AVOCADO COPRODUCTS: POTENTIAL FOR OBTAINING BIOACTIVES FOR FOOD

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ABSTRACT

Obtaining stable bioactives with high biological activity and nutritional potential from agro-industrial co-products can reduce production costs and add value to raw materials, contributing to the minimization of environmental problems of incorrect disposal. Avocado (*Persea americana*) is consumed worldwide and has a high concentration of bioactive compounds. Its processing generates approximately 2.4 million tons of by-products. Peru is a major producer of avocados and Brazil has stood out in the production of this fruit. The objective of this work was to obtain phenolic compounds and determine the antioxidant activity of avocado seed flour and oil. This work is ongoing and is part of a Brazil-Peru partnership that aims to value Latina researchers, highlighting our biodiversity and technological potential. The avocados were obtained from a producers' association in Trujillo (Peru). The fruit was sanitized and the seed powder was obtained by grinding. The oil was cold extracted. Phenolic quantification analyzes and measurement of antioxidant capacity were carried out using spectrophotometry. The flour and oil were obtained in high yields. It was possible to extract phenolic compounds in 15 minutes using water as a solvent. The highest inhibition values using seed flour extract (74%) were obtained in 30 min with DPPH.

Keywords: antioxidant. phenolic. DPPH. sustainability.

1 INTRODUCTION

Many matrices processed by the agroindustry, mainly the food ones, present a high rate of production of waste that is not fully used and ends up generating an environmental problem about its inadequate disposal, in addition to substantial social and economic problems [1]. Therefore, the waste of food due to the incorrect use of matrices has gained increasing attention from public, national, and international organizations. It is known that there is a cultural, economic, and resource gap when we consider the waste management system between developed and developing countries that needs discussion and can help in industrial execution [2]. Most wastes from food processing are excellent candidates for biotransformation processes due to their composition rich in carbohydrates, lipids and proteins [3] . According to the 2021 World Economic Forum reports, 931 million tons of food waste are generated per year. At the current rate of waste generation, global waste is expected to reach 3.4 billion tonnes by 2030 [4]. Some authors cite that the use of waste from food processing will contribute to the transition to the bioeconomy and to a society with reduced waste [3–5].

Brazil and Peru are countries that have a rich biodiversity. The present work focuses on the co-products generated in the processing of avocado (*Persea americana* 'Hass'). According to an April 2023 publication by HortifrutiBrasil, the avocado has been highlighted in the fruit sector and the FAO (Food and Agriculture Organization of the United Nations) projects that the avocado will become the most commercialized tropical fruit by 2030. Avocado has a high concentration of bioactive compounds, such as unsaturated fatty acids, vitamins, phenolic compounds, anthocyanins and carotenoids [1].

Global exports of avocado are above four million tons, surpassing external sales of mangoes and pineapples, and second only to bananas. Currently, the main world exporters are, in the Northern Hemisphere, Mexico, Spain and the United States, and, in the Southern Hemisphere, Peru, Chile, Colombia and South Africa. Brazil is still not a major global player, but since 2015 it has been registering strong growth in production, which has led the country to position itself among the 10 largest global producers.

Obtaining bioactives with high biological activity and nutritional potential from agro-industrial co-products can reduce production costs and add value to raw materials, contributing to the minimization of environmental problems of incorrect disposal. Among the bioactives, antioxidant compounds stand out for delaying and helping to protect the body's cells from oxidation caused by free radicals. Free radicals are unstable organic or inorganic molecules and atoms produced by the human body, and can cause great harm to health. They can be generated in the cytoplasm, mitochondria or cell membrane (proteins, lipids, carbohydrates and DNA) and are related to their site of formation [2].

According to the Peruvian government portal Agroideias, currently the *Asociación de Productores Orgánicos Gran Chimú* has managed to consolidate its production chain by charging S/.7.00 per kg ($1.84) for its fruit that meets international quality and safety standards. If it is considered that in the avocado processing industry, seed and skin make up 20-30% of the total and are underutilized [6], using what would otherwise be discarded, keeping in mind its nutritional potential, can increase options and help enhance the production chain.

Therefore, using these matrices to obtain bioactive compounds can enhance and add value to these co-products. This work is ongoing and is part of a Brazil-Peru partnership that aims to value Latina researchers, highlighting our biodiversity and technological potential.

2 MATERIAL & METHODS

The avocado fruits of the HASS variety were provided by the Rancho Grande Agricultural Producers Association (Cascas-Peru) (Figure 1a). The samples studied in this work include avocado seed flour and oil. To choose the sample to be used, it turned out that the avocados were ripe. Then, storage was carried out in cold room, controlled temperature (5-6°C) and humidity (50-60%) to avoid deterioration. In the selection stage, the fruits were selected, removing impurities. Then, washing was carried out: the fruit was immersed in an ozone washing machine for 10 minutes. Finally, the fruit was separated and chopped; the seeds were removed from the mesocarp and subsequently cut into 1.0 cm thick slices. The process of seed flour production consisted of drying, followed by grinding and subsequent placement in an oven at 40°C for 2 days.

