v. 3, n. 14, 2023

Journal of
Agricultural
Sciences
Research

SOY AS A FUNCTIONAL COMPONENT: OKARA

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Abstract: Okara is a soybean residue generated during the processing of tofu after the extraction of aqueous fractions. Despite its composition having a high nutritional value in proteins, micronutrients and dietary fibers – which would be an excellent alternative for different markets, especially when we think of the vegan, vegetarian and flexitarian consumer; it is still little explored as a functional ingredient, being used for animal feed or disposal. Due to its high levels of bioactive compounds and functional properties, such as isoflavones, it ends up being a strong ally with regard to the prevention of numerous Non-Transmissible Chronic Diseases. Finally, further exploration is needed in the use of this ingredient, as in addition to leading to less waste, it would also add fiber, bioactive compounds and protein to the diet at a reasonable price.
Keywords: Soy, okara, by-product.

INTRODUCTION

The new social needs provoked an evolution of the food sector, forcing food producers to consider issues beyond price or convenience in their offer. In view of this scenario, vegetarianism/veganism has been gaining more and more prominence as a type of activism that proposes a redefinition of the relationship between humans and animals, being an ideology based on ethical and responsible consumption, which leads to changes in lifestyle and eating habits of consumers (ALEMÁN, 2018).

Although vegetarianism is not a new concept, formal studies on vegetarian diets are becoming more and more remarkable and, with that, new approaches are emerging that aim to meet the real needs of this public (CORRIN; PAPADOPOULOS, 2017; RUBY, 2012).

According to the studies analyzed by the *Brazilian Food Trends* for 2020 on new food trends, the convergence of the entire food chain, whether for production or for services, was observed in the direction of insertion in the plant products segment based, the damnn report Thompson -The Future 100, Trends and change I'm watch in 2021 suggests that the plant-based market is trending towards flexitarian products, which are products developed with animal and plant ingredients.

In 2020, the Institute of Food Technology (ITAL) pointed out transformative actions by companies in production sustainability, as well as signaled in Brasil Food Trends; with regard to reducing losses and waste, reducing the carbon footprint, efficient use of water and sustainability of the ingredients used. With this, consumption gains other dimensions, which transcend individual needs and desires, starting to value prisms such as solidary consumption; care regarding environmental impacts; concern for animal welfare, as well as the ethical behavior of companies. This makes the opportunities within reach and perception of the potential public increasingly evident (ITAL, 2020; SVB, 2018).

In Brazil, the agricultural crop that most contributed to the 2020 harvest was soybeans, the main product in the national export basket, with production of 121.8 million tons, generating R$ 169.1 billion, 35% above the production value of this crop in 2019 (CONAB, 2021).

It is noted that with the increase in soy consumption, large amounts of okara are produced annually in the world. However, the use of okara as a functional ingredient is very low, thus generating a lot of disposal of this poorly exploited ingredient (LI; QIAO; LU, 2012; O'TOOLE, 1999).

In order to reduce the environmental impacts resulting from waste generation, alternatives to the use of agro-industrial by-products as a source of nutrients are sought (GUIMARÃES et al., 2018). Furthermore, okara, as a soy by-product, can be an excellent alternative as a new food ingredient, due to its high levels of bioactive compounds and functional properties, with regard to the prevention of numerous Non-Transmissible Chronic Diseases (NCDs), (PORCEL; CAMPDERRÓS; RINALDONI, 2017).

