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Nutritional, Phytochemical Contents and Cytotoxicity of Bua China, *Adonidia Merrillii* Fruits

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Abstract

Bua China adonidia merrillii is one of the most popular ornamental palms in the world. It has been extensively introduced mostly in tropical regions as an indoor plant. It robustly grows and fruit voluminously. This investigation focused on the determination of the nutritional, phytochemical contents, and cytotoxicity of underutilized bua china fruits as bases for their potential added value, utilization, and consumption. The fruits were gathered from Quirino State University, Diffun campus. Analyses revealed that the green and red fruits contained moisture of 45.07% and 46.18%, total ash of 21.26g and 20.79g/100g, total lipids of 0.0679 and 0.1311g/100g, the crude fiber of 0.07g and 0.12 g/100 g sample, total carbohydrates of 0.7683 and 0.7536 g/100g sample, respectively and protein of 0.5 mg/ml for both. These primary metabolites are essential for plant growth, development, reproduction, defense against diseases, and stress. These nutrients are vital for human nutrition and wellness. Phytochemical screening also revealed the presence of anthraquinones, anthrones, essential oils, fatty acids, flavonoids, phenols, steroids, sugars, tannins triterpenes for both stages of fruits. The red bua china fruit contained alkaloids that were not present in green fruit. But the green fruit contained coumarins which were not present in the red fruit. These secondary metabolites are distinct characteristics of plants that can have breakthroughs in food development, nutraceuticals, and pharmaceuticals. The fruits were asserted to be nontoxic, and thus safe to be eaten. These results are baseline data for adonidia merrillii fruits found within Quirino and nearby provinces to optimize the fruits for food and medicine development, income generation, and cultivation.

Keywords: adonidia merrillii, bua china, nutritional component, phytochemical contents, primary metabolites.

1. INTRODUCTION

Today, the world is in its challenging times. All are affected. Sustainable developments are on the verge of real implementation to completion. Accepting the facts that all aspects of human needs for survival and protection are at their major setbacks though. This situation is directly challenging the policies on food security, nutrition, and health systems along with other major essentials of human well-being.

Millions of people around the world suffer from food insecurity and different forms of malnutrition because they cannot afford the cost of healthy diets. Projections show that the world is not on track to achieve Zero Hunger by 2030 and, despite some progress, most indicators are also not on track to meet global nutrition targets. The food security and nutritional status of the most vulnerable population groups are likely to deteriorate further due to the health and socio-economic impacts of the contagion. (http://www.fao.org/publications/card/en/c/CB4474EN). With this, people recourse to substitutes for food and medicine to live on.

Demand for functional foods is on the upsurge as they are believed to provide exceptional health benefits owing to their nutrient content. This expresses an expected boost to the growth of the market for nutraceuticals. The positive attitude of consumers towards functional foods primarily on account of the added health and wellness benefits offered by these nutraceutical products is fueling the market growth. The growing geriatric population, increasing healthcare costs, changing lifestyles, food innovations, and expectations regarding higher prices have aided the overall growth of the nutraceuticals industry. Accordingly, nine out of ten adults consume 55% minerals and over 50% vitamins in their daily diets (https://www.grandviewresearch.com/industry-analysis/nutraceuticals-market).

The global nutraceutical industry has been witnessing key developments in terms of product innovation and portfolio expansion over the past few years. Rising levels of disposable income, changing lifestyle, and shift in preferences for healthier dietary intake in emerging economies are expected to drive the demand for nutraceuticals in Asia Pacific.

In the Philippines, the Nutraceutical market is presently in its early growth stage due to the dependence on the traditional pharmaceutical medicine system by the growing middle-class population, the middle-class consumers. The multi-herb formula usually comprises numerous herbs in one single formula, thereby providing benefits to the overall body.

In a revenue review conducted from 2012-2017, the combination of herbal or traditional dietary ingredients clearly established itself as a market leader with massive revenue share in the Philippines herbal dietary supplements market. It showcased robust year-on-year progress and is expected to increase at a stable compound annual growth rate (CAGR) during the forecasted period from 2017 to 2022. The expected growth and popularity of this industry can be directly linked to consumers' rising inclination toward health and wellness (Wood, 2019). Price and affordability are key barriers to accessing sufficient, safe, nutritious food to meet dietary needs and food preferences for an active and healthy lifestyle (Herforth, A. et al, 2020).