Figure 1 (a) Hass avocado from Rancho Grande Agricultural Producers Association (Cascas-Peru). Source: https://agroideas.gob.pe/project/organicos-chimu-palta-hass/ (b) Extracts from avocado seed flour (c) avocado oil obtained by cold extraction

Avocado oil was extracted using the cold pressing method. Oil extraction was carried out at the Pharmaceutical Technology Laboratory of the Faculty of Pharmacy and Biochemistry (Trujillo - Peru), and at the CITEagroindustrial Chavimochic (Trujillo – Peru).

(I) Obtaining bioactive extracts: The procedure for obtaining the extracts consisted of weighing 1.5 g of avocado seed flour in an Erlenmeyer flask (Figure 1b). Then, 15 mL of distilled water was added. The Erlenmeyer flask was placed on the shaking table, where it remained for 60 min, shaking at 100 rpm, to ensure obtaining the extract. Samples were taken every 15 min. The oil was diluted in ethanol for subsequent analysis.

(II) Quantification of phenolic compounds: Folin-Ciocalteu reagent was used to quantify the phenolic compounds. In the spectrophotometer, readings of the absorbance values of the Folin-Ciocalteu solution were taken in reaction with the extract sample. Gallic acid was used as standard. [7]

(III) Determination of the antioxidant potential of avocado seed flour extracts: The antioxidant activity of the extracts was evaluated using DPPH (2,2-diphenyl-1-picrylhydrazyl) solution 0.03 mM in methanol. Different concentrations of the extracts were tested. Readings were taken at 10, 20 and 30 minutes at 515 nm [7].

All analyzes in the present work were carried out in triplicate

3 RESULTS & DISCUSSION

Avocado was obtained as shown in Figure 1a. It was possible to recover 21% of oil from the matrix. Avocado seed processed into flour have good yield (40%). The quantity and quality of the oil depends on the fruit's state of maturity, variety and extraction method. The content of phenolic compounds was higher in avocado seed flour, which was already expected. The extracted molecules are directly related to the extraction methodology and solvent used, as well as the nature of the matrix [8]. The influence of time on the quantification of phenolic compounds present was studied. As can be seen, there was no significant difference in the extraction times studied.

Table 1 Concentration of phenolic compounds in avocado seed flour and oil over the extraction time

Time (min)	Concentration of phenolic compounds (mg/L)	
	Avocado seed flour	Avocado seed oil
14	149.5±0.5	33.4±0.5
30	155.7±1.5	34.5±0.9
45	164.4±5.3	35.0±1.1
60	160.7±4.2	35.1±3.7

The antioxidant capacity of the compounds was measured by measuring the scavenging of the DPPH free radical, a simple measurement, but it can lead to an indication of the potential of the extracts obtained. According to Moon and Shibamoto [9], this technique is used in more than 90% of antioxidant evaluation studies of pure substances, mixtures or complex matrices. A value of 74% inhibition was obtained using a low concentration of phenolic compounds. This value indicates the potential of the compounds present in the flour. Oil, on the other hand, has a much lower value. Other methodologies should be used to study the potential of bioactive compounds that are probably in the matrix, but could not be detected by the methodology used.
It is worth mentioning that the use of water as a solvent may not be the most suitable medium for in-depth studies of antioxidant capabilities. Different solvents, such as ethanol and methanol, can be used in the extraction and study of antioxidants, aiming to extract different molecules and better interact with free radicals.

Table 2 Antioxidant capacity of avocado seed flour and oil extracts using the DPPH free radical scavenging method

Time (min)	Extract of Avocado seed flour (% inhibition)		Extract of Avocado seed oil (% inhibition)	
	20 µL	30 µL	20 µL	30 µL
10	23.4±4.0	18.0±3.6	30.5±1.5	28.9±1.0
20	30.0±3.0	60.0±4.3	29.5±0.9	28.8±2.0
30	32.8±3.4	74.0±6.8	30.3±0.7	31.0±0.6

Much remains to be done. Such as the use of other methodologies to determine antioxidant capacity and quantify other interesting biomolecules, such as carotenoids. As a sustainable and economical alternative, increasing the range of applications of avocado seed flour and oil by proving its potential in bioactive compounds could be interesting.

4 CONCLUSION

The flour and oil obtained from Peruvian avocado seed were obtained in high yields. Avocado seed flour can be considered an alternative source of nutrients such as antioxidants. The high inhibition potential indicated in the present work suggests the possible use of this co-product as a source of natural antioxidants, whether for the food industry, replacing synthetic antioxidants, or for the human diet. Furthermore, phenolic compounds, which are a large portion of phytochemical compounds and are responsible for the antioxidant activity present in fruits, were quantified in the matrix studied and can be extracted in just 15 minutes using water as a solvent.

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