Functional characterization of peanut (*Arachis hypogaea*) waste and its use in the development of nutraceutical products

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Abstract. Peanut (*Arachis hypogaea*) is a legume composed of seeds, cuticle and pericarp, structures composed mainly of mostly insoluble fiber phenolic components, antioxidants and proteins. In the present work, it was characterized physicochemical and functionally to the pericarp and tegument, obtaining a humidity of 2.37 and 5.97 g/100 g, ashes of 3.22 and 2.69 g, 6.54 and 19.12 g of proteins, 2.84 and 13.99 of ethereal extract, 14.51 and 38.78 g of non-nitrogenous extract, 72.86 and 19.43 of crude fiber, respectively. Also, for the functional properties values of 0.39 and 8.75 mL of water/g were obtained for HC, 3.80 and 7.32 mL of water/g for AAC as well as 2.49 and 6.32 g/g of oil for AaC respectively. Non-standard microbiological results were obtained for the pericarp, which discards its use in product development. Only the tegument was used for the preparation of a wheat flour tortilla,, in which 1% of this was replaced by peanut cuticle; with this, the importance of the use and use of these residues is emphasized to provide the consumer with nutritional benefits, such as fiber and protein in this particular case; thus helping to reduce the production of such waste by not being used.

Keywords: peanut, cuticle, physicochemical, functionally, use of residues

1. Introduction

Arachis hypogaea, from a plant with a height of 30 to 40 centimeters, with branches tended, the seeds are surrounded by a very thin cover (cuticle or tegument) whose color varies from red, red or coffee, according to its subspecies and variety of the peanut (León J., 1987). These are given within a woody texture sheath commonly known as a shell or pericarp. This part contains important levels of insoluble fiber, antioxidants, and proteins that can be harnessed for food uses.

This seed is the part most widely consumed legumes in the worldwide (The Peanut Institute, 2010); countries like China, India, Nigeria, the United States and Senegal are positioned as the main producers. Consequently, shell and cuticle wastes are generated, which are usually released to the soil, thus generating contamination that is hardly degradable when exposed to the outside (Arguello and col.2005).

An important characteristic of the residues is the content of bioactive compounds, better known as nutraceutical substances, which in definition are chemical or biological substances, considered as food or part of it, capable of providing great health benefits ranging from breeding. Physiological functions to the prevention or treatment of certain disease within this group are fibers, pigments, flavonoids, phenolic compounds and vitamins to mention a few (Casas L., 2014); Noting that some of these are found in the pericarp or cuticle. Currently, only the pericarp is used in other areas, such as food for cattle, vehicle for pesticides or fertilizers, as well as a medium for growing fungi, among others. The objective of the present work was the functional characterization of the Virginia variety peanut residues from the state of Morelos, Mexico; with the purpose of taking advantage of them and incorporating them into new nutraceutical products.

2. Materials and methods

2.1. Conditioning of the raw material

The size reduction was performed in a cyclone mill followed by a size classification; 500 g were weighed, and then passed through Tyler 40 mesh sieves.

Chemical characterization

Proximal chemical analysis was performed according to the official methods described by the Association of Official Analytical Chemist (AOAC, 2006), covering the following analyzes: moisture (Method 934.01); total ash (method 955.04); total protein % N X 6.25 (Method 993.19); ethereal extract (Method 920.39); crude fiber by acid-alkali hydrolysis (Method 991.42) and total carbohydrates as nitrogen-free extract (ELN).

Microbiological evaluation

Samples were prepared according to Mexican Official Standard NOM-110-SSA1-1994, followed by total count (NOM-110-SSA1-1994), fungi and yeast (NOM-111-

SSA1 -1994), total coliforms (NOM-113-SSA1-1994), as well as aflatoxins.

Functional characterization

All determinations were performed using the methodology proposed by Zambrano *et al* (2001).

Swelling capacity (CH)

In a graduated tube 0.5 grams of the sample was weighed, measuring the volume occupied (Vo); then 5 mL of water was added to stand for 24 hours. Subsequently the volume was measured and the calculations were made (gram of water / gram of dry sample).

Water absorption capacity (WAC)

0.5 g of the sample was placed, which will be p1; in a falcon tube, then 5 milliliters of water were added and stirred for 30 minutes; then centrifuged for 10 minutes at 3000 rpm, the supernatant removed and concluded by weighing the supernatant, weight was p2; finally we will proceed to make its calculation and report in mL of water / gram of dry sample.

Oil absorption capacity (OAa)

In a tube Falcon were placed 0.5 g of the sample (p1), which was added 5 mL of extra virgin olive oil and stirred for 30 minutes; taking the sample centrifuged for 10 minutes at 3000 rpm, remove the supernatant after even though the sediment (p2), and finally it was reported in gram of oil/gram of sample with the calculation with the following equation

Processing of the product

There were wheat flour tortillas to which was added a proportion of 1% only of cuticle. The mass was carried out with 100 g of wheat flour, 11 g of butter, 0.5 g of baking powder, 0.8 g of salt and 52 g of water, for the case of the witness; mixing all the materials in that respective order, in the case of the replacement the procedure was the same only with the change of 99 g of wheat flour and 1 g of cuticle of peanut butter

3. Results and Discussion

In Table 1 is presented the chemical composition of the pericarp of peanut butter; it can be seen that the crude fiber content was of 72.86 g/100g, which indicates that this is the major component of this structure, as Guerrero-Colin *et al*., 2016 with 75.34g/100g. As for the other characteristics, we showed small variations on Guerrero-Colin *et al*., 2016, attributed to the variables in terms of variety of peanut butter, among others.

