Introducing Microgreens to Pinggang Pinoy: Prospects in Cultivation, Marketability, and Indigenous Crops Utilization

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ABSTRACT

Controlled Environment Agriculture (CEA) addresses modern farming challenges, such as climate change, diminishing arable land, rising costs, and pest issues, thus, it becomes vital to meet global food demand. Microgreens, a subset of CEA in the commercial scale, have surged in popularity due to their rapid growth, typically maturing in 7 to 21 days, and their nutritional value, rich in phytochemicals, vitamins, and antioxidants, turning them into superfoods. This review explores the potential of microgreens in the Philippines, emphasizing their integration into the Filipino Food Plate as well as promotion of indigenous vegetables and legumes such as pansit-pansitan, tapilan, bataw, patani, samsamping, sigarilyas, kadios, paayap, saluyot, ulasiman, alugbati, and talinum. This initiative will support local farmers in diversifying crops and engaging in the growing microgreen market. The review calls for action in the Philippines to adopt microgreen production, stimulate innovation, and bolster local agriculture and communities. It underscores the importance of indigenous crops and encourages researchers, entrepreneurs, and farmers to participate in the microgreen movement.

Introduction

Controlled Environment Agriculture (CEA) has arisen from the heightened need to address to changing climatic conditions, decreasing arable land areas, high production inputs, alarming pest incidents, and long production cycles (Stoleru et al., 2016; Goodman and Minner, 2019;...

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Wood, 2019). CEA employs a technology-based approach to agricultural production that involves controlling environmental factors such as temperature, humidity, light, and carbon dioxide levels to create optimal growing conditions for crops (Ojo and Zahid, 2022). As technology continues to advance, CEA becomes even more relevant in meeting the growing demand for food in a changing world.

Microgreens, which are good candidates for the Controlled Environment Agriculture (CEA) movement, have emerged as a rapidly growing category of crops with a short cultivation cycle, typically between 7 to 21 days or until the appearance of the first true leaves (Kou et al., 2013; Xiao et al., 2014a; Xiao et al., 2014b). These miniature greens, smaller than baby greens, feature edible stems and leaves, and are frequently cultivated from plant families such as mustard (Brassicaceae), bean (Leguminosae), amaranth (Amaranthaceae), parsley (Umbelliferae), and sunflower (Asteraceae), as commonly observed in microgreen production (Klopsch et al., 2018; Bantis, 2021).

In the business context, one of the Unique Value Propositions (UVP) of microgreens is its nutritional composition. These emerging food commodities are also labeled as superfoods due to their high amount of phytochemicals including antioxidants, vitamins, phenolic compounds, anthocyanins, and glucosinolates (Wojdylo et al., 2020). When compared to the conventional sprouts, which is widely used in Filipino cuisines, the emergence of the first true leaves and the photosynthetic activity in microgreens increases vitamin C, phylloquinone, and tocopherol accumulation. Microgreens, when consumed raw, also retain their thermostable ascorbic acid content as opposed to cooked mature vegetables (Ebert, 2022).

In the realm of growing conditions, light-emitting diodes (LED) lighting has gained significant popularity as the primary light source for indoor cultivation of vegetables, particularly microgreens. This is primarily due to the numerous advantages offered by LEDs compared to traditional light sources (Gerovac et al., 2016). LED technology also exhibits compatibility with the photosynthetic and light-sensing requirements of plants, owing to its wide range of peak emission wavelengths (460–674 nm) and the capability to regulate light intensity (Olle and Viršilė, 2013; Darko et al., 2014; Vastakaite et al., 2015). Zhang et al. (2020) also conducted research indicating that LED lighting plays a crucial role in enhancing the accumulation of diverse phytochemicals, including phenolic compounds, vitamins, glucosinolates, chlorophyll, and carotenoids. Furthermore, microgreens production in hydroponic systems reduces the need for pesticides compared to conventional agriculture, as hydroponic environments are generally less susceptible to infestations by pests and diseases (Rusu et al., 2021).

Considering all these advancements in the microgreen industry in several nations, this review endeavors to illuminate the potential of microgreens in the Philippines, particularly their integration into the Filipino Food Plate (Pinggang Pinoy). Integrating microgreens into the Filipino Food Plate through CEA offers significant benefits including addressing food and nutrition insecurity, supporting local Filipino farmers, and promoting sustainable cultivation methods. This article emphasizes the importance of leveraging indigenous vegetables and legumes to diversify and stimulate the local microgreen market, ultimately calling for innovation and participation from researchers, entrepreneurs, and farmers in the Philippines.
The Filipino Food Plate (Pinggang Pinoy)

The Food and Nutrition Research Institute (FNRI), working together with the World Health Organization (WHO), Department of Health (DOH), and National Nutrition Council (NNC), created Pinggang Pinoy. This visual aid aims to help Filipinos determine the appropriate food portions per meal for a balanced and healthy diet (Food and Agriculture Organization of the United Nations, n.d.).

The Pinggang Pinoy® is a food guide created by FNRI for adults, introduced in 2014. It shows how much of each major food group—rice and alternatives, fish and alternatives, and vegetables and fruits—you should eat per meal. Each group has a specific role: "go" foods give energy, "grow" foods help build the body, and "glow" foods help keep the body healthy. The portion sizes are made to meet the recommended energy and nutrient needs (FNRI-DOST, 2016).

Microgreens

Microgreens represent a novel category of leafy vegetables (Figure 2), consisting of tiny seedlings from edible herbaceous plants. These seedlings are typically harvested within a span of 7 to 21 days following germination, a duration that varies depending on the specific plant species. Harvesting occurs when the cotyledon leaves have fully developed, and the initial true leaves have emerged (Xiao et al., 2012; Di Gioia et al., 2015; Pinto et al., 2015; Wojdylo et al., 2020).

In terms of growth stages, microgreens fall between "sprouts" and "baby greens," exhibiting a more advanced stage of development than sprouts (Kumar et al., 2018). During the harvesting process, the stem is precisely severed just above the base, with the shoot length typically ranging from 5 to 10 cm, a dimension contingent upon the plant species and intended use.
Essentially, the consumable portion comprises the single stem, cotyledon leaves, and the emerging first true leaves (Renna et al., 2017).