In connection, rich and cheap sources of nutraceuticals that are plant-based are readily available around. These plants which are full of potential but not given much emphasis and attention are exponentially growing subjects of study today. One of which is the very visible ornamental palm commonly called bua china, bua,manila palm, Christmas palm, kepis palm,veitchia, adonidia merrillii. These palms are aesthetically seen along streets, parks, and even within the Quirino State University-Diffun campus.

Adonidia merrillii which is commonly called bua china is an evergreen, single-stemmed palm tree that grows about 6 meters tall. The straight, cylindrical, unbranched stem is around 15 - 21cm in diameter with pinnate leaves of about 1.5 meters long. The plant is harvested from the wild for local use as a masticatory and source of beads. Nowadays, it is often grown as an ornamental in tropical gardens, and as a pot plant in cooler areas (http://www.palmpedia.net/wiki/Adonidia_merrillii). It has been introduced and can be found naturalized across Asia, Caribbean, Central and South America (Jørgensen and León-Yánez, 1999; Idárraga-Piedrahita et al., 2011; Acevedo-Rodríguez and Strong, 2012; Govaerts, 2016). It can be found growing in coastal areas, disturbed sites, and open forests.

As a native palm in Palawan and Negros, Philippines (Fernando,2011), it occurs on karst limestone cliffs (Dransfield et al. 2008). It is also planted along roadsides and sidewalks and in gardens and parks. The plant is very cold-sensitive and can only be grown outdoors in genuinely tropical climates. Its large and very attractive inflorescences and unisexual flowers are pollinated by insects, mostly bees. Of which is appreciated by beekeepers for its high-quality nectar. It can be grown in the subtropics but is cold-sensitive. It thrives in open sunny areas with well-drained, fertile soil. This species is moderately salt tolerant and has good wind resistance. But very susceptible to lethal yellowing disease, a phytoplasma disease that affects many palm species (Lim, 2012; Wong et al., 2015; Useful Tropical Plants, 2019; Broschat, 2017). This palm grows at a moderate rate and needs only some basic care to thrive.

Bua china fruit has a thin epicarp, a dry, yellowish, thin-fleshy mesocarp, and a thin, fragile endocarp. Ripe fruit is ovoid, 2 to 3 centimeters long, beaked, pale green becoming bright red when mature. The seed is ovoid, truncated basally, and pointed apically, with a ruminate endosperm and embryo basally. It is classified as Lower Risk or Near Threatened in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species in 2013 (Stuart Jr, 2018) and included in the Endangered(EN) category of the National List of Threatened Philippines Plants issued as Department of Environment and Natural Resources (DENR) Administrative Order No. 2007-01 (Fernando,2008;2011).

As to chemical contents, some scientific analyses yielded the presence of gallic acid, pyrogallol, caffeic acid, vanillic acid, syringic acid, naringin, and rutin. The methanolic extract showed higher total phenolic and flavonoid contents with values of 17.80 ± 0.45 mg gallic acid equivalents/g dry weight (DW) and 5.43 ± 0.33 mg rutin equivalents/g DW, respectively (Vafei et al, 2018).

A proximate analysis of fruit which included pulp and kernel, respectively of veitchia merrillii also revealed a moisture content of 74.4 and 44.3, ash of 1.4 and 1.0, proteins of 1.5 and 2.6, carbohydrates of 11.6 and 51.2, lipids of 10.9 and 0.6, respectively and energy 629/942 kJ/100g for both parts (Silva et al 2015).

A study of the palm's fruit for carotenoid content (μg/g) and total retinol activity equivalents (RAE) yielded the following 70.7 ± 2.8 for pulp, 0.4 ± 0.2 for the kernel, and 592 total RAE (Silva et al 2015).

The study by Vafaei (2018), evaluated the antioxidant and cytotoxicity activity of various extracts of adonidia merrillii fruits. It was found that the Methanolic Extract (ME) showed higher antioxidant activity by α, α-diphenyl-β-picrylhydrazyl (DPPH) free radical scavenging method, nitrogen dioxide (NO_2) and 2, 2'-Azino-Bis-3-Ethylbenzothiazoline-6-Sulfonic Acid (ABTS) scavenging assays compared to ethanolic Assay and water extracts. Extracts showed weak to moderate cytotoxicity in human hepatocytes (Chang liver cells) and NIH/3T3 (fibroblasts cell) cell lines. The results suggested a potential for antioxidant and cytotoxic drugs from natural sources.

