Anticancer Potential of Anthocyanin from Purple Fleshed Sweet Potato (Ipomoea Batatas)

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***Abstract*—Background and Objective Breast cancer is among the most common and deadly cancers affecting women across the globe. Due to the limitations associated with traditional treatment methods, there is a growing interest in investigating naturally sourced compounds with protective effects against cancer. Purple sweet potatoes (Ipomoea batatas) are abundant in anthocyanins and have demonstrated antioxidant, anti-inflammatory, and anticancer properties.**

This research aimed to assess the chemopreventive effects of ethanolic extracts from purple sweet potato peels in a rat model of breast cancer induced by 7,12-dimethylbenz(a)anthracene (DMBA).

The study focuses on the potential of purple sweet potato peels as a safer, natural option for breast cancer prevention. Ipomoea batatas L. varies in ecotypes, characterized by different colors of root peel and pulp, which are linked to health benefits. For instance, a deeper yellow hue indicates a higher presence of carotenoids like ßcarotene.

Yellow- and orange-fleshed varieties are rich in phenolic acids, while purple types have significantly higher amounts of anthocyanins, including both nonacylated and acylated forms of peonidin, cyanidin, and pelargonidin glycosides.

***Index Terms*—Anthocyanin natural antioxidant functional food, health benefits 7,12-dimethylbenz(a)anthracene; anthocyanins; antioxidant effects; breast cancer; Ipomoea batatas; tumor latency**

I. INTRODUCTION

Cancer is characterized by uncontrolled cell growth and division, leading to the formation of tumors or metastasis, the process through which cancer cells spread to other parts of the body [1]. Metastasis is the primary factor contributing to illness and death in cancer patients [2]. Breast cancer is the most commonly diagnosed cancer in women and is a leading cause of cancer-related deaths in many nations [3]. Worldwide, breast cancer is generally classified into ductal and lobular subtypes, with ductal carcinoma comprising around 40%-75% of all cases diagnosed [4].

Despite significant progress in cancer treatment [5], traditional therapies still encounter major issues [L, Z], such as harmful side effects and the development of resistance to treatment [B, 2]. As a result, purple-fleshed sweet potatoes are known to contain higher levels of phenolic acids and flavonoids compared to other varieties [13]. The chemical profile of I. batatas supports its numerous medicinal benefits, which include antioxidant, immunomodulatory [14], antiinflammatory [15], hypoglycemic [IL], cardioprotective, antimicrobial, and anticancer properties.

Extracts rich in anthocyanins from I. batatas have shown to inhibit several cancer cell lines, such as the Michigan Cancer Foundation-7 (MCF-7) for breast cancer, Seoul National University-I for gastric cancer, and a derivative of another colon adenocarcinoma cell line [1B]. In vivo studies using mouse models of induced colorectal cancer have also substantiated its anticancer efficacy [12].

Additional research has examined polysaccharides from I. batatas, which help safeguard macrophages from damage caused by lipopolysaccharides.

showing anti-inflammatory properties and reducing excessive phagocytosis, as well as tumor growth. Additionally, glycoproteins like sweet potato

proteoglycans (SPG-8700 and SPG-56), derived from purple varieties of I. batatas, have been associated with anticancer effects against colon and breast cancer cell lines. Phytosterols from I. batatas, including daucosterol linolenate, daucosterol linoleate, and daucosterol palmitate, have demonstrated the ability to inhibit the proliferation of MCF-7 breast cancer cells and slow tumor development in DMBA-induced breast cancer models in mice. Despite major progress in cancer treatments, breast cancer continues to be a primary cause of illness and death among women globally.

Traditional methods such as chemotherapy, radiation, and hormonal therapies frequently present adverse effects and lead to drug resistance. Therefore, there is an urgent need to discover alternative, safer treatment options, especially those derived from natural resources with fewer side effects. While I. batatas (purple sweet potato) has been widely researched for its antioxidant, anti-inflammatory, and antimicrobial characteristics, its potential for preventing breast cancer using peel extracts rich in anthocyanins remains largely unexplored. Most existing research has concentrated on the anticancer properties of anthocyanins in colon and gastric cancers, with limited in vivo studies confirming their effectiveness against breast cancer development.

Furthermore, there has been minimal investigation of the dose-dependent impacts of anthocyanin-rich extracts in animal models of chemically induced breast cancer, especially concerning tumor latency, volume, and histopathological outcomes. This study set out to investigate the chemopreventive effects of an ethanolic extract from purple sweet potato (I. batatas L.) peels in a rat model of DMBA-induced breast cancer. It specifically aimed to evaluate the extract's antioxidant capacity, total anthocyanin content (TAC), and its dose-dependent effects on tumors.