![Sprout Microgreens Baby Greens](image)

**Figure 2.** Broccoli (*Brassica oleracea* var. *italica*) at different growth phases.

**Table 1.** General differences between sprouts, microgreens, and baby greens (Renna et al., 2017; Kumar et al., 2018).

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sprouts</th>
<th>Microgreens</th>
<th>Baby Greens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth Stage</td>
<td>Germinated seeds with tiny,</td>
<td>Germinated seeds with cotyledon (first leaves) and true leaves</td>
<td>Young, leafy greens with more developed true leaves</td>
</tr>
<tr>
<td></td>
<td>underdeveloped leaves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvest Time</td>
<td>Typically harvested within 2-7 days</td>
<td>Harvested within 7-21 days of</td>
<td>Harvested when the plants are 10-30 days old</td>
</tr>
<tr>
<td></td>
<td>of germination</td>
<td>germination</td>
<td></td>
</tr>
<tr>
<td>Appearance</td>
<td>Short, tender stems with very small</td>
<td>Tender, leafy greens with</td>
<td>Leafy greens with</td>
</tr>
<tr>
<td></td>
<td>or no leaves</td>
<td>distinct cotyledon and true leaves</td>
<td>developed true leaves</td>
</tr>
<tr>
<td>Flavor</td>
<td>Mild and slightly nutty or earthy</td>
<td>Concentrated flavors, which can</td>
<td>Tender, mild, and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>range from mild to intense,</td>
<td>slightly more mature flavors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>depending on the plant</td>
<td></td>
</tr>
<tr>
<td>Nutritional</td>
<td>Rich in enzymes, vitamins, and</td>
<td>High in vitamins, minerals, and</td>
<td>Good source of vitamins, minerals,</td>
</tr>
<tr>
<td>Value</td>
<td>minerals</td>
<td>antioxidants</td>
<td>and fiber</td>
</tr>
<tr>
<td>Culinary Use</td>
<td>Often used as a garnish, in salads,</td>
<td>Used to enhance flavors and</td>
<td>Typically used as a base for salads,</td>
</tr>
<tr>
<td></td>
<td>sandwiches, or as a topping</td>
<td>textures in salads, soups, and various dishes</td>
<td>sandwiches, or as a side dish</td>
</tr>
<tr>
<td>Popular</td>
<td>Alfalfa, mung bean, broccoli, radish</td>
<td>Sunflower, pea, broccoli, basil</td>
<td>Spinach, arugula, kale, Swiss chard</td>
</tr>
<tr>
<td>Varieties</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Uses

Microgreens are regarded as innovative culinary elements and are often referred to as "vegetable confetti." They serve as valuable additions to a wide array of dishes, including bread dough, sandwiches, salads, soups, desserts, and beverages, enhancing both taste and nutritional value. The appeal and popularity of microgreens lie in their distinctive physical attributes, which include delicate textures, vibrant colors, and diverse shapes and structures, setting them apart from standard vegetables. From a culinary perspective, their ability to seamlessly integrate with primary food ingredients and contribute robust and concentrated flavors makes them particularly intriguing (Xiao et al., 2012; Pinto et al., 2015; Renna et al., 2017).

Species Used

Microgreens encompass a wide range of crop species (Table 2) that can be consumed, including amaranths (Amaranthaceae), crucifers (Brassicaceae), legumes (Leguminosae), and cereals (Poaceae). These versatile options offer a diverse palette of flavors and textures for culinary exploration.

Table 2. List of common commercial microgreens (Renna et al., 2017).

<table>
<thead>
<tr>
<th>FAMILY</th>
<th>SPECIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaranthaceae</td>
<td>amaranth, red orach, Swiss chard, beet, spinach, quinoa</td>
</tr>
<tr>
<td>Amarilloldaceae</td>
<td>garlic, onion, leek, chives</td>
</tr>
<tr>
<td>Apiaceae</td>
<td>dill, carrot, fennel, celery, cilantro, cumin</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>lettuce, endive, escarole, chicory, radicchio, sunflower</td>
</tr>
<tr>
<td>Brassicaceae</td>
<td>arugula, broccoli, cabbage, cauliflower, Chinese cabbage, kale, mizuna, mustard, radish, rapeseed, rappini, Savoy cabbage, tatsoi, watercress,</td>
</tr>
<tr>
<td>Cucurbitaceae</td>
<td>melon, cucumber,</td>
</tr>
<tr>
<td>Leguminousae</td>
<td>chickpea, alfalfa, bean, green bean, fenugreek, fava bean, lentil, pea, clover, soybean</td>
</tr>
<tr>
<td>Lamiaceae</td>
<td>basil</td>
</tr>
<tr>
<td>Linaceae</td>
<td>flax or linseed</td>
</tr>
<tr>
<td>Poaceae (mainly cereals)</td>
<td>oat, soft wheat, durum wheat, corn, barley, rice</td>
</tr>
</tbody>
</table>

Bioavailability of Food Bioactives and Minerals

In recent years, microgreens have garnered significant attention owing to their heightened nutritional content and diverse sensory attributes (Turner et al., 2020). When considering microgreens from radish, kale, mustard, and broccoli, it is noteworthy that radish and mustard exhibit the highest bioaccessible fraction (BF) for key constituents such as ascorbic acid, total carotenoids, and total isothiocyanates, while broccoli, kale, and radish display elevated BF levels for total polyphenols (de la Fuente et al., 2019). In a possible marketing perspective, research has demonstrated that baked lupin microgreen bread retains substantial quantities of genistein, a compound renowned for its anticarcinogenic properties (Romagnolo et al., 2017; Klopsch et al., 2018). Tables 3 and 4 summarize the proximate composition and phytochemistry of crops grown as microgreens.
In Thailand, Kowitcharoen et al. (2021) reported various families of crops produced as microgreens. In their study, they attributed increasing consumer acceptability to microgreens’ low-calorie content and their abundant micronutrients and antioxidants. They examined the nutritional and bioactive properties of 14 different microgreens belonging to various plant families, such as Brassicaceae, Fabaceae, Pedaliaceae, Polygonaceae, Convolvulaceae, and Malvaceae. The findings revealed that all the microgreens had low calorie content, ranging from 20.22 to 53.43 calories 100 g⁻¹, and low levels of fat, with fat content ranging from 0.15 to 0.66 g 100 g⁻¹. Notably, mung bean microgreens had a relatively high carbohydrate content of 7.16 g 100 g⁻¹, while lentil microgreens contained a substantial amount of protein, measuring at 6.47 g 100 g⁻¹. Table 3 provides a glimpse into the nutritional composition of several microgreen species.

The crop varieties displayed in Tables 3 and 4 represent locally accessible crops within the Philippines. With the promising data on their nutritional potential, this heightens prospects for commercialization and integration into the Filipino Food Plate.

