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Research Article

Assessment of Antinutrient Properties of Selected Fruit Peels

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ABSTRACT

Objectives: The study examined the anti-nutritional composition of four distinct fruit peels and assessed whether these discarded peels retain bioactive substances that have potential health benefits. **Materials and Methods:** Antinutrient analysis was conducted on each extract obtained from the peelings to assess the health consequences of their utilization or absence. The chosen fruit peels, specifically avocado, jackfruit, mango paho, and pineapple, were obtained from the local markets of Cagayan de Oro. The Tukey Method was used for statistical comparisons of fruit peel combinations. **Results:** The alkaloid concentration of mango paho peels was the highest among the studied fruit peels, measuring 1.0802+0.185. The differences between all fruit peel pairs were statistically significant, with values exceeding the critical threshold of 0.05. Pineapple peels had the greatest oxalate concentration at 6.2297+0.060, while avocado peels contained only 0.41162+0.057. The comparison of pineapple peel with other fruit peels demonstrated a significant difference according to the Tukey Method. All combinations of fruit peels showed statistically significant differences, with *p*-values higher than the crucial value of 0.05. Phytate levels in the fruit peels were extremely low, with avocado and jackfruit peels having the lowest average values of 0.2441 and 0.2477, respectively. The average phytate concentration of mango paho was 0.4774. Mango paho had the highest saponin concentration at 5.5385, while avocado peel had the lowest quantity at an average of 1.8236. There was no notable variation in the alkaloid and total saponin levels among the chosen fruit peels. However, there was a considerable difference in their oxalate and phytate levels. **Conclusion:** The study recommends assessing the antioxidant capacity of the chosen fruit peels, as these peels have been found to contain antinutrient compounds that are harmless for human consumption. Further, each fruit peel can be tested for cytotoxicity levels to ensure safety for animal consumption and to prevent allergic or toxic reactions.

Keywords: Fruit Peels, Antinutrient, Alkaloids, Oxalates, Phytate, Saponin.

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INTRODUCTION

Wadhwa and Bakshi reported that in India, the United States of America, China, and the Philippines, 55 million tons of fruit waste were sent to landfills due to systematic fruit processing, packaging, consumption, and distribution operations.[13] These agro-waste products can cause odor, soil contamination, insect breeding grounds, and severe environmental damage.[12] Avocado (*Persea americana*) is a commonly consumed tropical fruit with a distinctive creamy texture and rich, nutty taste. It is pear-shaped, frequently more or less necked, oval, or nearly round, perhaps 7.5-33 cm long and 15 cm broad. The skin or peel is yellow-green, deep green, dark green, reddish-purple, or so dark purple as nearly black and frequently speckled with small yellow dots. The skin or peel is smooth or pebbled, glossy or not glossy, thin or leathery, up to 1/4 in (6 mm) thick, pliable or granular, and brittle.[1,2]

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Mango paho (*Mangifera altissima*) also known as pahutan, paho, or pajo, is a Philippine native mango variety as well as in neighboring areas in Indonesia, Malaysia, Papua New Guinea, as well as the Solomon Islands. Not cultivated commercially, it is wild harvested in the Philippines. Pale yellow small fruit that is extremely sweet when it is ripe but much more fibrous than commercially cultivated *Mangifera indica* varieties such as the Carabao mangoes. It is also under threat of loss of habitat.[3] The paho is like an unripe mango in appearance. They are much smaller than the piko and kalabaws that we know.

The jackfruit (*Artocarpus heterophyllus*), or nangka for short, is a tropical tree species that is the world's largest fruit tree with typical sizes of round-cylindrical to pear-shaped, measuring 60-90 cm in length and 25-50 cm in diameter. It has a thick, green to yellowish-brown outer skin covered with many small spiky projections. It is rubbery in texture. The thick skin enclosing the fruit segments is bitter and is usually considered waste. It can, however, be utilized as a supplementary feed material for animals, especially ruminants, and for biogas production; further, being pectin-rich; it is utilized as a gelling agent in food products and pharmaceuticals.[4]

Pineapples (*Ananas comosus)* peels are rough, spiky, and brown. They have a tough, fibrous texture. Pineapple peels are a rich source of bromelain, an enzyme with various medicinal and industrial. The fibrous nature of pineapple peels makes them a potential source of dietary fiber. Fruit peels of these fruits can play many roles because of their high nutritional content, instead of being discarded and causing environmental problems.[5] Fruit peels also play a critical function in many biological processes such as preventing long-term diseases like cancer, diabetes, hypertension, aging, and inflammation.[6] Their potential food supplement use heavily depends on their chemical makeup.