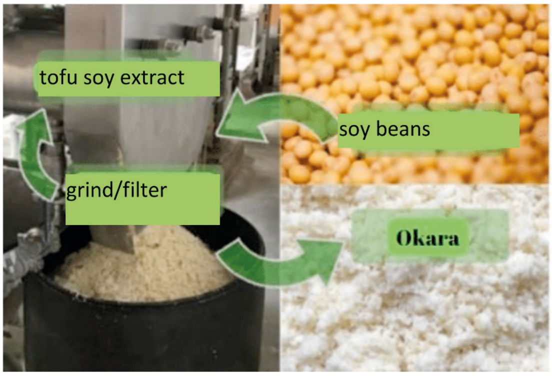
By finding ways to reuse okara and reduce food waste in order to promote the health of the environment; because by encouraging the consumption of this ingredient, it would not only improve the demand to lead to less waste, but also add fiber and protein to the diet at a reasonable price (KASSAHUN; GEBREMICHEAL, 2003; SUZUKI; BANNA, 2021).

Thus, it is important to study okara and its potential for various applications and properties in food products.

OKARA

Soybean (*Glycine Max*) is a grain that belongs to the *Fabaceae family.* The consumption of this legume, its products and derivatives are expanding due to its high nutritional value (about 40% of proteins) and composition rich in calcium and bioactive compounds such as, for example, isoflavones, saponins and high fiber content (RIBANI; COLLINS; BOTTOLI, 2014; SLAVIN; GREEN, 2007).

One of the most popular soy derivatives is the hydrosoluble soy extract popularly known as "soy milk", which can be obtained by washing, macerating and heating soy beans. After these processes, the grains are ground and heated to then undergo a filtration process that will separate the aqueous extract from its by-product, the "okara", shown in figure 1 (QUINAUD *et al.,* 2020).



Okara extraction process.

Source: Adapted from SUZUKI et al. (2021)

Numerous studies demonstrate that the use of the by-product okara would promote improvements, from a nutritional point of view, in food products (BOWLES; DEMIATE, 2006). Amid this range of information, it was possible to observe that it has several components of great nutritional importance, we can mention proteins and dietary fibers, with emphasis on insoluble fibers, as shown in table 1. (DENG et al., 2020; PAULA *et al.*, 2019).

Macronutrients (g/100g)					
Proteins	Lipids	Food fibers	carbohydrates	ashes	Reference
25.4–28.4	9.3-10.9	52.8-58.1	3.8-5.3	3.0-3.7	Riet et al, 1989
15.2	8.3	42.4	4.1	3.9	Li et al, 2008
28.5	9.8	55.5	5.1	4.5	Cuenca et al, 2008
33.4	8.5	54.3	3.9	3.7	Aparício et al, 2010
Micronutrients (mg/100g)					
K	At	Here	mg	Faith	Reference
1046–1233	16.2–19.3	260-428	158-165	6.2-8.2	Riet et al, 1989
1350	30	320	130	0.6	Aparício et al, 2010
936	96	419	257	11	Li et al, 2008

Table 1. Nutritional Composition of Okara.

Source: elaborated by the authors (2023).

NUTRITIONAL ATTRIBUTIONS TO THE CONSUMPTION OF OKARA

Despite the different values found in different studies regarding the nutritional composition of okara (Table 1), in general, okara flour has a high percentage of total dietary fiber and protein (MATEOS-APARICIO et al., 2010; SCHVED et al., 2010).

Due to the prevalence of dietary fibers in its composition, mainly insoluble ones, okara, with its potential prebiotic effect, can be an effective ingredient in a weight loss diet. Despite the complexity surrounding weight loss management, increased satiety may represent a legitimate way to facilitate this process and it is in this sense that fibers seem to play an important role in body weight balance (PRÉSTAMO et al., 2007; SLAVIN; GREEN, 2007; SUZUKI; BANNA, 2021).

Due to its increased protein content, it fits as an ingredient with increased content in this macronutrient, following the parameters for characterization provided for in IN nº 75 (2020) – thus providing an alternative to proteins of animal origin and potentially leading to reduced intake of saturated fat. (SUZUKI; BANNA, 2021).

Soy stands out for presenting some substances, and among them isoflavones, which are evidenced in investigations as agents of prevention and health promotion through their properties, making it a prominent food in nutrition, due to its important role in prevention. of some chronic diseases. (BARBOSA et al., 2016).

