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Benefits of the *Moringa oleifera* seed husk as bran for human consumption

Abstract

Bran is the husk of cereals, crushed by grinding. It is a food that helps improving different symptoms, mainly for the digestive system. *Moringa oleifera* Lam. It is a plant with a high nutritional value, so the use of Moringa seed husk was evaluated for human consumption and for strengthening foods by producing bran. To characterize the Moringa seed husk for human consumption as bran and emphasize its benefits to health. The bran was produced by grinding *Moringa oleifera* Lam. seed husks with a sieve of 2.0mm. The proximal composition was made by infrared near spectrocospy. The determination of minerals and metals was done by the method PT-AQ-23 and moisture by the gravimetric method. The bran from Moringa seed husks, allowed to have a product with soft powder characteristics and a slightly sandy feel, of beige color with brown tips, discreetly bitter and fresh wood odor. From the nutritional point of view, it contributed the following compounds: fiber protein, starch and fat; everything comparable or superior to the contents in other bran of wheat, rice, oat and barley, among others. The bran from Moringa seed husk is a highly beneficial product for digestive health due to the quantity of fiber it provides, the high nutritional value of its other properties.

Keywords: husk, seed, *Moringa oleifera*, bran, fibre

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Introduction

Moringa oleifera Lam. (Figure 1) is a plant known for many years for its benefits to human health.[1] It is native from the Himalayas[2] and at present, it is distributed throughout Cuba.[3] It provides beneficial nutrients for human health, apart from being a safe food source in areas with few economic resources.[4] Nutritionally, it is a natural product with a high content of proteins, vitamins, minerals and all essential aminoacids.[5]

Figure 1 *Moringa oleifera* Lam. Plant.

Bran is like a dust coming out from seed husk grinding including all seed layers. There are brans from different grains, mainly cereals; their composition records a high percentage of plant fiber made up of cellulose, hemicellulose, lignin and polysaccharides, as well as proteins, fats, minerals and water.[3]

At present, different bran properties beneficial for human health are documented thanks to its components which include dietetic fiber, proteins, minerals, B complex vitamins, vitamin E, phenolic compounds, lutein, anthocyanins, tocotrienols and phytic acid.[6] Its consumption has a protective effect against different cardiovascular and colorectal cancer diseases, obesity, gastrointestinal disorders like constipation, diverticulitis, among others.[7] So it is adapted to the current demands of the food sector where not only its need is tried to be met, but also providing a protection or improvement of the final consumer health.[8]

Moringa seed husk is a byproduct of the oil extraction process. Its composition shows similar characteristics to other parts of the plant, which makes an attractive source of components for nutritional supplements and functional foods.[9] One of the possible ways to evaluate its consumption for human beings is through the production of bran and its addition to strengthen foods based on its plant fiber nature rich in minerals and proteins; however, no references were found in the literature related to it.

Taking advantage of this characterization, the use of Moringa seed husk was evaluated for human consumption, despite not being a cereal, and thus using it to strengthen foods, mainly as source of non-digestible plant fiber and provide other nutrients like proteins and minerals. Based on the above, the objective of this research consisted in characterizing the Moringa seed husk for human consumption as bran to emphasize its benefits to health.

Materials and methods

Plant material

Moringa oleifera Lam. seeds, from India were used and conserved in jute fiber bags at a temperature of (25ºC) and room humidity of (75%).

Seeds selection

Seed selection was manually made on stainless steel tables. The physical evaluation was made by direct observation according to the shape, size, color and texture of the seeds. Foreign matters were separated, empty seeds and those physically damaged by insects as well as those broken at touch, were removed.

Seeds packing process

Selected seeds were washed with abundant fresh water, they were strained over a flexible plastic mesh of vinyl polychloride and were temporarily stored on high-density polybags. Moist seeds were spread over stainless steel stretchers under protected conditions for their sun drying till they reached a stable value of moisture, similar or lower than that prior to washing. All these procedures were manually practiced.

Peeling process of Moringa seeds and husk grinding

Peeling was mechanically made, with a craft equipment prepared for the separation of the endosperms and seed husk, previously cleaned with an ethanol solution at 70% (V/V). Husks were directly collected in high-density polybags at the outlet of the equipment and put in quarantine till checking that microbiological quality requirements were right, more details are provided further ahead.

Obtaining bran implies to crush seed husk on a pharmaceutical quality knife grinder (S200, Retsch), with a sieve of 2.0mm. Then it was packed in high-density polybags.