**Proximate Analysis.** Notably, moisture content consistently registers at relatively high levels across various microgreen varieties. Leguminous crops stand out for their elevated protein content, establishing them as a significant source of plant-based protein within this category. In contrast, microgreens, as a whole, exhibit comparatively low levels of crude fat. The ash content, serving as an indicator of mineral concentration, demonstrates a remarkable uniformity across different microgreen species. Furthermore, there is discernible variability in total carbohydrate content among these species. These nuances in nutritional composition underscore the diversity inherent in microgreens, imparting significance to their selection for dietary or culinary purposes.

**Bioactive Constituents.** In microgreens, bioactive compounds were also documented, which include alkaloids like indoles and phenolic amines, betacyanins like betanin and amaranthin, organosulfurs like glucosinolates and isothiocyanates, phenolics like coumarins and flavonoids, and terpenes like carotenoids (Johnson et al., 2021). A general trend observed across studies is that microgreens consistently exhibited higher levels of chlorophyll compared to sprouts. Table 4 summarizes the other reported bioactive compounds in several microgreens that could be adopted in the Philippines for household and commercial production.

**Mineral Content.** In terms of the mineral content, Johnson et al. (2021) compared microgreens and their mature counterparts. They found that in some cases, microgreens had much higher amounts of certain minerals compared to their mature versions. For example, arugula and broccoli microgreens had a lot more selenium and copper than mature arugula and broccoli. Broccoli microgreens had 13.7 times more copper than mature broccoli. Pea microgreens had significantly more selenium and molybdenum, with increases of 16.8 and 12.2 times, respectively. Red amaranth microgreens had 2.2 times more copper than mature red amaranth. Red beet microgreens were rich in selenium (10.2 times more), chromium (3.1 times more), and copper (2.5 times more) compared to mature red beets. Red cabbage microgreens had 2.1 times more phosphorus, 2.4 times more iron, 9.1 times more copper, and 3.8 times more zinc than mature red cabbage. On the other hand, some microgreens had lower amounts of certain minerals compared to their mature counterparts. For example, arugula microgreens had less sulfur, potassium, and molybdenum than mature arugula. Red amaranth microgreens had lower amounts of cadmium, phosphorus, sulfur, and molybdenum than mature red amaranth. Surprisingly, pea and red beet microgreens had lower levels of many minerals, including magnesium, calcium, manganese, and copper, compared to their mature counterparts. Notably,
broccoli and red cabbage microgreens did not have significantly lower levels of any minerals compared to their mature counterparts.

**Table 3.** Proximate composition (g 100 g\(^{-1}\)) of selected microgreen species (Kowitcharoen et al., 2021).

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Moisture</th>
<th>Crude Protein</th>
<th>Crude Fat</th>
<th>Ash</th>
<th>Total Carbohydrates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leguminosae</strong></td>
<td>Mung Bean</td>
<td>87.29±2.28</td>
<td>4.55±0.05</td>
<td>0.36±0.01</td>
<td>0.64±0.04</td>
<td>7.16±0.02</td>
</tr>
<tr>
<td></td>
<td>Green Pea</td>
<td>92.37±2.38</td>
<td>3.73±0.02</td>
<td>0.15±0.00</td>
<td>0.36±0.02</td>
<td>3.39±0.04</td>
</tr>
<tr>
<td></td>
<td>Lentil</td>
<td>86.57±1.12</td>
<td>6.47±0.11</td>
<td>0.43±0.02</td>
<td>0.61±0.00</td>
<td>5.92±0.01</td>
</tr>
<tr>
<td><strong>Brassicaceae</strong></td>
<td>Broccoli</td>
<td>94.07±3.11</td>
<td>2.23±0.11</td>
<td>0.49±0.01</td>
<td>0.51±0.02</td>
<td>2.70±0.20</td>
</tr>
<tr>
<td></td>
<td>Chinese Kale</td>
<td>93.63±2.12</td>
<td>2.23±0.00</td>
<td>0.36±0.02</td>
<td>0.65±0.00</td>
<td>3.13±0.11</td>
</tr>
<tr>
<td></td>
<td>Radish</td>
<td>93.19±1.23</td>
<td>2.58±0.01</td>
<td>0.50±0.01</td>
<td>0.44±0.02</td>
<td>3.29±0.09</td>
</tr>
<tr>
<td><strong>Pedaliaceae</strong></td>
<td>Black Sesame</td>
<td>93.75±2.27</td>
<td>1.92±0.02</td>
<td>0.41±0.02</td>
<td>0.34±0.00</td>
<td>3.58±0.03</td>
</tr>
<tr>
<td><strong>Malvaceae</strong></td>
<td>Red Roselle</td>
<td>92.51±1.19</td>
<td>4.10±0.07</td>
<td>0.24±0.01</td>
<td>0.64±0.00</td>
<td>2.51±0.05</td>
</tr>
<tr>
<td><strong>Polygonaceae</strong></td>
<td>Buckwheat</td>
<td>92.74±1.11</td>
<td>1.75±0.03</td>
<td>0.27±0.01</td>
<td>0.34±0.00</td>
<td>4.90±0.01</td>
</tr>
<tr>
<td><strong>Convolvulaceae</strong></td>
<td>Morning Glory</td>
<td>94.26±1.21</td>
<td>1.76±0.00</td>
<td>0.36±0.01</td>
<td>0.54±0.01</td>
<td>3.08±0.03</td>
</tr>
</tbody>
</table>