Table 1. Proximal chemical analysis of the peanut pericarp (g / 100g)

(g / 100 g sample)	**Pericarpio**	**Cutícula**
Humidity	2.38 $\pm$0.03	5.97 $\pm$0.26
Ashes	3.22 $\pm$0.10	2.69 $\pm$0.07
Ethereal Extract	2.85 ±0.07	13.99 $\pm$0.4
Protein	6.55 ±0.01	19.12 $\pm$0.09
Crude Fiber	72.86	18.27
Non-Nitrogenated Extract	14.52	38.78

On the other hand, the proximal chemical analysis in the cuticle was carried out in the same way, and it can be seen in Table 1 that the major components of the peanut cuticle are carbohydrates, fiber, proteins and ethereal extract in a smaller proportion. The results were 38.78, 19.43, 19.12, and 13.99 g/100g of sample, respectively. It should be noted that the values obtained cannot be compared with others reported, since no similar work has been found in this study, although there have been reports of replacing the soy cuticle for the production of feed for cattle and (Crawfor and Garner, 1993), with values of 3.50, 4.12, 5.31 and 7.80 g in moisture, ash, ethereal extract and proteins respectively.

In the analysis, in the determination of aerobic mesophiles showed that in the shell there was a growth of 166,000 CFU / mL, while the cuticle had 76,000 CFU /mL; according to the NOM-147-SSA1-1996 it is considered that the values of the shell are not acceptable whereas the cuticle itself is within norm. According to the results obtained and by normativity the shell is out of standard and therefore its use is ruled

As for the functional properties, the water retention capacity has to do with the size of the bolus of food that it will take in the organism and with it, the effect of satiety is presented; it was obtained from 0.39 mL of water/g dry sample, a value not far from that obtained in the work of Guerrero-Colin *et al* 2016. With 0.95 and 0.98 mL of water /g regarding the cuticle, a value of 8.75 mL of water /g dry sample was obtained.

Table 2. Functional properties of pericarp and cuticle of peanut

Functional properties	**Pericarp**	**Cuticle**
Water absorption capacity - WaC	3.83 ± 0.22 $mL\ water / dry\ sample$	7.32 ± 0.64 $mL\ water / dry\ mass$
Oil absorption capacity	2.45 ± 0.11 $(g\ oil)/(g\ dry\ sample)$	6.32 ± 0.87 $(g\ oil)/(g\ dry\ sample$

Capacity of retention ions CRI	0.02 ± $0.41x10^{-4}$ $\frac{meq[H]}{gmuestra\ seca}$	$1.91x10^{-5}$± $3.5x10^{-7}$ $\frac{meq[H]}{gmuestra\ seca}$
Water retention capacity WRc	0.39 ± 0.28 mL H 2 O / g dry sample	8.75 ± 0.43 mL H 2 O / g dry sample

In water absorption capacity, it is the maximum amount that can be retained when excess water is present; the shell had 3.83 mL of water /g dry sample, the value of which was far from that obtained by Guerrero-Colin *et al*, 2016. Since they register 2.45 and 2.95 g / g, this can be considered that it varies due to the type of peanut variety since the shell will not have the same structural properties; the cuticle was 7.32 mL of water /g shows dry and equally in this and other cases there is no reference range with which to compare these results. The capacity of oil absorption is based on the determination of the ability of fiber (especially lignin) to bind to bile acids, cholesterol, drugs, carcinogens and mutagens to extract them and depends on the size of the molecules of the fiber to attract oil and other molecules. The results show that the peanut cuticle is an agent with high capacity to extract organic molecules with a value of 6.32 g oil /g sample, comparing it with the peel because it had a lower value (2.49 g oil/g sample) which is recorded in the work of Guerrero-Colin *et al*, 2016 which was 2.69 and 3.28 g/g returning to the idea of why the variations, as already mentioned.

Finally, the capacity of retention ions is the ability of the fiber to bind to cations and is related to the amount of minerals that are absorbed at the intestinal tract by the fiber, so a high value is bad for because it would cause decalcification. The result obtained from the peanut cuticle for this determination was very low (1.91x10-5 meq/g sample), which is considered suitable for human consumption since it would avoid decalcification problems as mentioned; although for the case of the shell, it was obtained that it was 0.0207 meq/g sample equally low, which is favorable; in this case, a reference margin was not found either. Finally, wheat flour tortillas were made at 1% of peanut cuticle with a thickness of approximately 2 mm and a weight of 8 g, which showed characteristic white coloration of the product with small reddish areas typical of the cuticle, to emphasize that this change was not unpleasant for the moment of its consumption, its flavor was the characteristic one with a small residue of peanut, that is considered, it is due to the fat of the seed that absorbs the cuticle when being covered it, as for the smell was characteristic of the product; with this one can propose to realize this product with the incorporation of the peanut cuticle.

4. Conclusions

Only the peanut cuticle is viable to be treated and incorporated into a new product due to its protein content as well as its functional properties, besides having values within the norm in terms of its microbiological analysis and taking advantage of the little sensorial change that it produces the food to which it is incorporated.

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