Microbiological analysis of bran from Moringa seed husks

The microbiological control was done according to the Cuban Standard issued by the Institute of Nutrition and Food Hygiene,[10] and the facilities of the Research Center on Protein Plants and Bionatural Products (CIPB), Havana, Cuba, were used. The presence of total enterobacteria was evaluated, *Escherichia coli,* also the total count of aerobian bacteria and fungi with limits lower or equal to 10^3, 10, 10^5 and 10^3 (UCF/g), respectively and the non-presence of *Salmonella typhi* (UCF/g).

Determination of moisture

The determination of the moisture content was done through the gravimetric method in the moisture analytical balance (MA37, Sartorius).[11]

Proximal characterization

The determination of ashes, proteins, fibers, starch and fats was made through the method of near infrared spectroscopy (NIRs), using a FOSS equipment, model DS2500, serial number 91780964.[11]

Mineral and metal content

Mineral and metal content analyses were contracted to the Laboratory of Chemical Analysis of the Center of Technological Applications and Nuclear Development (CEADEN), in Havana, Cuba. They were made by the technical procedure for the complete dissolution of samples of biological origin, method PT-AQ-23, and Trace series AAS COOKBOOK 1. All the analyses were replicated three times according to the standards of Good Laboratory Practices (GLP).

Bioactive compounds

Lignin content was determined by the procedure NREL/TP-510-42618.[12] The cellulose content was measured by the method of Kushner and Höffer. [13]

Toxicology

The acute toxicity study of the bran from Moringa seed husk was made orally using rats Cenp:OFA (SD), at the Experimental Toxicology Center (CETEX) of the National Center of Lab Animal Production (CENPALAB), Havana, Cuba.

Manufacturing of baker cookies and mini pancakes with bran from Moringa seed husk

The production of baker cookies with bran was made according to the methodology described by Almora,[14] and the production of mini pancakes with bran followed the methodology described by Lago.[9]

Statistical analysis

The descriptive method was used for the statistical analysis. Data from all tests were the results of the mean of three replicates (n=3). The mean and the standard deviation of all processed values were calculated using EXCEL, 2016.

Results

From Moringa seeds (Figure 2) the procedure used allowed to get bran from its husk (Figure 3) with the following organoleptic features. Soft powder, slightly sandy feel, of beige color and brown tips, discreetly bitter flavor and fresh wood odor.

Figure 2 Moringa seeds.

Figure 3 Bran from Moringa seed husks.

Proximal characterization

The bran from Moringa seed husk in its proximal composition showed a higher moisture content, proteins and plant fiber compared to other brans (Table 1), unlike the concentration of starch and fat content that recorded lower values.

Table 1 Proximal composition of different brans

Parameter (%)	Bran of: Moringa	Wheat	Rice	Oat	Barley	Rye	Sorghum
Moisture	5.82±0.165	12.1	10.0	9.0	10	11.1	12.0
Protein	22.9±0.411	14.7	12.2	12.8	11.6	15.9	7.8
Fat	13.0±0.212	4.0	11.8	5.6	3.4	2.9	4.8
Fibre	37.2±0.258	9.9	12.3	13.5	14.6	6.3	7.6
Ash	7.04±0.363	5.8	16.1	4.8	5.0	4.5	2.1
References	Own data	FAO, 2002	FAO, 2002	FAO, 2002	FAO, 2002	FAO, 2002	FAO, 2002

Bioactive compounds

Lignin and cellulose are the fundamental polymers providing structural hardness to the plants. Lignin has a high stiffness and acts as an adhesive to the cellulose, giving plants its structural integrity. Table 2 shows the content of both compounds in the bran of Moringa seed husk and wheat.

Table 2 Structural bioactive compounds

	Types of bran	
	Moringa	**Wheat**
Lignin	25%	2.2 a 9.0%
Cellulose	21%	6.5 a 9.9%
References	Own data	Chaquilla *et al.*,[6]

Mineral and metal content

Table 3 shows the chemical composition of the bran from Moringa seed husk. All evaluated compounds showed a higher value compared to the bran from wheat seed husk.

Table 3 Chemical analysis of bran from Moringa seed husks and wheat

Compound	Moringa seed husks (mg/kg)	Wheat (mg/kg)
Sodium	284	2 a 41
Magnessium	1431	390 a 640
Potassium	6532	1182 a 1900
Calcium	10287	24 a 150
Manganese	8.54	4 a 14
Iron	144.6	2.5 a 19.0
Nickel	2.02	-
Copper	6.99	-
Zinc	64.2	2.5 a 14.1
Cadmium	<0.63	-
Lead	3.49	-
References	Own data	Chaquilla *et al.*,[6]

Microbiological analysis

The microbiological control made to the bran from Moringa seed husk showed a total count of aerobials of 4.2 x 10^3 UCF/g, total enterobacteria 10^2 UCF/g, whereas the total count of fungi, *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Salmonella sp.* was equal to 0 UCF/g. Any of these values surpassed the acceptance limit of the product, therefore, the microbiological result was satisfactory, since it met the requirements for this type of foodstuff.