**Table 4.** Bioactive compounds highly present in selected microgreen species.

<table>
<thead>
<tr>
<th>Species</th>
<th>Bioactive Compounds Reported</th>
<th>Amount</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cowpea</td>
<td>Ascorbic Acid</td>
<td>28.66 mg/g</td>
<td>Eswaranpillai et al. (2023)</td>
</tr>
<tr>
<td>French Basil</td>
<td>Ascorbic Acid</td>
<td>120.6 mg/100 g FW</td>
<td>Ghoora et al. (2020)</td>
</tr>
<tr>
<td></td>
<td>Total Chlorophyll</td>
<td>80.0 mg/100 g FW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Phenolics</td>
<td>28.6 mg/100 g FW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Antioxidant Activity (DPPH)</td>
<td>154.4 μg/ml mg/100 g FW</td>
<td></td>
</tr>
<tr>
<td>Mung Bean</td>
<td>Ascorbic Acid</td>
<td>15.28 mg/g</td>
<td>Eswaranpillai et al. (2023)</td>
</tr>
<tr>
<td></td>
<td>Total Antioxidant Activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Phenolics</td>
<td>840.68 μg/100 g FW</td>
<td>Dhaka et al. (2023)</td>
</tr>
<tr>
<td></td>
<td>Anthocyanin</td>
<td>62.12 mg/100 g FW</td>
<td></td>
</tr>
<tr>
<td>Pak Choy</td>
<td>Total Phenolics</td>
<td>145.4 mg/100 g FW</td>
<td>Xiao et al. (2019)</td>
</tr>
<tr>
<td></td>
<td>Antioxidant Activity (DPPH)</td>
<td>160.1 μmol/100 g FW</td>
<td></td>
</tr>
<tr>
<td>Radish</td>
<td>Total Phenolics</td>
<td>61.8–135.7 mg/100 g FW</td>
<td>Ghoora et al. (2020)</td>
</tr>
<tr>
<td></td>
<td>Antioxidant Activity (DPPH)</td>
<td>207 μmol/100 g FW</td>
<td>Yadav et al. (2019)</td>
</tr>
<tr>
<td>Sunflower</td>
<td>Ascorbic Acid</td>
<td>94.0 mg/100 g FW</td>
<td>Ghoora et al. (2020)</td>
</tr>
<tr>
<td></td>
<td>Total Phenolics</td>
<td>39.4 mg/100 g FW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Antioxidant Activity (DPPH)</td>
<td>148.3 μg/ml</td>
<td></td>
</tr>
<tr>
<td>Watercress</td>
<td>Total Phenolics</td>
<td>181.1 mg GAE/100 g FW</td>
<td>Xiao et al. (2019)</td>
</tr>
<tr>
<td></td>
<td>Antioxidant Activity (DPPH)</td>
<td>216.6 μmol Te/100 g FW</td>
<td></td>
</tr>
</tbody>
</table>
A common discrepancy among proximate composition, bioactive compounds, and minerals is contingent upon various factors, including genotype, environmental conditions, germination methods, storage, and postharvest processing. Unlike sprouts, microgreens are cultivated within controlled environments, such as greenhouses or open settings, utilizing soil or alternative growth substrates, and are exposed to light throughout their growth cycle (Vastakaite et al., 2015; Kyriacou et al., 2016; Eswaranpillai et al., 2023).

Cultivation and Handling of Microgreens

Seed Sources, Storage and Preparation

Seeds of edible vegetables, herbs, and grains, including wild and weedy species can be used for microgreen production (Xiao et al., 2012). The success of microgreen production largely depends on sustainable seed supply system (Di Gioia et al., 2015). The seed quality determines the germination rate, seedling vigor, and the quality of harvested microgreens. In addition, the seeds must be free from any chemical treatments and microbial contamination. When buying seeds, it is fundamental to check the labels or catalogs, if in doubt, it is always best to clarify with the company before buying.

Seeds should be stored in secure, enclosed containers to avoid any contamination and pest infestations (Dadlani et al., 2023). Furthermore, soaking the seeds in diluted hydrogen peroxide and hot water treatment may be used as disinfectants thus lowering the risk of seed-borne pathogen and bacteria contamination (Gilbert et al., 2023).

Growing Containers and Potting Substrates

Microgreens can be grown in different containers depending on the volume of production. For household consumption and small-scale cultivation, plastic trays are the best economical option. With handy plastic trays, the product could be transported along with the growing media, thus avoiding the need to cut the product before it is shipped on the market. For commercial scale, aluminum, galvanized iron, wood benches, and floating polystyrene plug trays are used with advanced hydroponic systems. Among the common substrates used for microgreens production, peat-based media are the most utilized, followed by coconut coir, perlite, and vermiculite either individually or in mix. Recently, growing mats made of natural-fiber based media such as coco coir, jute, cotton, cellulose, algae fiber, and paper pulp have gained increasing popularity as sustainable alternatives. These commercial mats have well defined and standardized physical, chemical, and agronomic properties, and have a good balance between water holding capacity and air capacity and, not less important, have good hygienic-sanitary quality (Di Gioia et al., 2015).

Growing Conditions

The growth and development of microgreens are significantly influenced by various environmental factors, including temperature and humidity, throughout their life cycles. Researchers have observed a range of environmental conditions in their experiments, typically falling within the range of 15°C to 30°C for average air temperature and 60% to 80% for relative humidity (Ghoora et al., 2020; Rusu et al., 2021).

Light quality affects many aspects of plant growth, morphology, color, flavor, and nutrition (Kyriacou et al., 2016). Vastakaite et al. (2015) reported that application of blue (447 nm) LED
lighting in combination with red (638, 665 nm) and far red (731 nm) affected phytonutrient levels differently in red pak choi, tatsoi, and basil microgreens. The balance of the light was made up with 638 nm red light, providing the same total photosynthetic photon flux density (PPFD) for all treatments.

Alrifai et al. (2019) explain that red, blue, and combined red plus blue light are more effective than white light and other wavelengths for enhancing photosynthesis and regulating plant metabolism. Supplementation with green light (510 nm) improved antioxidant properties of lentil and wheat-sprouted seeds (Samuoliene et al., 2011). The antioxidant profile of baby leaf lettuce and sprouted seeds grown under natural lighting and HPS lamps has also been reported to be sensitive to spectral light quality, with different wavelengths of blue and green supplementary LED lighting altering the amounts of phytochemicals produced (Samuoliene et al., 2011, 2012). There is a potential for LED light in the UV and blue ranges to enhance food safety of hydroponically grown microgreens by treating the water as it circulates. Light in blue and UV wavelengths can kill bacteria (Maclean et al., 2009; McKenzie et al., 2014; Kim et al., 2016).

In terms of photoperiod, a comprehensive review by Appolloni et al. (2021) examined a total of 40 articles comprising 389 trials. The review revealed that most of these trials, specifically 95%, employed a photoperiod ranging from 12 to 16 hours per day. Among these experiments, 78% specifically utilized a 16-hour per day photoperiod, while a smaller proportion, 4%, extended their photoperiod beyond 16 hours per day. Only 1% of the trials involved a photoperiod of less than 16 hours per day.