Antinutrients are organic compounds primarily found in plants that can cause nutritional deficiencies when consumed excessively, but their concentration in the typical diet is not likely to be excessively high. Consuming excessive anti-nutrients may result in gastrointestinal issues, inflammation, arthritis, and brain fog. Therefore, accurate and sensitive methods for analyzing and estimating anti-nutrients in foods are urgently required.[7] Alkaloids are naturally occurring toxic amines that plants generate primarily as a defensive mechanism against herbivores. Also, alkaloids are mostly found in the legume family (peas and beans), with high quantities in some lupin cultivars. The main risk of alkaloids is that they cause problems with the central nervous system, digestion, reproduction, and the immune system.[8] Oxalates, or oxalic acid, are naturally occurring chemicals in most plants. Plant oxalates are ingested via food and are subsequently excreted as waste by the body. Some foods high in oxalates include spinach, soy products, almonds, potatoes, beets, navy beans, and raspberries. One of the significant adverse health consequences of oxalate is that it has the potential to bind with minerals in the intestines, thus making it impossible for the body to absorb these essential nutrients. In extremely sensitive individuals, high oxalate diets have been shown to contribute to the formation of kidney stones and other health conditions.[1,9] Plants store phosphorus as phytates or phytic acid, especially in seeds and grains. They can attach to vital minerals like magnesium, zinc, and iron and decrease their bioavailability, resulting in shortages. Some people are blocked from calcium, zinc, magnesium, iron, and copper by phytic acid found in whole grains. In contrast, others seem immune to these side effects, probably because of beneficial gut flora that may break down phytic acid in certain situations. Additionally, phytic acid's effects are lessened when dietary whole grains are mixed with animal fats that include vitamins A and D.[10]

As secondary metabolites found in terrestrial plants and marine invertebrates, Saponins represent one of the most extensive families of natural products. These are chemical substances found in various plants, including herbs, seeds, and vegetables.[11] Starfish and sea cucumbers contain them as well. Also, these are used in vaccine formulations to regulate immunological function in medicine. Excessive consumption can affect the integrity of cell membranes, reduce nutrient absorption, and possess both beneficial (antioxidant and anti-inflammatory) and adverse hemolysis of RBC) health effects.

Statements of the Problem

The principal objective of this study was to investigate the antinutrient composition (dry basis) of the selected fruit peel extract from jackfruit, pineapple, avocado, and mango paho.

For this study to be completed, it sought to answer the following questions:

How do the selected fruit peel extracts compare regarding their alkaloid, phytate, oxalate and saponin contents?

MATERIALS AND METHODS

Research Design

This research was conducted adopting a descriptive-comparative methodology. It was accomplished by describing and comparing the anti-input contents of selected fruit peels. The quantitative data was reported and analyzed to examine the factual occurrences among factors.

Research Locale

The fruit samples were from the Cagayan de Oro market. Part of the growing Metropolitan Cagayan de Oro area, which includes the city of El Salvador, the towns of Opol, Alubijid, Laguindingan, Gitagum, Lugait, Naawan, Initao, Libertad, and Manticao on the western side, the city is the regional center and business hub of Northern Mindanao. Taglioan, Villanueva, Jasaan Rising on Mindanao Island's north central coast, it faces Macajalar Bay. The provinces of Bukidnon and Lanao del Norte and the towns of Opol and Tagoloan surround it. Peelings were air-dried, extracted, and examined in the Chemistry Laboratory of the University of Science and Technology in Southern Philippines (USTP).

Sampling Scheme

Purposive sampling was employed for the gathering of fruit peel specimens. Fruits were purchased in local markets of Cagayan de Oro where the selected fruits avocado, jackfruit, mango paho and pineapple were most abundant.

Sample Preparation

The fresh fruits of the chosen plants were gathered, cleaned, and peeled using a sharp knife. The peels were then allowed to air dry at room temperature in the shade. The desiccated substances were pulverized in a laboratory blender and preserved in a freezer pending additional analysis. The powdered materials were preserved in an airtight container until extraction and analysis were conducted.

Antinutritional Analysis

Utilizing anti-nutritional tests, the samples were examined for alkaloids, phytate, oxalate, and saponin presence. All tests were conducted in three iterations. The alkaloid concentration was assessed using alkaline precipitation gravimetric technique. Five grams of the sample were placed in a 250 mL beaker, which was then filled with 200 mL of 20% acetic acid in ethanol, sealed, and allowed to stand at 25°C for 4 hr. The filtrate was concentrated to one-fourth of its original volume utilizing a water bath. Concentrated ammonium hydroxide was added to the extract incrementally until the precipitation was complete. The precipitate was collected and purified with a diluted NH4OH solution after allowing the complete mixture to settle. Subsequently, pre-weighed filter paper was employed for filtration. The alkaloid residue on the filter paper was desiccated at 80°C in a calibrated oven. The titration method was utilized to ascertain the oxalate content.

