.363	0.867	0.966	0.607	-0.507	0.923	—									
Digestibility	-0.839	0.277	0.991	0.610	0.454	0.121	0.500	0.795	—								
DPPH	0.544	0.861	0.121	0.722	1.000	-0.993	-0.866	0.607	1.075	—							
Total phenols	0.525	0.961	0.241	0.760	1.000	-0.913	-0.756	0.607	1.075	1.000	—						
Tannins	0.512	0.981	0.511	0.452	1.000	-0.893	-0.966	0.607	1.075	1.000	1.000	—					
Amylose	0.534	0.721	0.131	0.792	1.000	-0.963	-0.763	0.607	1.075	1.000	1.000	1.000	—				
L	0.906	0.408	0.964	0.494	0.139	-0.258	0.375	0.702	-0.990	0.139	0.139	0.139	0.139	—			
a	-0.262	0.830	0.427	0.941	0.952	0.908	0.977	0.821	-0.306	0.932	0.915	0.922	-0.952	0.170	—		
b	0.999	0.734	0.781	0.113	0.516	-0.616	-0.019	0.367	-0.856	0.516	0.516	0.516	0.516	0.920	0.230	—	
Hardness	-0.397	0.901	0.294	0.883	0.986	0.959	-0.937	0.731	-0.167	0.986	0.986	0.986	-0.986	0.028	0.990	0.366	—

Table 3. Pearson's correlation coefficient of 'Argentino 148' cowpea accession.

Variable	Moisture	Lipids	Protein	Ashes	Fibers	Carbo-hydrates	Hydration coeficient	Cooking	Digestibility	DPPH	Total phenols	Tannins	Amylose	L	a	b	Hardness
Moisture	—																
Lipids	-0.845	—															
Protein	-0.709	0.976	—														
Ashes	-0.774	0.993	0.995	—													
Fibers	-0.641	0.952	0.996	0.982	—												
Carbohydrates	-0.985	0.741	0.578	0.655	0.500	—											
Hydration coeficient	-0.466	0.867	0.954	0.921	0.978	0.308	—										
Cooking	0.760	0.990	0.997	1.000	0.986	-0.637	0.929	—									
Digestibility	-0.275	0.747	0.873	0.821	0.914	0.107	0.979	0.834	—								
DPPH	0.641	0.952	0.996	0.982	1.000	-0.500	-0.978	0.986	-0.914	—							
Total phenols	0.641	0.952	0.996	0.982	1.000	-0.500	-0.978	0.986	-0.914	1.000	—						
Tannins	0.641	0.952	0.996	0.982	1.000	-0.500	-0.978	0.986	-0.914	1.000	1.000	—					
Amylose	-0.641	0.952	0.996	0.982	1.000	0.500	0.978	0.986	0.914	1.000	1.000	1.000	—				
L	-0.340	0.216	0.422	0.332	0.504	0.496	-0.674	0.353	-0.811	0.504	0.504	0.504	-0.504	—			
a	-0.954	0.966	0.888	0.929	0.842	0.888	0.710	0.920	0.551	0.842	0.842	0.842	0.842	0.042	—		
b	-0.602	0.081	0.136	0.039	0.227	0.730	-0.426	0.062	-0.602	0.227	0.227	0.227	-0.227	0.955	0.335	—	
Hardness	0.686	0.190	0.026	0.071	0.119	-0.800	-0.324	-0.048	-0.511	0.119	0.119	0.119	0.119	0.917	0.436	0.994	—

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Sensory analysis

Table 4. Sensory analysis of the attribute profile test (scale of 9 points) for consumers of beans.

Attribute	Mamoninha 79	Argentino 148
Uniform color	5.71±3.02[ns]	7.08±1.34
Softness	4.12±2.09	5.93±1.34
Rupture of the skin	3.71±2.39[ns]	4.67±2.65
Granularity	4.02±2.64	1.95±1.78
Residual husk	2.90±2.60[ns]	2.22±2.28
Broth viscosity	1.21±1.35[ns]	1.47±1.17
Bitterness	3.15±2.73[ns]	2.6±2.38
Sweetness	2.53±1.95[ns]	3.20±2.78
Bean characteristics	5.85±2.01[ns]	6.34±2.02

[ns]The variable has no significant effect by thet-test, at 5% probability.

The 'Argentino 148' sample showed the highest values for the attributes "softness", "rupture of the skin", "sweetness", "bean characteristics", "uniform color" and "broth viscosity", which are desirable attributes in beans for consumers, and which is consistent with what was showed by the hardness, measured instrumentally, since the sample showed lower values for this parameter. Although 'Mamoninha 79' was not statistically significant, it had higher values for the attributes "residual bark" and "bitterness", showing that it has firm bean seed coat and remains intact after cooking. The "granularity" parameter showed difference between the samples, and the lowest value was that of'Argentino 148'.

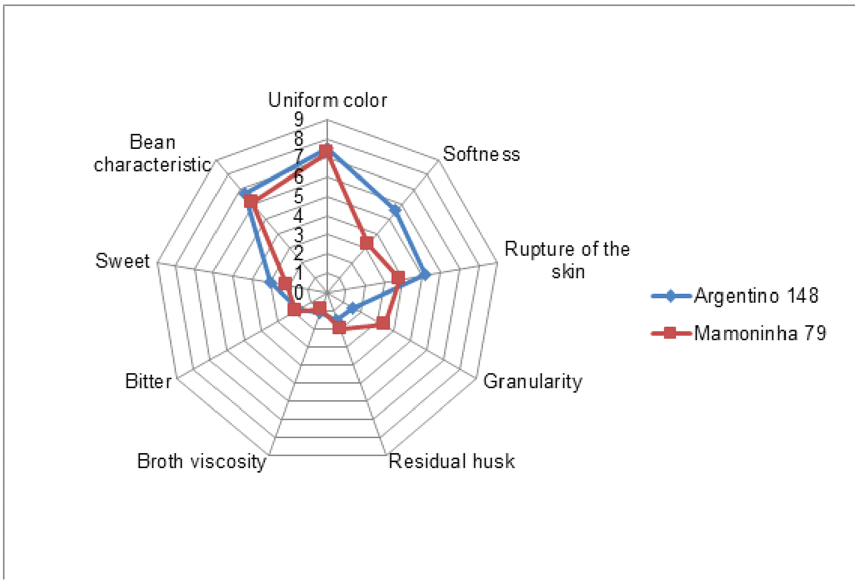

Figure 2. Sensory analysis of the evaluated attributes represented by the spider graph.

CONCLUSIONS

'Mamoninha 79' can be considered a high protein food. 'Argentino 148' shows rapid hydration, besides showing six min cooking time and less hardness, which is a very important parameter for texture. 'Argentino 148'also shows high values for softness, tegument rupture, and sweetness; moreover, it also shows bean characteristics, such as uniform color and broth viscosity, which are some of the attributes more desirable by consumers.

The preservation of genetic resources by family farming for creole seed provides considerable values of essential nutrients for the human diet, consequently offering good market options.

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