**Pest and Disease Management**

Rusu et al. (2021) stated that hydroponic production systems, which can also include microgreens, have the potential to diminish or eliminate the necessity for insecticides, herbicides, or pesticides. This not only contributes to a decrease in greenhouse gas emissions but also allows for the reuse of water, resulting in a substantial reduction in water consumption, up to 90%, compared to traditional soil-based production in open fields. This makes microgreens beneficial from sustainable agriculture viewpoints as they minimize the use of agrochemicals and their associated environmental risks, further emphasizing the environmentally conscious nature of hydroponic systems.

**Postharvest Handling and Food Packaging of Microgreens**

Ghoora and Srividya (2020) conducted an experiment to assess the impact of different packaging methods and coating techniques on the quality and shelf life of radish microgreens. Their study examined two types of packaging: polyethylene terephthalate clamshell containers and self-seal bags made of low-density polyethylene. The findings revealed that, when stored at a temperature of 5°C, the clamshell containers proved to be more effective packaging than the self-seal bags.

In a recent review, Garcia-Guzman et al. (2022) put forward the idea that commercial materials derived from starch have the potential to significantly contribute to the food packaging sector by serving as an eco-friendly and sustainable substitute for synthetic packaging materials. The review emphasized the utilization of advanced packaging technologies featuring bioactive elements and intelligent packaging films possessing antibacterial, antioxidant, and barrier functionalities. These encompass lignocellulosic fibers (Li et al., 2019; Bangar et al., 2021), as
well as starch derived from sources such as potato (Islam et al., 2021), corn (Lopez et al., 2015), and cassava (Andretta et al., 2019).

In a separate study by Kou et al. (2013), the researchers investigated the influence of storage temperature on changes in aerobic mesophilic count and tissue electrolyte leakage in buckwheat microgreens. They conducted experiments at various storage temperatures, including 20, 15, 10, 5, and 1°C. After a storage period of 10 days, their results indicated that microgreens stored at 15 and 20°C exhibited significantly higher bacterial counts (1-2 log CFU/g) compared to those stored at 10, 5, and 1°C. Furthermore, they concluded that even after 14 days of storage, microbial activity in microgreens stored at 10°C remained minimal.

Microgreens in the Business World

Microgreens have gained popularity among health-conscious individuals and chefs who use them for their vibrant colors and rich flavors (Enssle, 2020). These tiny greens are densely packed with essential nutrients and beneficial phytochemicals. Recent years, from 2019 to 2022, have witnessed a significant increase in research exploring the nutritional value of microgreens (Teng et al., 2023). Figure 3 displays a unique value proposition canvas for microgreens in general based on literature.

![Figure 3. Unique Value Proposition (UVP) canvas for microgreens.](image)

Microgreens can serve as a valuable addition to urban farms, contributing to improved food security by providing households with a readily available source of nutrients during emergencies (Di Gioia et al., 2015). Furthermore, their minimal space requirements and relatively high market prices make microgreens a profitable choice for controlled environment agriculture (CEA) and urban/vertical farms, enabling year-round production in various climatic conditions.
Global Market for Microgreens

Raju and Roshan (2022) analyzed the global microgreens market and identified several key categories, which are outlooks on region (growing location), farming type (cultivation methods), produce (predominant crops), and distribution channel (primary users), as displayed in Figure 4.

This market was also analyzed in different regions like North America (which includes the U.S., Canada, and Mexico), Europe (with countries like Russia, Spain, Italy, France, Germany, the UK, and others), Asia-Pacific (including China, Japan, India, South Korea, Australia, and more), and LAMEA (which stands for Latin America, Middle East, and Africa). Notably, the Philippines is not highlighted as one of the countries analyzed for microgreens consumption in this report. They are grown in different ways, either indoors in vertical farms, in commercial greenhouses, or other methods. Different varieties like broccoli, cabbage, radish, arugula, basil, amaranth, and other species such as cauliflower, peas, and cress dominate the world microgreens market. The specific market segments using them include retail, food service, online stores, and farmer’s market (Grand View Research, 2021; Raju and Roshan, 2022).

Market Trends in Microgreens

In a global perspective of indoor farming, the significance of microgreens is evident. As of April 2017, 55% of hotel restaurants in the United States expressed their intent to purchase microgreens ingredients and products, signifying the increasing demand and utilization of microgreens within the culinary industry. These trends collectively underscore the expanding significance and market presence of microgreens, both domestically and on a global scale (Statista Research Department, 2017).

The vertical farming segment also showed significant growth trends. In 2019, it was valued at $776.0 million, and it is projected to reach an impressive $1,361.1 million by 2028, demonstrating a strong compound annual growth rate (CAGR) of 11.3% (Raju and Roshan, 2022). A separate analysis by IMARC Group (2022) emphasizes the global growth of the microgreens market. It forecasts that by 2028, the market's value will reach a substantial US$2,470 million (Figure 5a). Over the period from 2023 to 2028, the market is expected to
grow at a CAGR of 8.3%, underlining its steady expansion on a global scale. Straits Research (2022) paints a robust picture for the microgreens market, with a projected value of USD 2.6 billion by the year 2031. This growth is anticipated to be driven by a significant CAGR of 11% during the period from 2022 to 2030, indicating substantial opportunities and demand for microgreens on the horizon.

Moving specifically to the Asia Pacific region, according to KBV Research (2022), the microgreens market is witnessing notable growth. In 2021, the Chinese market led the way in the Asia Pacific Microgreens Market, and it is expected to continue its dominance until 2028, reaching a market value of $208.7 million. In Japan, there is a steady growth trajectory, with a CAGR of 10.5% during the years 2022 to 2028 (Figure 5b). Meanwhile, India is also poised for impressive growth with an anticipated CAGR of 11.9% during the same period, indicating increasing interest and demand for microgreens across the region.

**Figure 5.** Microgreens market trend: a) global based on IMARC Group (2022) and b) Japan from the Asia-Pacific region based on KBV Research Group (2022).

**Business Models and Distribution Channels for Future Philippine Enterprises**

In the Philippines, there are a few enterprises that focus on microgreens production, for instance, Pedro Farms and MicroGreens Philippines for large commercial farms and Nama Microgreens and The Manna Farm for small-scale enterprises. These enterprise markets commercially grown microgreens species known worldwide such as broccoli, lettuce, radish, peas, mustard, amaranth, among others.