1 g of the pulverized fruit seed samples was mixed with 75 mL of 3N H2SO4, and the combination was gently stirred for 1 hr using a magnetic stirrer. The mixture was subsequently filtered employing Whatman No. 1 filter paper (single layer). Subsequently, 25 mL of the filtrate were obtained, subjected to boiling for five minutes in a water bath, and titrated with a 0.05 M standardized KMnO4 solution until a faint pink hue emerged and persisted for thirty seconds. The phytate content of the seed samples was determined using the procedures established by Lucas and Markaka (Markakes, 1975). Weigh two grams of each sample into a 250-mL conical flask. The samples were immersed in 100 mL of 2% concentrated HCl within the conical flask. 50 mL of each sample filtrate was placed in a 250 mL beaker with 107 mL of distilled water to achieve the desired acidity. The combination was allowed to rest for 3 hr and filtered through a double layer of filter paper. Each sample solution was titrated with a standard iron chloride solution containing 0.00181 g of iron per mL, following the addition of 10 mL of 0.3% ammonium thiocyanate solution as an indicator. The endpoint was signified by a sustained, brownish-yellow hue that persisted for four to five minutes. The percentage of phytic acid was calculated (Russel, 1980).

Statistical Analysis

The data were analyzed using IBM SPSS, Microsoft Excel 2007, and Statistic 22. They were represented as the Standard Deviation±Mean.

RESULTS

Table 1: Anti-nutritional Contents of the Selected Fruit Peels.

Selected Fruit Peels	% Alkaloid	% Oxalate	% Phytates	% Saponin
Avocado	1.08024+0.185	0.41162+0.057	0.24411± 0.017	1.82359+0.0.350
Jackfruit	1.02427+0.253	2.44085+0.091	0.24770+0.108	2.56391+0.332
Mango paho	1.86932+0.299	5.60464+0.023	0.47745+0.053	5.53846+3.633
Pineapple	1.41498± 0.275	6.22967± 0.060	0.28719± 0.012	2.57220+0.023
One Way ANOVA Summary (p)	p=0.013	p<0.05	p<0.05	p value 0.141

*The values are expressed as mean±SD of three parallel determinations on a dry weight (dw) basis, p=p-value; α=0.05 level.

Table 2: Summary of Results of Tukey Method of the Percent Alkaloid on the Mean of the Selected Fruit Peels.

	Avocado	Jackfruit	Mango paho	Pineapple
Avocado	-	0.055970	-0.789079	-0.334741
Jackfruit	-0.055970	-	-0.845050	-0.390711
Mango paho	0.789079	0.845050	-	0.454339
Pineapple	0.334741	0.390711	-0.454339	-

$R_{Critical}$=4.25 @ alpha 0.05.

Table 3: Summary of Results of Tukey Method of the Percent Oxalate on the Mean of the Selected Fruit Peels.

	Avocado	Jackfruit	Mango paho	Pineapple
Avocado	-	-2.029233	-5.193019	-5.818054
Jackfruit	2.029233	-	-3.163786	-3.788821
Mango paho	5.193019	3.163786	-	-0.625035
Pineapple	5.818054	3.788821	0.625035	-

$R_{Critical}$=4.25 @ alpha 0.05.

Table 4: Summary of Results of Tukey Method of the Percent Phytate on the Mean of the Selected Fruit Peels.

	Avocado	Jackfruit	Mango paho	Pineapple
Avocado	-	-0.003590	-0.233339	-0.043078
Jackfruit	0.003590	-	-0.229749	-0.039488
Mango paho	0.233339	0.229749	-	0.190261
Pineapple	0.043078	0.039488	-0.190261	-

$R_{Critical}$=4.25 @ alpha 0.05.

Table 5: Summary of Results of Tukey Method of Saponin on the Mean of the Selected Fruit Peels.

	Avocado	Jackfruit	Mango paho	Pineapple
Avocado	-	-0.740325	-3.714876	-0.748613
Jackfruit	0.740325	-	-2.974551	
Mango paho	3.714876	2.974551	-	2.966264
Pineapple	0.748613	0.008288	-2.966264	-

$R_{Critical}$=4.25 @ alpha 0.05.

