Spice plants as a biology learning resource based-education for sustainable development

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ABSTRACT

Studying biology has research topics that are closely related to all the living things around the student and important for them to understand thoroughly. One of the local potentials in the environment around students that can be used as a source of learning biology is spice plants. This research is a qualitative descriptive study. The research aims to describe the spice plants in the Botanical Smartpark, which can be used as learning resources. The result of this research shows that there are 57 species and 27 families of spice plants found at the Botanical Smartpark, Yogyakarta, Indonesia. Spice plant biology objects can be used in biology learning by using project-based learning and socio-scientific issues-based learning models. In addition, this local potential can support education for sustainable development (ESD), through environmental conservation.

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1. INTRODUCTION

Biology learning has an object of study that is closely related to all living things around students [1]. Materials of biological studies that are close to students are important for them to master [2]. Biology teaching and learning in schools is intended to provide students with opportunities to learn about themselves and their surroundings [3]. Students are expected not only to understand but also to apply biological concepts to solve problems in life teaching of biology requires contextuality aspects, considering that the scope of biological problems is closely related to the facts found in daily life [4]. Biology teaching has to involve the context of the surrounding environment [5]. So, it is important to link learning in school with the reality that occurs in the surrounding environment [6], [7], especially the spice plants in the environment around the school.

Biology education entails not only knowledge but also attitudes and skills for identifying, responding to, and solving existing biological problems [8]. As a result, it should be designed and implemented using strategies or learning models that are contextually appropriate [9]. Students are able to work on real-world problems related to biology to help them acquire knowledge, beliefs, attitudes, and problem-solving skills [10]. Students are more interested in studying biology whenever the subjects are presented in an integrated and holistic manner through the use of context [11].

Teaching that emphasizes the context aspect can be done by utilizing the local potential that exists in the environment around the school [12]. The local potential is everything that is the hallmark and advantage of an area that can provide benefits to people's lives [13]. The teaching of biology can be developed by relying on the uniqueness and abundance of an area's potential, including local potential and (traditional) technology [14]. The utilization of local potential in the teaching of biology is considered indispensable. Teachers need to develop the local potential of the surrounding environment as a tool in presenting biological material that is suitable for everyday life, such as learning resources [15].

Local potential based learning may enhance students' relationships with the surrounding area and connect local knowledge with today's science [16]. In reality, biology learning is limited to the subjects delivered in class only. Biology learning resources used in learning are not based on local potential [17]. It thus indicates that the teacher does not associate learning to diverse components of the surrounding environment. Based on observations, many students know neither the names of the spices and medicinal plants in their surrounding environment, nor the benefits of these plants. Developing biology learning resources based on local wisdom is not widely researched in Indonesian school [18], [19]. In addition, it has not included several research findings about local phenomena and potential objects in the environment surrounding students [20]. Several other studies focused on specific aspects of the model and/or learning strategy, such as the implementation of a natural science learning model that utilized local wisdom [21]. It is still uncommon for research that increases local potential in Yogyakarta to be utilized as a source of biology lessons.

Researchers needs to elaborate environmental literacy and attitudes toward conservation in a learning activity [22]. One of them is education for sustainable development (ESD). ESD is now part of education as a new vision [23], [24]. ESD is a means to achieve the sustainable development goals (SDGs) by providing knowledge, skills, and values and by applying attitudes to make responsible actions, responsibility for the environment, economic sustainability, and social life of the community [25], [26].

The utilization of local potential such as spice plants as a source of learning is also necessary to develop aspects of ESD. This is because spice plants are rarely studied and are starting to be forgotten. So, it is necessary to preserve spice plants by learning them. In addition, the spice plant is a local potential, a characteristic of the historical icon of the Indonesian nation and is an asset to the wealth of the Indonesian nation.

Sustainability can be implemented in learning in high school through the selection of learning material (context) using the learning model to achieve learning outcomes [27]. Teachers have to prepare the students to be responsible civilians for the support of the sustainable developments, especially environmental sustainability, that need to acquire a holistic approach, envision change, and achievement [28]. So, it is important to know the diversity of spice plants in the environment around students such as Botanical Smartpark in Yogyakarta and make them a source of learning biology through integrating ESD in learning.