Its fruits are sometimes said to be used as a substitute for the betel nut, in preparing buyo (fruit of Areca catechu, leaves of Piper betel, and lime) for chewing (Usvat,2015). But for individuals used to betel nut chewing, these bua china nuts are more astringent than the betel nut popularly chewed.

In Nigeria, the kernels of A. tukeri and A. merrilli were subjected to amino acids, fatty acids, proximate, anti-nutrients, and mineral element analyses, in addition to acute toxicity evaluation. It was found that it contains carbohydrates (85.73% and 90.15%) and oxalate contents (1927.2 and 2072.4 mg/100 g) which were relatively high, while low levels of cyanide (12.05 and 65.45 mg/100 g), phytates (6.32 and 2.53 mg/100 g) and tannins (35.36 and 20.16 mg/100 g) were observed. A. tukeri indicated higher Ca, Cu, Fe, Zn, Mg, Mn, and Na contents.

Moreover, the study also showed the presence of glutamic acid (11.30 and 5.33 g/100 g) and leucine (5.9 and 4.2 g/100 g) were the most abundant essential and non-essential amino acids; the fatty acids profile revealed three major fatty acids: palmitic acid (20.14 and 11.27%), oleic acid (61.83 and 25.78%) and linoleic acid (13.05 and 55.26%); low linolenic acid levels were also observed (<1%) with 75.87 and 81.98% total unsaturated fatty acids in A. tukeri and A. merrilli respectively.

The anti-nutrient-mineral ratios were computed and compared with critical values. Acute toxicity of A. tukeri and A. merrilli was 866.03 mg/Kg. These palms contain vital

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nutritional components, and with proper processing could serve as potential products for both human and animal nutrition(Antia et al, 2017).

With the above findings, characteristics, aesthetic value, and belief that everything around has a potential for a purpose, as bases and the dire interest of the researcher, this study was conceived. It was conceptualized to shed light in maximizing and optimizing the bua china produce of Quirino and its nearby provinces through the determination of the fruits' nutritional, phytochemical contents and cytotoxicity.

2. OBJECTIVES

The main objective of this project is to develop food products out of analyzed bua china, *adonidia merrillii* and establish it as a medicinal source in Quirino and nearby provinces for cultivation and consumption.

For this phase, it aimed to determine bua china's

a. nutritional content;
b. Phytochemicals; and
c. cytotoxicity.

3. MATERIALS AND METHODS

This chapter presents the research design, research environment, instrument, and procedures of analyses for the study.

Research Design

This study used Qualitative Descriptive Research.

Research Environment

The samples were gathered during the young and mature ripening stages of the fruits along the perimeters of Quirino State University, Diffun, campus. The samples were analyzed in Saint Mary's University, Center for Natural Sciences laboratory (SMU CNS). The laboratory is recognized for performing nutritional content analysis, phytochemical screening, and cytotoxicity assay. The laboratory is equipped with facilities that cater to the needs of the tests. Tests were conducted by qualified and certified analysts and technicians.

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Research Instrument

The Laboratory instruments were as per Laboratory Protocols in SMU CNS.

Data Gathering Procedure

After the approval of the research by the authorities to pursue the research, collection, identification, and characterization followed.

Collection of Samples

As per protocol of the laboratory, the adonidia merrillii fruits were collected freshly from the campus and taken immediately at SMU CNS for nutritional and secondary metabolites components and cytotoxicity.

Identification of Samples

SMU CNS technicians supported the identification of the samples by different literature, local naming, and use of the samples.

The sample descriptions and identification were also validated by the individuals who had experienced eating or chewing the berries/fruits.

Preparation of Plant Extracts

Collected samples were cleaned, peeled thoroughly, and ground finely in preparation for laboratory analyses. The samples were green and red fruits. They were separately analyzed using the following tests.

For the **determination of nutritional components**, the following were considered.