Toxicology

When the study of acute toxicity at a unique rate was done, no toxic damages, negative clinical expressions and weight reduction were found in the rats used for the study. Besides, no anatomopathological disorders were found in the organs of the animal sacrificed for the trial.

Manufacturing of baker cookies and mini pancakes with bran from Moringa seed husk

Strengthened baker cookies with bran from Moringa seed husk at concentrations of 5, 10 and 15% maximum (Figure 3A), were accepted by consumers.[14] The fiber provided by the bran from Moringa seed husk when mixed and baked with the other components making up flour-made products, was not unpleasant to palate, it was neither bitter nor astringent.

Mini pancakes were also strengthened at Papa´s & Co.[9] Bran concentrations were 1, 3 and 5% (p/p) (Figure 3B) and showed positive results from the organoleptic point of view and were accepted by consumers without rejections by the presence of this plant fiber in them.

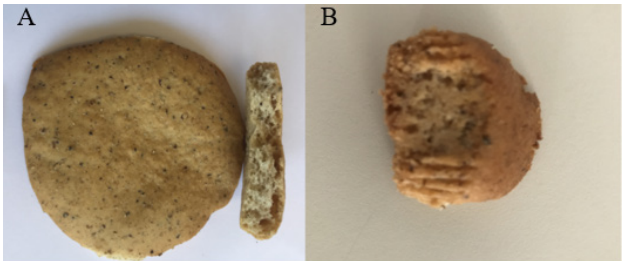

Figure 3A&B Strengthened foods with bran from Moringa seed husks. A) Baker cookies; B) Mini pancakes.

Discussion

The results of the proximal analysis showed that the bran from Moringa seed husk, provided a higher content of protein, fat, fiber and ashes than the brans from cereals like rice, oat, wheat, sorghum and barley; unlike the moisture content that showed a lower value (table 1). In this parameter, the fiber content of the bran from Moringa seed husk, doubled that of the barley and was five times higher than the wheat's. This issue is of great importance to human diet and it is a very useful tool to increase the non-digestible components of foods.[15]

Fiber is an important element within a balance diet; due to its physiological features and multiple effects for digestive transit, it is considered to play a significant role in physiopathology, prevention and treatment of multiple diseases.[16] Epidemiological studies made to a large sample of healthy people, dietetic fiber had a protective effect against cardiovascular diseases, both from the incidence and mortality points of view.[17]

Most of the epidemiological data indicate that a higher ingestion of fiber relieves symptoms and reduces the intraluminal pressure of the colon; avoids the saccular formation through the intestinal wall which improves its function (Rubio, 2002; Ruiz, 2015).[7,18] That is why most of the clinical practice guidelines suggest to increase the consumption of fiber to avoid diverticulitis and its deleterious consequences (FAO, 2002).[15] So it can be deduced that the bran from Moringa seed husk has a similar effect, however, it is something to consider and that should be experimentally confirmed.

It has been published that the protective effect of wheat bran in the colon cancer, is due, among other factors, to its high fiber content, which causes an increased fecal volume, a dilution effect on the faeces of potential carcinogens or carcinogen promoters and reduced time of intestinal transit, all of which limits the entrance of faeces into the epitelial cells.[19] This is something that can also be attributed to the plant fiber present in the bran from Moringa seed husk.

There are evidences that soluble dietetic fiber contributes to reduce the concentration of glucose and insulin in the postprandial serum, both in healthy persons and in those suffering from diabetes mellitus. Among the mechanisms to express the beneficial effect are: increased viscosity of nutrients in the small intestine, which delays the diffusion of glucose towards the ciliated edge of the intestine mucous; the union of the glucose to the dietetic fiber and the reduced availability for uptake and inhibition of the α-amilase action over the starch.[20]

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Different authors state that wheat bran acts on the physiology regulation and improves digestive health, delays gastric emptying, contributes to satiation, accelerates intestinal transit and increase the fecal mass. On the other hand, epidemiological results showed an inverse relationship between the ingestion of fiber and obesity,[14] as well as with the risk of suffering colon cancer.[20]