This study explores latency, tumor size, and histopathological changes in mammary tissue. By clarifying the possible protective effects of I. batatas peel extract, it offers new perspectives on creating functional foods or nutraceuticals as supportive approaches in the prevention and treatment of breast cancer.

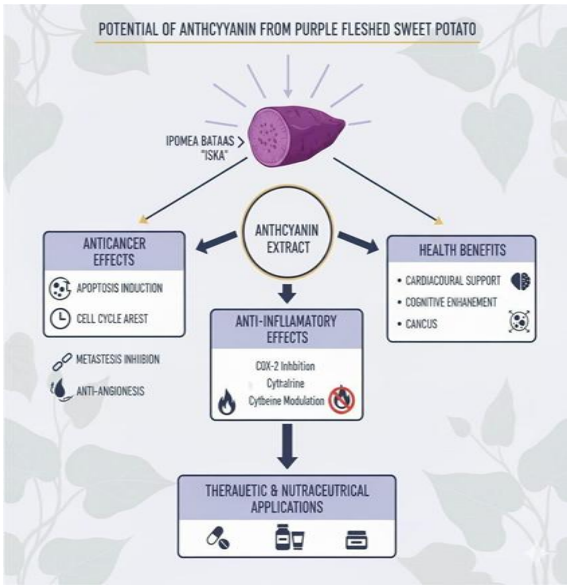

Figure 1:

Effects of purple sweet potatoes (Ipomoea batatas) on (a) tumor formation, (b) latency, and (c) volume in rats with 7,12-dimethylbenz(a)anthracene - induced breast cancer. All data are presented as mean ± standard deviation (n = 10 per group, $p < 0.05$, analysis of variance, post hoc Tukey honestly significant difference test. * and #indicate statistical similarity between groups.

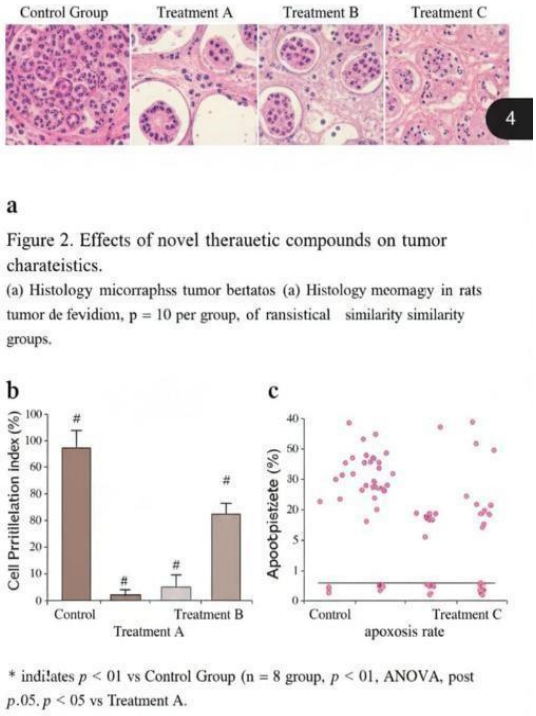

Figure 2:

Photomicrographs of histological changes in breast tissue (hematoxylin and eosin, (a) Group I:
control 7,12-dimethylbenz(a)anthracene, (b) Group Il: Ipomoea batatas-200 mg/kg/dia, (c) Group Ill: I. batatas-400 mg/kg/dia, (d) Group IV: I. batatas-600 mg/kg/day, and (e) Group V: control I. batatas: I. batatas-600 mg/kg/day.
DC=Ductal carcinoma in situ, NC=Necrosis, red arrowhead:
microcalcifications, CT-D=Dense connective tissue; green arrowhead:
lymphocyte, Red star=Cystic fibrous changes with cystically dilated irregular ducts, AT=Adipose tissue, D=Ducts.

II. MATERIALS AND METHODS

Fifty female Rattus norvegicus weighing between 170-200 g were randomly divided into five groups. Breast tumors were induced with a single subcutaneous injection of DMBA (20 mg/rat). Three experimental groups received a daily oral dose of the extract at 200, 400, and 600 mg/kg body weight for four months. One control group was given only DMBA, while another group received the highest extract dosage without DMBA. Antioxidant activity was evaluated using the DPPH and ABTS assays, while anthocyanin content was measured by spectrophotometry. Tumor latency, volume, and histopathological changes were also assessed.

Ethical Approval:
The animal study protocol received approval from the Ethics Committee of the Faculty of Medicine at Universidad Nacional de Trujillo (Approval Certificate No.: 014 - 2021/1-JNT-FMC.E.).

Study Period and Location:
This study took place from January 2022 to July 2023, with all procedures conducted in the Toxicology Laboratory at the School of Pharmacy and Biochemistry, Universidad Nacional de Trujillo, Peru.