For **Moisture content.** Five (5) grams of fresh bua china fruits were weighed in a weighted moisture box. Oven-dried at 100 to 105^{o}C and cooled in a desiccator. Repeatedly heated and cooled until it reached a constant weight. The Moisture content was calculated following the equation by the procedures of Raghuramulu et.al.,2003).

Moisture (%) = (initial weight) – final weight) x 100/weight of sample;

For **Total Ash content.** One gram of the sample was weighed accurately into a crucible. The crucible was placed on a clay pipe triangle and heated over a low flame until all the sample was completely charred. Then it was heated in a muffle furnace for about 20 hours at 150^{o}C. Then was cooled in a desiccator and weighed. To ensure that the content was in total ash, the crucible was again heated in the furnace for one hour, cooled, and weighed. The process was repeated several times until two consecutive weighs were the same and the ash turned into white.

The total ash content was then calculated following the equation by the procedures of Raghuramulu et.al., 2003).

Ash content (g/100g sample) =weight of ash x100/weight of sample taken;

For **total lipid content.** Total lipid was determined by a modified method of Folch et al 1957 (Butangon and Padayao, 2017). Five grams of the sample was suspended in 50 mL chloroform: methanol (2:2 v/v) mixture, homogenized thoroughly, and left to stand for three (3) days. Then the solution was filtered and centrifuged further. Through the Pasteur pipette, the upper layer of methanol was removed and chloroform was evaporated by heating. The remaining particles were weighed and recorded as the amount of crude lipid. The total lipid content was then calculated following the equation by the procedures of Raghuramulu et.al, 2003).

Total Lipid (g) = Weight of fresh sample –final weight;

For **total crude fiber content.** Moisture-free samples were put in a beaker and 200mL of boiling 225n sulfuric acid, H_2SO_4 was added. The mixture was boiled for boiled in 30 minutes keeping the volume constant by adding water at frequent intervals. The mixture was then filtered through a muslin cloth and the residue was washed with hot water until free from acid. The sample was transferred to another beaker and 200mL of 0.313N NaOH was added. After boiling for 30 minutes and keeping it in constant volume, the mixture was again filtered through another muslin cloth, and the residue was washed with hot water to be free from alkalis. Followed by washing with alcohol and ether. The samples were transferred to a crucible, dried overnight at 80-100^{o}C, and weighed (this was the We) in an electric balance. It was then again heated in a muffle furnace at 150^{o}C for 20 hours cooled and weighed (this is the Wa) again. The difference in their weights (We-Wa) is the weight of the crude fiber. The total crude fiber content was then calculated following the equation by the procedures of Raghuramulu et.al.,2003).

Crude fiber (g/100g sample) = {100 – (moisture + fat)} x We –Wa)

Weight of sample; and

For the **total Carbohydrate content.** The total carbohydrate content was then calculated following the equation by the procedures of Raghuramulu et.al.,2003).

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Carbohydrate (g/100g sample) = 100 - {(moisture + fat + protein + ash + crude fiber) g/100g}.

For **secondary metabolites**, the fruits were chopped into small pieces and air-dried for seven (7) days and oven dried for three (3) days (five (5) hours per day. After the drying period, the samples were powdered using a high-powered blender. The powdered samples were weighed and soaked in 100ml ethanol for one day (24 hours). Filtration and decantation followed for the removal of precipitates and a water bath were for evaporation.

Phytochemical Screening was carried out for each plant extract to detect the secondary metabolites present. Each plant extract was spotted on marked and labeled TLC (thin layer chromatography) 7 x 4 cm, and was developed in the acetate-methanol (7:3) mixture in the developing chamber. The spots for a certain metabolite were visualized on the TLC plates and were exposed to UV light and a hot plate to check the separation of the different compounds.

For typical visualization of the secondary metabolites, vanillin-sulfuric acid reagents were utilized. This solution can determine the presence of Phenols, Steroids, Triterpenes, and essential oils. Methanolic potassium hydroxide was used to test Anthraquinones, coumarins, and anthrones while phenolics compounds and tannins were detected through the use of potassium ferricyanide-ferric chloride reagent. Dragendorff's reagent was used to spot alkaloids and Antimony (III) chloride was used to detect the presence of flavonoids (Guevara *et al*.,2005).

The laboratory technician agreed that the A. merrillii fruits will no longer be tested for cytotoxicity since there had been validation from individuals that the fruits were chewed unless the liquid that are formed are being expelled or released.