Future microgreens enterprises should explore both wholesale and direct-to-consumer sales channels. One strategy is to first pursue direct-to-consumer sales from their existing customer base. This approach is relatively low risk and will allow future microgreens enterprises to gather information about consumer preferences from an immediate source. Current trends indicate a shift in consumer purchasing of local foods, and many research firms believe this shift toward local will remain in the post-COVID environment. Outdoor farmer’s markets are a strong channel match for future microgreens enterprises, as farmer’s markets provide access to their target demographic of customers who prefer local, sustainable, and healthy products. Finally, future microgreens enterprises should target local restaurants and cafes. Farmer’s markets could potentially expose these enterprises to local chefs or business owners. Chefs prefer to purchase from local producers that can offer fresher products in less time than large distributors. Brewpubs and hospital cafeterias should be targeted in a similar manner (Enssle, 2020).
Profitability of Microgreens

Growing microgreens is a profitable enterprise that can support the economies of underprivileged communities. The global market is expanding, with growth rates expected between 7.5% (2021-2026) and 13.1% (2020-2028). In 2020, North America led the market, while Asia-Pacific saw the fastest growth (Lone et al., 2024). Mixed crop varieties offer more options and sell for $66 to $110 per kilogram in the U.S (Treadwell et al., 2020). Microgreens generate a 40% return on investment, higher than flowers (30%) and tomatoes (10%) (Agrilyst, 2017). Retail outlets accounted for 46.8% of the market in 2019, with an annual growth rate of 11.4% projected through 2028. The industry is expected to grow from $1.4 billion in 2020 to $3.8 billion by 2028, driven by advanced production technology, indoor and vertical farming, and demand for nutritious food (Paraschivu et al., 2021, Allied Market Research, 2022).

According to the Agrilyst (2016) survey with 150 respondents spanning various countries, including the United States, Canada, the Caribbean, Slovakia, Bahrain, Dubai, Tunisia, Finland, Belgium, China, and Japan, it was revealed that the annual revenue generated from microgreens was 12.86 USD per pound and 56.23 USD per square foot. This data illustrated the economic impact of microgreens cultivation, highlighting their growing presence in the agriculture sector.

With these global market trends along with potential business models in microgreens production, the Philippines should bolster its production and harness the potential of Filipino farmers as microgreens practitioners and business owners. This will start as we heighten knowledge and awareness on microgreens as an emerging commodity.

Philippine Indigenous Crops with Potential as Microgreens

The indigenous vegetables and legumes highlighted in Figure 6 exhibit the potential for consumption as microgreens, given their current use as mature leafy vegetables and seeds.

1. Pansit-pansitan (*Peperomia pellucida*)

Pansit-pansitan, belonging to the Piperaceae family, is an annual erect herb that can grow up to 40 cm in height. This plant features very succulent round stems approximately 5 mm thick. Its leaves are alternate, heart-shaped, smooth, and waxy. The flowers are borne on very slender, green, erect spikes that are about 6 mm long (Suratos et al., 2017). In terms of phytochemistry, the plant contains a range of phytochemical components, including saponins, sesamin, dill apiole, isoswertisin, terpenoids, phytol, stigmasterol, alkaloids, steroids, secolignans, sitosterol, glycosides, highly methoxylated dihydronaphthalenone, tetrahydrofuran lignans, and flavonoids (Raghavendra and Prashith Kekuda, 2018).

2. Tapilan (*Vigna umbellata*)

Tapilan, also known as ricebean, is an annual legume belonging to the Leguminosae family. Bepary et al. (2017) found that the primary nutrients in tapilan seeds include 54.21–60.49% carbohydrates, 15.64–21.60% protein, 1.22–2.3% fat, 5.53–6.56% crude fiber, and 3.34–3.8% ash. Katoch (2013) reported that the accession BRS-2 from India contains 25.57% protein with an in vitro digestibility of 54.23%. Additionally, tapilan seeds are rich in diverse saccharides
(Bepary and Wadikar, 2019) and contain about 60% digestible proteins, enriched with essential amino acids (Katoch et al., 2013; Kaur et al., 2013; Bepary et al., 2017).

Figure 6. Utilized parts of the indigenous vegetables: pansit-pansitan (*Peperomia pellucida*), tapilan (*Vigna unguiculata*), bataw (*Lablab purpureus*), patani (*Phaseolus lunatus*), samsamping (*Clitoria ternatea*), sigarilyas (*Psophocarpus tetragonolobus*), kadios (*Cajanus cajan*), paayap (*Vigna unguiculata*), saluyot (*Corchorus olitorius*), ulasiman (*Portulaca oleracea*), alugbati (*Basella alba*), and talinum (*Talinum paniculatum*).

3. **Bataw (*Lablab purpureus*)**

Bataw is a short-lived perennial vine with oval, three-pointed leaflets that measure 6-12 cm in length and 5-9 cm in width. (Molina, 2021). In terms of utilization, Pelser et al. (2011) noted that the young pods of bataw can be boiled and eaten as a salad or mixed into curries. The young seeds can be boiled or roasted. The young leaves, tops, and flowers can be boiled as a salad or added to local dishes like *dinengdeng* (pinakbet). Dried seeds can be cooked on their own, made into bean cakes, or sprouted like mung beans. Nutrient-wise, in every 100 grams of
pods, there are 10 grams of carbohydrates, 2 grams of fiber, 4.5 grams of protein, 0.1 grams of oil, 82.4 grams of moisture, and an average of 1260 kJ of energy. Dried leaves contain 155 mg of iron per 100 grams, while dried seeds have 21-29 grams of protein per 100 grams. The whole plant has a crude protein content ranging from 10 to 22%, seeds contain 23 to 28%, leaves have 14.3 to 38.5%, and stems have 7 to 20.1%. The whole plant also includes 28% crude fiber. However, certain bataw grains have cyanogenic glucosides, which reduce palatability.

Considering this, it is crucial to cook bataw microgreens when using it as microgreens, since Bolarinwa et al. (2016) noted that processing methods such as boiling or cooking can decrease cyanide content in foods containing cyanogenic glycosides to safe levels.

4. Patani (Phaseolus lunatus)

Seeds of patani are a source of saponins samples are from Isabela, Philippines (Ruma, 2016). Queddeng (2017) also tested on the presence of physiologically active constituents in patani leaves, and found out that it contains carbohydrates, reducing sugars, gums, mucilages, glycosides, tannins, proteins, alkaloids, leucoanthocyanins, triterpenes, and unsaturated sterols. These constituents can be used for various phytochemical, nutrition, and medicinal uses.