Among all bran types, that of Moringa seed husk, is the one that provides more proteins (Table 1), it even tripled that of sorghum, which is an indicator of the high protein level of this bran. Proteins are the main structural and functional component of the cells and have lots of important functions in the organism.[21] From the nutritional point of view, it is a macronutrient present in foods whose limitation causes a growth delay;[22] its corporal loss in adults is associated to several pathological disorders and increased mortality. It is a potential to be used in the formulation of food products.[23]

One of the main uses of Moringa is by pressing seed husk to prepare a cake to formulate rations for animal feeding[24] for its high protein content.[25] The strengthening of foods with Moringa increases nutritional values, organoleptic properties, oxidative stability and the useful life of the product.[26]

On the other hand, the bran from Moringa seed husk, showed a high ash content (7.23%) with the second higher among the brans under study. This indicator is considered of importance over the uptake capability of soil minerals and their content in plants.[27]

It was also observed (Table 1), that this bran had a moisture content (5.82±0.16%) below the convenient value for its conservation (12%). Values above this range could generate the proliferation of fungi, bacteria and undesirable enzymatic reactions.[20]

The fat content (13.09±0.21%) surpassed that of other brans and its high level backs up what was observed when baker cookies were strengthened with this bran at different rates, which caused an increased fat content in them.[19]

Lignin and cellulose are polysaccharides making up the stiff structure of the plant, so they favor the hardness feature. As for bran in this study, the concentration of lignin and cellulose (Table 2) did not cause hardness to tasting the plant fiber ingested in foods made with flour (mini pancakes and baker cookies).[9] The cooking for bran in these products, allowed its total softening. The quantity of lignin and cellulose in the bran from Moringa seed husk provided 46% of the non-digestible fiber which is very beneficial for the digestive system.

Minerals have several functions in the human body, among them, chlorine, sodium and potassium that are present as salts in the corporal fluids where they have the function of keeping osmotic pressure. Likewise, they are part of the structure of several tissues.[28]

The calcium content in the composition of bran from Moringa seed husk tripled the quantity present in wheat (table 3). Calcium is a macronutrient that should always be present in the human diet, since it is the most abundant mineral element in the human body, an important component of the skeleton and teeth. It is also indispensable for muscular contraction and nerve system functioning.[14]

Likewise, the bran from Moringa seed husk showed a high sodium and potassium contents (Table 3). The former one is the main determinant of the osmolality of the extracellular fluid, so it has a key function in controlling water distribution and water balance in the whole body; it promotes the transmission of nerve impulses; activates different enzymatic reactions; makes easier the regulation of the acid-base balance and encourages the contractility of the myocardium, the skeleton muscle and the smooth muscle.[29] In turn, potassium is a mineral that has a special importance as to cell and electrical function are concerned, because it is a type of electrolyte taking part in vital functions of the muscular and heart contraction, transmission of nerve impulses, hydration and acid-basic balance. A diet rich in potassium helps to counteract some negative effects of sodium over the blood pressure.[30]

Potassium concentrations are regulated by the renal elimination and influenced by the pump Na^+/K^+ and by the pH. The pump Na^+/K^+ regulates extracellular levels of potassium by extracting sodium from cells and passing potassium inside. Besides, it avoids that osmotically active sodium particles accumulate inside the cells, which would cause and intracellular edema due to the incoming water after the sodium. In kidneys, sodium and potassium keep a reciprocal relationship.[31]

The study made with baker cookies enriched with bran from Moringa seed husk showed increased the evaluated bromatological parameters as the rate of bran in them increased too.[19] Whereas the use of Moringa seed husk as bran to strengthen mini pancakes, showed a directly proportional relationship between the strength provided by the bran and the concentration of minerals present in them and provided by the bran; as the bran content was higher, the higher content of minerals in the pancakes.[9] All the above, coincided with the reviewed literature; Moringa is a plant with a high content of essential minerals as potassium, iron, calcium and sodium.[32]

The use of Moringa seed husk as bran to strengthen foods, allowed to incorporate a set of nutritional elements essential to feeding, since they provide the human body with a balance of proteins, carbohydrates and minerals. Thus, it is fair to say that baker cookies and mini pancakes strengthened with bran from Moringa seed husk are products with good organoleptic and nutritional quality as to flavor, texture and odor are concerned, that also received the approval of tasters.[9,19]

The microbiological controls were proven by the Microbiology Laboratory of the Cuban Ministry of Public Heatlh, an institution that certifies products as suitable for human consumption as per the requisites of Cuban Standards "Microbiological Contaminants in Foods for Manufacturing".[20]

Conclusion

The bran from Moringa seed husk is a product accepted by the human taste, highly beneficial for digestive health due to the quantity of fiber it provides. It also has a high nutritional value based on its properties. It can be mainly use to improve the nutritional quality of flour baked products.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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