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3. RESULTS AND DISCUSSION

This part presents the data gathered in tabular and textual form, the analysis and interpretation of the data based on the results of the tests.

Nutritional Content

Table 1.Nutritional component of bua china berries from QSU

bua china fruits	Moisture Content (%)	Total Ash Content (g/100g sample)	Total Lipid (g)	Crude Fiber (g/100g sample)	Total Protein (mg/ml)	Total Carbohydrates Estimation (g/100g sample)
green	45.07	21.26	0.0679	0.07	0.5	0.7683
red	46.18	20.79	0.1311	0.12	0.5	0.7536

Table 1 shows the nutritional composition of bua china green and red fruits from the identified location.

It can be gleaned from the table that the moisture content of the green (g) and red (r) samples, respectively were 45.07 % and 46.18%, the total ash of 21.26 and 20.79 g/100g sample, the total lipid of 0.0679g to 0.1311g, crude fiber of 0.07 and 0.12 g/100g sample, total protein of 0.5 mg/ml for both and total carbohydrate estimate of 0.7683 and 0.7536.

The red fruit sample had higher moisture content than the mature fruit. Water content (moisture) plays a vital role in the physical and chemical stability of pharmaceutical ingredients for pharmaceutical preparations that may lead to the degradation of the substance. It affects the quality of the finished product, processibility, storage, accuracy, and analytical indicators for calculations. The total ash content for the samples ranges from 20.79 (r) to 21.26 (g). The green sample had relatively higher ash content than the green. The ash content is a measure of the total amount of minerals present within a food, in comparison with the mineral content which is a measure of the amount of specific inorganic components present within a food, such as Ca, Na, K, and Cl. Determination of the ash and mineral content of foods is important for nutritional labeling, quality, microbiological stability, nutrition, and food processing. Ash is the inorganic residue remaining after the water and organic matter have been removed by heating in the presence of oxidizing agents, which provides a measure of the total amount of minerals within a food (Gutierrez, 2020).

The presence of ash in the fruits in this study pointed out that there are minerals present within this wonder plant; thus a good source, vital for human consumption.

The total lipid contents of the berries ranged from 0.0679 (g) to 0.1311 (r). This presence meant that the samples contain fats which are an important source of energy for our diet and essential lipid nutrients. In contrast, over-consumption of certain lipid components can be detrimental to our health, *e.g.* cholesterol and saturated fats.

In many foods, the lipid component plays a major role in determining the overall physical characteristics, such as flavor, texture, mouthfeel, and appearance. For this reason, it is difficult to develop low-fat alternatives to many foods, because once the fat is removed some of the most important physical characteristics are lost (http://people.umass.edu/~mcclemen/581Lipids.html; Gutierrez, 2020).

Crude fiber content was relatively higher in the red sample(0.12) than in the green (0.07). But this significantly proved that there is a nutritive component for both. Accordingly, this primary substance in plants is used to measure the quantity of indigestible cellulose, pentosans, lignin, and other components which can be present in foods. These components have little food value but provide the bulk necessary for proper peristaltic action in the intestinal tract.

Eating more crude fibrous foods has four advantages: it improves gastrointestinal function, can prevent constipation, prevent colon cancer; improves glycemic response, reduce postprandial blood sugar levels, helping to treat diabetes; reduces plasma cholesterol content, hyperlipidemia, and cardiovascular disease prevention; and controls weight, reduce the incidence of obesity.

Fiber offers a variety of health benefits and is essential in reducing the risk of chronic diseases such as diabetes, obesity, cardiovascular disease, and diverticulitis. It is a known fact that fiber helps eliminate waste from the gastrointestinal tract because of its ability to bind water and thus soften the stool. However, it should be noted that not all are suitable for eating crude fiber foods (https://www.foodscience-avenue.com/2008/04/crude-fiber.html).

Both samples contained 0.5 mg/ml of protein. This signaled a good indicator of food nutrients. It provides the calorie (energy) for the body. It is necessary for blood clotting, fluid balance, immune response, vision, and production of hormones and enzymes (www.fda.gov).