Chemicals and Reagents:
DMBA was sourced from Sigma-Aldrich Co. (St. Louis, MO, USA). Neutral buffered formalin
(10%), hematoxylin, eosin, and fuming hydrochloric acid (37%) were provided by Merck
(Darmstadt, Germany). Ethyl alcohol (96%) was obtained from Alkofarma E.I.R.L. (Lima, Peru). Sodium pentobarbital (6.5%) and sodium chloride (0.9%) were supplied by Medifarma (Lima, Peru).

Plant Material and Extraction:
Purple sweet potatoes (I. batatas) were sourced from the town center of La Constancia in the Simbal District of the
La Libertad Region, Peru. A voucher specimen, designated as code 61442, was deposited at the Herbarium Truxillensis (HUT) of the National University of Trujillo. For extraction, 5 kg of the chopped sweet potato peel was macerated for 72 hours in 960 mL of ethyl alcohol adjusted to pH 3.5 with 1.5 N hydrochloric acid. The extract was filtered and dried in an oven at 45°C for 48 hours to produce a dry extract, which was then stored at -20°C.

Assessment of Antioxidant Activity:
To evaluate the antioxidant activity of the extract, the DPPH scavenging capacity assay was used. This test was performed in a 96-well microplate by adding 20 µL of the extract at different concentrations (1.95, 3.9, 7.81, 15.62, 31.25, 62.5, 125, 250, 500, 1000, 1500, and 2000 ppm) to 180 µL of a 0.1 mM DPPH solution. After incubating the mixture in the dark for 30 minutes at room temperature (23°C), the absorbance was measured at 517 nm using a microplate reader, with methanol serving as the blank. The scavenging percentage was calculated using the provided formula. Ascorbic acid and quercetin were used as positive controls, and all experiments were carried out in triplicate.

ABTS Assay:
The ABTS reagent was created by combining 5 mL of 7 mM ABTS with 88 µL of 140 mM potassium persulfate. This solution was then incubated in darkness at room temperature for 16 hours to produce free radicals, before being diluted with distilled water at a 1:44 (v/v) ratio. To assess scavenging activity, 100 µL of the ABTS reagent was combined with 100 µL of the sample in a 96-well microplate and allowed to incubate at room temperature for 6 minutes. Following the incubation, the absorbance was measured at 734 nm using a microplate reader, with methanol serving as a blank. The percentage of scavenging effect was

calculated using the formula mentioned in the DPPH assay.

Evaluation of Anticancer Activity

Animals

Fifty female Rattus norvegicus var. albinus, aged between 50 and 60 days and weighing between 170 and 200 g, were sourced from the Animal Center of the School of Pharmacy and Biochemistry. The animals were kept under standard housing conditions with access to a balanced diet and water available at all times.

Breast Cancer Induction

Breast cancer was induced by administering a subcutaneous injection of DMBA, diluted in 1 mL of olive oil, at a single dose of 20 mg into the mammary tissue. The animals were randomly assigned to five groups, with ten female rats in each. Group I (DMBA Control) received a single dose of DMBA and was treated with physiological saline for four months. Groups II, III, and IV also received DMBA.

A single dose of DMBA was administered, followed by daily oral doses of ethanolic extract from I. batatas at 200,

400, and 600 mg/kg/day for Groups II, III, and IV over a period of four months. Group V, serving as the Extract

Control, received 600 mg/kg/day. Results showed that the 600 mg/kg group significantly prolonged tumor latency (101 days) compared to the DMBA control group (88 days) and also led to a notable decrease in tumor volume (2.26 cm^3 vs. 15.21 cm^3; $p < 0.05$). Histological analysis indicated enhanced ductal epithelial integrity and less necrosis in groups treated with the extract, especially at the highest dosage.

III. RESULTS

The reviewed literature indicates that purple-fleshed sweet potato (Ipomoea batatas) is a rich source of anthocyanins, mainly cyanidin and peonidin derivatives. These anthocyanins show strong antioxidant activity and contribute to anti-inflammatory, anti-diabetic, and anti-cancer effects. Studies also report good thermal and pH stability, making them suitable for use in functional foods, nutraceuticals, and pharmaceutical applications. Overall, the results confirm the significant health-promoting and commercial potential of anthocyanins from purple sweet potato..

IV.CONCLUSION

The study concluded that the ethanolic extract of purple sweet potato peels exhibits a dosedependent chemopreventive effect against DMBA-induced breast cancer in rats, likely attributed to its high anthocyanin content, which may enhance its antioxidant and antitumor properties. These results point to the potential for dietary chemoprevention, suggesting the need for further research into the underlying molecular mechanisms and clinical applications.

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