DISCUSSION

Table 1 shows the levels of four anti-nutritional compounds-alkaloids, oxalates, phytates, and saponins-in the fruit peels of avocado, jackfruit, mango paho, and pineapple. Anti-nutritional contents can hinder nutrient absorption in the body, so their levels are important to assess. Alkaloids are found in small amounts with mango paho peel containing the highest at 1.86932+0.299 and jackfruit the lowest at 1.02427+0.253. Alkaloids can be toxic in high amounts but may also have healthy benefits. The fruit peels have moderately low levels of oxalate content. Pineapple peels have the highest oxalate content (6.22967±0.060) which may form insoluble salts with calcium and contribute to kidneys at high levels. This is followed by mango (5.60464+0.023), and jackfruit (2.44085+0.091). The avocado peel has the lowest oxalate content (0.41162+0.057). The study of Madalageri (2017) of the oxalate contents of three mango varieties found in Nigeria has a mean of 7.24+1.36 which is higher than our native mango paho. Due to its high fiber and vitamin content, mango peel has the potential to be utilized in a variety of food matrices, even though it is typically seen as a waste product. All fruit peels have very low levels of phytate with avocado peels having the lowest content at 0.24411±0.017. The table also reveals that mango paho has the highest saponin content among the selected fruit peels with a value of 5.53846+3.633. The avocado peel has the lowest saponin content at 1.82359+0.0.350. One Way ANOVA summary indicates that significant differences exist between the fruit peels in alkaloid contents and saponin contents while there is no significant difference in the oxalate and phytate contents among the fruit peels.

On the other hand, to complement ANOVA, the Tukey test was done. Table 2 shows the results of the comparison of the means of the paired fruit peels. Significant differences (if $R_{Critical}$=4.25) are not found, as all pairwise results are below this threshold. Thus, there are no strong differences between the alkaloid contents of these peels.

Table 3 shows the results of the comparison of the means of the paired fruit peels in their oxalate content differences. Mango paho and pineapple show the largest positive differences compared to other peels, although none of the differences surpass $R_{Critical}$ so not statistically significant pairwise difference exists. The same goes with the results shown in Table 4 comparing phytate levels between fruit peels. Table 5 indicates that mango paho has much higher saponin content compared to the other peels, however it does not exceed the $R_{Critical}$ so the differences are also not statistically significant.

CONCLUSION

Mango paho peels have the highest alkaloid content than the other three selected fruit peels. The oxalate content of pineapple peels is the highest while avocado peels are the lowest. Phytate contents of the fruit peels were very low with avocado and jackfruit peels at the lowest rank. Lastly, saponin contents showed mango paho with the highest level and avocado peel the lowest. The following conclusions were drawn considering the findings of the study: There is no significant difference among the selected fruit peels compared to their alkaloid and total saponin contents. There is a significant difference among the selected fruit peels when compared to their oxalate and phytate contents.

An analysis of anti-nutrients is important as the human body experiences adverse effects from some of them. By knowing them, we can avoid certain parts and some kinds of foods that contain the said anti-nutrients. That is why there are also methods such as blanching and frying which we commonly do every day not knowing that they are used to reduce the said anti-nutrients.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

USTP: University of Science and Technology of Southern Philippines; **HCl:** Hydrochloric Acid; **H_2SO_4:** Sulfuric Acid; **$KMnO_4$:** Potassium Permanganate; **NH_4OH:** Ammonium Hydroxide; **RBC:** Red Blood Cells; **SPSS:** Statistical Package for the Social Sciences; **SD:** Standard Deviation; **ANOVA:** Analysis of Variance; **IBM:** International Business Machines; **dw:** dry weight; **N:** Normal (concentration); **mL:** Milliliter; **g:** Gram; **hr:** Hour; **°C:** Degree Celsius; **α:** alpha; **p:** Probability value; **$R_{Critical}$:** Critical Value for Tukey's Test.

RECOMMENDATION

The study's findings suggest that additional research is necessary to fully realize the potential of fruit peels in a variety of applications. Firstly, additional studies are required to explore the utilization of fruit peels in both dietary and pharmaceutical contexts, to reduce the environmental burden associated with their waste. Determining the antioxidant potential of the selected fruit peels is a crucial step, as these peels have been found to contain antinutrient substances that may be safe for human consumption. Conducting cytotoxicity tests for each fruit peel is also essential to ensure the safety of their ingestion, both for animal consumption and to prevent potential allergic or toxic reactions. Furthermore, it is suggested that pharmacological industries undertake thorough research on the possible applications of the nutritional analyses of the selected fruit peels, to benefit both human and animal populations. Exploring these avenues can lead to the development of innovative and sustainable solutions that reduce waste and leverage the inherent nutritional and functional properties of fruit peels.

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