Proteins have the ability to form and stabilize foams; emulsifiers and emulsion stabilizers. Potato protein has a high content of amino acids with hydrophobic functional groups (branched: isoleucine, leucine, and valine) and aromatics (phenylalanine and tyrosine).These characteristics were essential to food product development (Karenlampi and White 2009 Gutierrez, 2020).

But dietary proteins are not all the same. They are made up of different combinations of amino acids to form a complete protein necessary for physiological processes.

For the total carbohydrate estimate, the samples contained 0.7536(r) and 0.7683 (g). Plant species with underground stems tubers and roots store carbohydrates in different forms. This uniqueness shows that underground storage organs have the capacity to accumulate a significant amount of Triacylglycerol (TAG) (Hofvander, P. et al.2016 in Gutierrez, 2020).

Tuber and root crops accumulate storage products in the form of carbohydrates. This suggests that plants like adonidia merellii can efficiently handle the accumulation of energy-dense oil. Thus, in the nutrition and economic aspect, it is highly recommended to utilize its high yield capacity (Hofvander, P. et al.2016 in Gutierrez, 2020).

These primary(central) metabolites which include vitamins, carbohydrates, proteins lipids, ash, fiber, and moisture are required for the growth and maintenance of cellular functions and their extraction is much easier than secondary metabolites (biofifferences.com./differences; slideshare.net). They are important constituents of daily diet both for plants and animals and are involved in maintaining normal and essential physiological processes: proper growth, development, and reproduction but deficiency of one constituent may lead to abnormalities in the body (Gutierrez, 2020).

There were only a few to no published studies yet regarding the metabolite contents of *adonidia merrillii* as far as the researcher is concerned. Thus, this study is an avenue for more research about the palm for utilization.

In developing nations like the Philippines, natural plants with medicinal potential are on the verge of exploration. Nutriceuticals and pharmaceuticals are hands in hand for healthcare sector improvements for diseases managements (Bhargava et al 2013). Good nutrition affects man’s ability to sustain its well-being, thus must take in nutritious balanced natural food products (Gutierrez, 2020).

Phytochemical Screening

Table 2. Secondary Metabolites present in bua china berries from QSU

Samples	Secondary metabolites present
Green	anthrones, anthraquinone, essential oils, *coumarins,* fatty acids, flavonoids, phenols, steroids, sugars tannins, triterpenes
red	*alkaloids,* anthrones, anthraquinone, essential oils, fatty acids, flavonoids, phenols, steroids, sugars tannins, triterpenes

Table 2 revealed the presence of secondary metabolites through phytochemical screening that both samples had ten (10) same secondary metabolites but a difference in coumarins and alkaloids content.

In general, secondary metabolites may not be required for cellular functions but are the byproducts of primary metabolism that are synthesized after the growth phase has been completed for the ecological and other activities of the cell. These substances increase the fitness of the producing organisms and decrease the fitness of the surrounding organism. Some of which are poisonous to animals, plants, and microorganisms (Atlas, n.d in Gutierrez, 2020.)

Anthrones and anthraquinones are present in the compound. These organic compounds found in plants are used for cellulose assay, colorimetric determination of carbohydrates, and a laxative. There are high-level plants with high content of this substance and lower amounts in other types of vegetables and herbs. There are ongoing studies that investigate its potential to be antibacterial, anti-fungal, antioxidant, anti-viral, anti-emetic, and insecticidal (https://www.verywellhealth.com).

Anthraquinones from the largest group of naturally occurring quinone pigments. They occur in plants as hydroxylated, methylated, or carboxylated derivates of Anthraquinones, anthrones, anthral or dianthrone. They are commonly used as dyes and cathartics or purgatives.

The samples considered in this study showed the presence of essential oils. This metabolite is obviously in the boom for the exploration of sources nowadays. No wonder why because of its anti-depressant, stimulating, detoxifying, antibacterial, anti-viral, and calming properties. It is considered to be natural, safe and cost-effective therapy for a number of health concerns. (info.achs.edu). Neuro Endocrinology Letters (2017) indicated some flowers with essential oils may help to balance hormone levels; boosts immunity and fight infections; support digestion (World Journal of Gastroenterology,n.d); boost energy levels (Journal of the International Society of Sports and Nutrition,n.d); and improve brain functions (Frontiers in Aging Neuroscience,n.d; draxe.com/essential-oils). But the quality of essential oil products may be compromised if harvesting and processing procedures are not met within standards (Lopez-Carillo et al, 2010; Epa. 2016 in Gutierrez, 2020).