5. Samsamping (Clitoria ternatea)

Samsamping, scientifically known as Clitoria ternatea and belonging to the Fabaceae family, is a climbing vine. Its pods are linear, ranging from 5 to 10 cm in length, flat, and dehiscent, typically containing 6 to 10 seeds (Suratos et al., 2017). Torres et al. (2022) analyzed the phytochemical composition of samsamping sourced from Victoria Tarlac, Philippines. Their study revealed that the total phenolic content of the C. ternatea extract was 3.9519 ± 0.1 mg GAE / 100 g, while the IC50 for DPPH radical scavenging activity was determined to be 53.6913 mg/kg. Phytochemical screening of the ethanolic extract from C. ternatea also identified the presence of triterpenes, saponins, reducing sugars, tannins, sterols, flavonoids, and alkaloids.

6. Sigarilyas (Psophocarpus tetragonolobus)

Sigarilyas, also known as asparagus pea, goa bean, four-angled bean, and winged bean is a tropical leguminous plant categorized as one of the underutilized legumes, making it an underexploited food source in tropical regions. Referred to as "poor man’s food," P. tetragonolobus is valued for its edible leaves, flowers, roots, and pods, which can be consumed either raw or cooked (Bassal et al., 2020). Phytochemical screening conducted by Ruma (2016) showed that the whole fruit of sigarilyas harvested from Isabela, Philippines contains flavonoids, phenolics, and tannins.

7. Kadios (Cajanus cajan)

Kadios, typically grown as an annual despite being a perennial crop, produces pods that are consumed for food. These pods, whether eaten as green peas or dried grains, contain protein levels ranging from 20% to 32%. This protein content is crucial in fulfilling the dietary protein requirements of vegetarian populations (Bernabe, 2021). Qualitative analysis of phytochemicals of kadios sourced from Isabela, Philippines revealed that it contains flavonoids, tannins, saponins, and triterpenes (Ruma, 2016).
8. Paayap (*Vigna unguiculata* L. Walp)

Paayap is an annual herbaceous legume from the genus *Vigna*, which are rich in micronutrients, nutraceuticals, and antioxidants. The leaves are known to contain alpha-tocopherols, flavonoids, lycopene, and anticancer compounds (Shetty *et al*., 2013). Paayap are packed with vital nutrients, including vitamins and minerals, which can greatly improve nutritional intake when utilized properly (Okonya and Maass, 2014). Fresh paayap leaves have been found to be high in beta-carotene and iron, with concentrations ranging from 0.25 to 36.55 mg/100 g dry weight for beta-carotene and 0.17 to 75.00 mg/100 g dry weight for iron (Owade *et al*., 2019).

9. Saluyot (*Corchorus olitorius*)

Saluyot, belonging to the Malvaceae family, is a common leafy vegetable in the Philippines. The Department of Science and Technology (DOST) classifies it as a functional food, offering health benefits beyond basic nutrition. Saluyot is recognized for its antioxidant, anti-inflammatory, analgesic, and anticancer properties, which help reduce the risk of lifestyle-related diseases such as obesity, atherosclerosis, cardiovascular disease, diabetes, and cancer (Tosoc *et al*., 2021).

10. Ulasiman (*Portulaca oleracea*)

Ulasiman, or *Portulaca oleracea*, belongs to the Portulacaceae family and is an annual, prostrate-growing herb measuring between 10 to 50 cm in length. It has succulent, purple-tinged stems and fleshy leaves that are oblong to obovate, up to 2.5 cm long, with an opposite attachment on the stem (Suratos *et al*., 2017).

Despite being classified as a highly invasive weed, ulasiman is esteemed for its nutritious edible parts, particularly rich in omega-3 fatty acids, especially α-linolenic acid (Oliveira *et al*., 2009). Additionally, these parts contain valuable minerals like calcium, potassium, and phosphorus, along with macronutrients such as proteins and carbohydrates. Ulasiman also provides tocopherols, carotenoids, and ascorbic acid, while extracts from its leaves are recognized for their antioxidant properties due to phenolic compounds and oleracein derivatives (Szalai *et al*., 2010; Sicari *et al*., 2018; Petropoulos *et al*., 2019).

11. Alugbati (*Basella alba*)

Alugbati in the Philippines is an underutilized crop with potential health benefits. Tongco *et al.* (2015) found that dried Alugbati leaves contain 15.49% ash (minerals), 1.58% crude fat, 7.23% crude fiber, 17.55% crude protein, and 50.62% total carbohydrates. Phytochemical screening showed the presence of saponins, diterpenes, phenols, tannins, and flavonoids in both ethanol and water extracts, alkaloids in water extracts, and cardiac glycosides in ethanol extracts. The total phenolic content was 93.89 mg gallic acid equivalents (GAE)/g for ethanol extracts and 85.13 mg GAE/g for water extracts, while quercetin equivalents (QE) were 100.18 mg QE/g for ethanol extracts and 90.80 mg QE/g for water extracts.

12. Talinum (*Talinum paniculatum*)

Talinum, also known as taltalinum, belongs to the Portulacaceae family and is a perennial erect shrub that can grow up to 50 cm in height. It features green, fleshy succulent stems and glossy,
bright green leaves that are spatulate to obovate-lanceolate with a whorled arrangement on the stem (Suratos et al., 2017).

According to phytochemical studies, talinum contains bioactive compounds such as flavonoids, alkaloids, terpenoids, saponins, and tannins. The raw leaves of this vegetable are rich in proximates, phytochemicals, minerals, vitamins, chlorophyll, and antioxidants, but they have low carbohydrate content and energy value. Cooking the leaves for 5 minutes resulted in minimal losses of proximates, phytochemicals, calcium, iron, zinc, thiamin, riboflavin, niacin, and tocopherol. However, there were significant reductions in vitamin C, carotenoids, magnesium, phosphorus, chlorophyll, and antioxidant activity. Cooking also increased moisture, protein, and crude fiber contents (Ogbonnaya and Chinedum, 2013).

Aside from the Philippine indigenous crops, there are also several indigenous crops per continent that has potential as microgreens, as displayed in Table 5.