Kamble et al., 2019 pointed out that the bioactive ingredients of okara, such as isoflavone, were used as a protective factor against hypolipidemic, hypocholesterolemic syndrome and type 2 diabetes. These anti-inflammatory advantages, cardiovascular defenses and enzymatic inhibitory roles of isoflavones are mainly associated with their antioxidant capacity, which is equivalent or superior to that of other polyphenols (BAIANO et al., 2009).

The predominant isoflavones found in soy consist of four chemical forms, being ß-glycosides, acetyl-glycosides, malonyl-glycosides and aglycones. (LU et al., 2013). In addition, okara has 0.02-0.12% (dry residue) of isoflavones, which represents about 12-40% of the total isoflavones present in soy in natura. (JACKSON et al., 2002). Figueiredo et al. (2019), pointed out that by performing okara protein hydrolysis, it is possible to increase the antioxidant activity and enrich the aglycone content. (Table 2).

	Protein Concentrate		Hydrolyzed Protein	
	Isoflavone content (µmol/g)	% in relation to total iso-flavones	Isoflavone content (µmol/g)	% in relation to total iso-flavones
Malonyl-glucoside	0.73	11.1	Nd	-
acetylgly-cosides	Nd	-	Nd	-
B—gly-cosides	0.81	12.3	2.19	13.3
aglycones	5.06	76.7	14.25	86.7
Total Iso-flavones	6.60	100	16.44	100

Table 2. Profile of isoflavones in protein concentrate and hydrolyzate from dried Okara residue

Source: adapted from Figueiredo et al (2019).

APPLICATIONS OF OKARA INGREDIENTS IN FOOD PRODUCTS

The okara market, comprising its use, source, application and distribution channel, is expected to grow at a rate of 10% from 2020 to 2027 (DATA BRIDGE, 2023). Therefore, it is already possible to observe studies that use okara in the development of new food products, drugs and encapsulations. (NAKAMURA *et al.*, 2021).

Benedetti et al. (2021) developed

three cheese bread formulations with the addition of okara in order to evaluate their physicochemical and physical characteristics and sensory acceptance. According to the results obtained, the three formulations of cheese bread did not show a significant difference in relation to the sensorial analysis of acceptability and the residue contributed to the increase in the concentration of lipids, ashes, proteins and all the concentrations used had fiber enrichment, making viable use in food

Gonsalves et al. (2021) elaborated three formulations of gluten-free cookies, with rice flour and okara, aiming to add value to this industrial residue and nutritionally enrich cookies. Concluding that the insertion of okara in new products becomes viable, since this residue has a high nutritional value and does not significantly affect the appearance of cookies.

Kharel et al. (2021) developed a scalable and cost-effective technique to recycle okara industrial food waste into polysaccharide. These extracts were then transformed into natural encapsulating materials for β-carotene micronutrients and also ferrous sulfate; both using zein as an excipient. Spray drying, as a scalable technique, was employed to produce several formulations that were evaluated for release profiles, shelf life, β-carotene antioxidant activity and cellular cytotoxicity. This demonstrated an optimized formulation of dual micronutrients in sequential release with release of ferrous sulfate in simulated gastric fluid and release of β-carotene predominantly in simulated intestinal fluid. This sequential release profile favors the absorption of micronutrients as well as increasing their bioavailability.

CONCLUSION

Okara is a soybean by-product that is produced in huge quantities worldwide. It is currently discarded or used in animal feed. Despite presenting high levels of bioactive compounds and functional properties, with regard to the prevention of numerous Non-Transmissible Chronic Diseases and starting to observe studies that use okara in the development of new food products, drugs and encapsulations; the use of okara as a functional ingredient is very low, thus generating a lot of disposal of this poorly exploited ingredient.

THANKS

Thanks to CNPq for granting the Productivity in Research 2 scholarship (Process number 303668/2022-9)

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