Fatty acids (FAs) are part of the lipid class; it is found widespread in nature, food, and organisms; and are an important component of the cell membrane. Its metabolism produces adenosine triphosphate (ATP). FAs from diet influence people's health condition and they can deteriorate or ameliorate the evolution of some diseases. Scientists are on the exploration of Biomarkers(measurable characteristics that reflect biological function or dysfunction for therapy, indications of progression of a disease) in

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which FA is eyed to be a potential. This metabolite if present in diets plays an important role in preventing cardiovascular diseases because of its anti-inflammatory character (Tiuca et al, 2017 in Gutierrez, 2020).

Flavonoids are a group of phenols that naturally occur in plants. Fortunately, this metabolite is present in the fruits under study. It consists of a wide range of colors from pale yellow to blue. It has antioxidant properties. It protects the walls of the vascular system (by scavenging free radicals) which decreases the risk of heart disease (Arbuckle,2016; Guevarra et al 2004). Flavonoids also prevent inflammation, tumor growth, osteoporosis, and viral infections (Arbuckle, 2016); antibacterial, anti-tumor, antiallergenic, and vasodilatory effects (Verena et 2006). Nevertheless, anti-oxidant potency and specific effects in promoting human health vary depending on the flavonoid type such as its chemical, physical and structural properties (Verena et al 2006).

Polyphenols which are also present in both samples are structurally similar to tannins. They are used as additives is the leather industry; as anti-oxidants in processed foods; some phenolic compounds are cancer chemopreventive (British Journal of Nutrition,n.d); promote healthy aging (Free Radical Biology and Medicine, 2002). It is good to note that bua china contains this, thus a genuine source of the compound.

Both samples contain steroids. Steroids are synthetic substances with legitimate medical uses (https://www.webmd.com/men/anabolic-steroids). These substances can be used to treat a wide range of conditions, including *asthma* and *chronic obstructive pulmonary disease (COPD)*, *hay fever*, *hives* and *eczema*, painful joints or muscles – such as *arthritis*, *tennis elbow*, and *frozen shoulder*, and other pain-related cases.

Sugars are also present in both samples. Aside from the main function of sugar as a sweetener, it has many other functions in food technology. The most important among these are a preservative, texture modifier, fermentation substrate, flavoring, coloring agent, and bulking agent. The various methods of use of sugar are based on its physical and chemical properties. The replacement of sugar by newly available sweeteners is difficult if the sweetness values (Brix) or physical and chemical properties of the substitutes differ greatly from those of sucrose. Again, bua china offers a new source of sugar.

Tannins are seen in both samples of A.merrellii.This compound has the ability to react with and precipitate proteins forming stable water-insoluble copolymers. It was applied in plant constituents capable of transforming raw animal skin into leather because of its protein cross-linking capability. This substance is used in pharmaceutical preparations because of its astringent action and potential for cytotoxic and

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antineoplastic agents (Guevarra, et al 2004) and as a plant oxidative defense (NIFA, 2011 in Gutierrez, 2020).

Triterpenes are present in the compounds. Terpenoids constitute the largest class of natural products found in abundance in higher plants. Many terpenoids occur as glycosides or glycosyl esters. They are commercially important as a basis of natural perfumes, spices, and flavorings in the food industry (Guevarra et al, 2004).

Alkaloids are present in the red fruit. Alkaloids are secondary metabolites, which carry one or several nitrogen atoms, mostly in their ring structures. More than 30000 different alkaloid structures have been found in nature. Most of them derive from amino acid precursors, such as phenylalanine, tyrosine, tryptophan, lysine, arginine, and ornithine.

Alkaloids have evolved in nature as defense substances against herbivores, and to a lesser degree against microbes or competing plants. As a consequence, most alkaloids show pronounced toxicity. Many alkaloids interact with elements of neuronal signal transduction, such as ion channels; ion pumps; neurotransmitter receptors; enzymes, which degrade neurotransmitters; and transporters.