**Table 5.** Indigenous crops per continent with potential as microgreens.

<table>
<thead>
<tr>
<th>Continent</th>
<th>Crop</th>
<th>Nutritional Characteristics</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>Bambara Bean <em>(Vigna subterranea)</em></td>
<td>fourth most important grain legume crop after groundnut, cowpea, and soybean; higher nutrient content compared to other legumes; protein composition: 6–43% globulin, 14–71% albumin, 1.6–2.2% prolamins, 3.3–5.2% glutelins</td>
<td>Hillocks et al. (2012).</td>
</tr>
<tr>
<td>Europe</td>
<td>Common Vetch <em>(Vicia sativa L.)</em></td>
<td>average crude protein content of 283.63 g/kg dry matter (DM), 8.95–38.00 g/kg DM of crude fat; potassium (9.10–12.30 g/kg DM), phosphorus (2.30–5.07 g/kg DM), and zinc (31.00–42.33 mg/kg DM).</td>
<td>Huang et al. (2017)</td>
</tr>
<tr>
<td>Australia and Oceania</td>
<td>Cooper Clover <em>(Trigonella suavissima)</em></td>
<td>among Australian legumes, it has the highest crude protein content at 370 g kg⁻¹ dry weight</td>
<td>Bell et al. (2012)</td>
</tr>
<tr>
<td>North America</td>
<td>Tepary Bean <em>(Phaseolus acutifolius)</em></td>
<td>exhibited significantly higher levels of boron, iron, manganese, and sulfur, while common beans had higher levels of calcium, cobalt, potassium, and sodium</td>
<td>Porch et al. (2017)</td>
</tr>
<tr>
<td>South America</td>
<td>Lima Bean <em>(Phaseolus lunatus)</em></td>
<td>20.69–23.08% crude protein, 0.59–1.14% crude fat, 4.06–6.86% crude fiber, 4.39–5.61% ash, 9.19–11.83% moisture, 54.31–59.64% carbohydrates, and 313.28–328.10 kcal/100 g energy</td>
<td>Jayalaxmi et al. (2016)</td>
</tr>
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**SWOT Analysis: Introduction of Microgreens in Philippine Business**

**Strengths.** Starting a small-scale microgreens enterprise benefit from a first-mover advantage in the nascent microgreens industry in the Philippines. This allows the enterprise to establish its brand and capture market share before competitors emerge. Moreover, utilization of indigenous vegetables and legumes, offers a unique and potentially nutritious microgreen option to consumers, providing the enterprise with a distinct competitive edge. The high potential of indigenous vegetables and legumes as microgreens translates into strong selling points such as taste, texture, and nutritional value. Additionally, the enterprise can explore partnerships with local growers, promoting sustainability and community engagement. Furthermore, the Philippine government's initiatives promoting local agriculture and entrepreneurship provide potential opportunities for grants or assistance programs.
Weaknesses. Despite its strengths, a small-scale indigenous microgreens enterprise may face several challenges. As a startup, the enterprise might lack experience in crucial areas like production, marketing, and business management. Additionally, financial constraints typical of startups can restrict marketing efforts, research and development, and overall growth. Moreover, limited research on indigenous crops as microgreens could pose challenges in optimizing growing conditions and best practices. However, the biggest challenge microgreens production is a stable seed supply system.

Opportunities. There are several opportunities for a small-scale indigenous microgreens enterprise to capitalize on. The growing demand for healthy food products like microgreens presents a significant opportunity for the enterprise to tap into. Moreover, the unique properties of indigenous microgreens justify premium pricing, increasing profitability potential. The enterprise can also explore innovation in growing techniques, product variations, and marketing strategies to cater to diverse customer preferences. Collaboration with chefs and restaurants can showcase indigenous microgreens in creative culinary applications, while participation in farmers' markets and food festivals can increase brand awareness and generate sales.

Threats. As the microgreen industry matures, competition from other growers and established vegetable producers is likely to intensify. Low consumer awareness of microgreens in the Philippines could limit sales growth. Additionally, unpredictable harvests or changes in consumer preferences could lead to fluctuations in supply or demand, posing challenges for the business. Moreover, ensuring food safety standards throughout the production process is crucial, especially for a new business.

Challenges and Opportunities

Regrettably, the field of microgreen technology in the Philippines is still in its infancy. Technical hurdles, lack of access to materials, and lack of knowledge also haunts the Philippines in relation to microgreen farming. Thus, extension activities and human resource training could be a viable action to counteract these challenges. To elevate awareness of microgreens, an effective approach involves implementing a project centered around hands-on education throughout local communities and e-course content creation accessible through social media applications.

Also, given that many of the plant materials are imported and that affordable seeds are essential for microgreen cultivation, it becomes imperative for the government to promote the use of indigenous species, not only in rural but also in urban homestead farming. Thus, this review recommends the utilization of indigenous species found in the Philippines, such as pansit-pansitan, tapilan, bataw, patani, samsamping, sigarilyas, kadios, paayap, saluyot, ulasiman, alugbati, and talinum. However, it is important to note that when it comes to these indigenous crops, information regarding seed morphology, post-emergence development, and the optimal conditions for seedling establishment is still lacking. Furthermore, since the biggest challenge in microgreens production is a stable seed supply system, focusing on maximizing the seed production of these indigenous crops and creating an organized storing system is a must.

Microgreens production also needs to abide with policies and regulations set by the Philippine government. Under Republic Act No. 10611, also known as the Food Safety Act of 2013, the Philippines commits to establishing a farm-to-fork safety regulatory system. This system ensures stringent food safety standards, supports fair trade, and enhances the competitiveness
of local food and products. Key governmental bodies responsible for food safety include the Department of Agriculture, Department of Health, Department of the Interior and Local Government, and Local Government Units (Aquino et al., 2020). Therefore, microgreens producers in the country must adhere to the Good Agricultural Practices and policies outlined in this legislation. It is crucial to emphasize proper production systems and sanitation when disseminating information about microgreens.

In a marketing lens, forging partnerships and collaborations with local establishments, such as restaurants, cafes, and health-focused businesses, can further integrate indigenous microgreens into consumer lifestyles. Collaborating with experts like nutritionists and chefs enhances brand credibility and offers consumers valuable insights into incorporating indigenous microgreens into their diets. Through these strategic initiatives, indigenous microgreens can establish a strong presence and resonate with target audiences in the dynamic Philippine market.

This review aims to inspire researchers to explore and select the most suitable morphotypes for microgreen production, establish growing protocols for indigenous crops, and also consider other areas such as pest and disease management, postharvest handling, and commercialization. The ripple effect of this article will create opportunities not just for research and academic institutions but also for farmer-growers and entrepreneurs looking to enter the microgreen industry. Ultimately, this review aspires to empower more Filipino researchers, entrepreneurs, and young individuals to embrace the growing microgreens market trend, initiate their own research endeavors, put them into action, and encourage our Filipino farmers to do the same.

In conclusion, this review is a call to action, urging the Philippines to take its place in the world of microgreen production, cultivating innovation and growth for the betterment of our communities and our nation.

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Statement of Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could influence the result reported in this research study.

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