As a consequence, plants with alkaloids are either known as toxic plants or as medicinal plants, because they can interfere with molecular targets that are relevant to health conditions. The use of alkaloids in medicine such as in the treatment of cancer, parasitic diseases, pathogenic bacteria, and neuronal disorders, and even in agriculture is an exciting field because many alkaloids have not yet been discovered, and in most cases, their exact mode of action has not been elucidated. Although there are new technologies that offer the possibility to understand the activity of alkaloids at the DNA level (Wink, 2019).

Coumarins are only present in the green bua china fruit. These phytochemicals are widely distributed in nature. It has a sweet odor as a scent of new mown-hay which is why it has been used in perfumes since 1882. It is considered to be emitted by plants as a chemical defense to prevent predation; It is used in pharmaceutical industries as a precursor in the synthesis of synthetic coagulants; enzymatic inhibitory agents in neurodegenerative diseases; but pharmacological and biochemical properties and therapeutic applications of simple coumarins depend upon the pattern of substitution (Matos et al 2017).

Plants synthesized secondary metabolites which served as natural defense mechanisms against insects, nematodes, bacteria, fungi, and viruses (Friedman, 2004; Maldonado et al 2016 in Gutierrez, 2020).

For plant survival and species propagation; serves as a warning signal and acts as a pollinator with their aesthetic hues(Arbuckle,C.2016.sites.psu.edu). These metabolites are present in vegetables consumed by humans and the bioactive effects might either be beneficial or dangerous. Thus, a thorough understanding of their bioactivities contributes greatly to the protection and welfare of consumers and medicinal applications (Friedman, 2004; S.Maldonado et al 2016; Gutierrez, 2020).

Production of secondary metabolites can also be due to controlled factors (Illahi, 1993; Ahmad et al 2002). Type, number, and quantity of the chemical substances present in medicinal plants are dependent upon soil, climate and season, nature and density of light, day length stage of growth, and other characteristics (Ghani, 1998; Ahmad et al 2002 in Gutierrez, 2020).

Notably, the presence of alkaloids, oxalates, and saponins at high concentrations contributes to being poisonous and inedible (Ogbuagu, 2008). But luckily among these metabolites, it was only alkaloid which is present in the red samples thus contributing to its non-edible and non-poisonous if taken in high concentration. Alkaloids contribute much to the astringent taste of the liquid of the fruit when mixed with saliva.

The findings showed that *adonidia merrillii* is a novel source of bioactive compounds which do not only enhance antibacterial properties but ascertain its health-promoting qualities (Adeosun, A.M., Arotupin, D.J. et al.2016); can serve as a base for the development of novel potent drugs and phytomedicines (Dahiya,2017).

It must be noted that there are only a few studies related to the secondary metabolites of the palm up to this time that this study is discussed.

Table 3. Cytotoxicity assay of bua china fruits

Samples	Cytotoxicity
green and red bua china fruits	non-toxic

The cytotoxicity test was no longer performed because of the confirmation from the laboratory technicians and validation from individuals that it is non-poisonous in moderate concentration and eradication of much liquid when chewed.

Likewise, there were only a few to no published studies yet regarding the metabolite contents of *adonidia merrillii* as far as the researcher is concerned. Thus, this study is an avenue for more research about the palm for utilization.

4. CONCLUSIONS AND FUTURE WORKS

Based on the findings of the study, the following were the conclusions.

a. Green and red *adonidia merellii* nutritional components were ash, carbohydrates, crude fiber, lipid, moisture, and protein. These contents are beneficial to humans when consumed especially from natural products.

b. Both green and red *adonidia merrillii* positively exhibited the presence of the secondary metabolites: Anthrones, anthraquinone, essential oils, fatty acids, flavonoids, phenols, steroids, sugars, tannins, and triterpenes which are potentials for medicinal breakthroughs for health care services enhancements and food developments for value-adding products and income generation.

Green bua china contains ten (10) secondary metabolites except for alkaloids likewise the red fruit does contain the ten metabolites but does not contain coumarins.

c. The bulbils were not toxic, thus safe to be eaten. These indicate that bua china must be properly maintained, cultivated, and adopted for food development and sources of photochemical needs and income generation.

Based on the nutritional contents, researchers must pursue the development of food products and a potential medicine. Further analysis should be conducted using other solutions and advanced test protocols and equipment to verify results. Lastly, related studies on other parts of the plant should be conducted. Thus, further specific and related studies must be conducted to strengthen the study to maximize the production of these wonder palms.

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