2. RESEARCH METHOD

The present study is characterized by a descriptive, qualitative approach. The emphasis of the writing method is on the analysis of the process of lifting the potential of the environment around students as a learning resource. This research was carried out at the Botanical Smartpark, Banguntapan, Bantul, Yogyakarta Special Region in January–April 2022. The research method modified data collection techniques, research instruments, and data analysis techniques [29]. The research was carried out in two stages. At the first stage, the activities included: i) an initial survey to determine the overall condition of the location, ii) the determination of the sampling location, and iii) an inventory of local potential, namely the inventory of spice plants at the Botanical Smartkpark. At the second stage was the analysis of the potential use of spice plants as a source of learning biology through literature studies. The utilization of the Botanical Smartpark as a local potential is carried out by analyzing: i) availability or completeness of objects; ii) suitability or relevance; iii) feasibility or eligibility; iv) potential clarity; v) compatibility with learning objectives/basic competencies; vi) clarity of objectives/learning subjects; vii) clarity of information that can be disclosed; viii) clarity/visibility of exploration, and ix) clarity of expected gains [30].

Data was gathered across observation, interviews, and a review of the literature. The research instrument was an observation sheet and an interview guide. Interviews were conducted with the Botanical Smartpark coordinator. This interview was conducted to find out the number and types of spice plants in Botanical Smartpark, so that researchers can verify the observed data with the results of the interviews. This is required at all three stages of data collection and data analysis. The data sample is all spice plants in the Botanical Smartpark. The data obtained was carried out interactively and that took place continuously until it was completed. The data analysis activities consist of three parts, namely i) data reduction, ii) data presentation (data display), and iii) conclusions/verification [31]. Data reduction is selecting, focusing, simplifying the data obtained, and turning it into a summary, using coding, and creating clusters, so that conclusions can be drawn. Data reduction serves to sort out the main and important things. The data display is organizing and compressing data in the form of tables, graphs, descriptive text, and narratives. In this study, data display is carried out by the researcher that serves to present data of spice plants found in Botanical Smartpark in the form of tables, descriptions, and narrative texts. Conclusion/verification is writing conclusions from the analysis of the data obtained and verifying it by matching the data. Researchers draw conclusions based on data on the diversity of spice plants obtained at Botanical Smartpark. This research is a preliminary study, collecting data so that in the end it can be concluded through the interpretation of the results of the analysis. The analyzed data are explained using sentences and paragraphs [32].

3. RESULTS AND DISCUSSION

The spice plant conservation park of Botanical Smartpark contains 53 types of spice plants (family), as shown in Table 1. One of the ways to determine species-level biodiversity is by looking at the family. At the species level, the biodiversity of spice plants at the Botanical Smartpark, Yogyakarta can be studied based on the variations found in living things or between species in the same genus or the same family based on same and different characteristics [33]. Figure 1 show grouping of spice plants in botanical smartpark based on family that consists of 16 spice plants, most of which belong to the *Zingerberaceae* family (red ginger, elephant ginger, *emprit* ginger), and then followed by *Asteraceae*.

Table 1. Spice plant species in Botanical Smartpark

No	Species name	Local name	Family	Total
1	*Zingiber officinale* var. Rubrum	Jahe merah	*Zingiberaceae*	246
2	*Zingiber officinale* var. Amarum	Jahe emprit	*Zingiberaceae*	274
3	*Zingiber officinale* Rosc.	Jahe gajah	*Zingiberaceae*	210
4	*Piper retrofractum*	Cabe Jawa	*Piperaceae*	108
5	*Capsicum frutescens*	Cabe Rawit	*Solanaceae*	32
6	*Curcuma longa*	Kunyit	*Zingiberaceae*	102
7	*Alpinia galanga*	Laos	*Zingiberaceae*	120
8	*Moringa oleifera*	Tanaman Kelor	*Moringaceae*	565
9	*Clitoria ternatea*	Bunga Telang	*Fabaceae*	7
10	*Piper betle*	Sirih hijau	*Piperaceae*	7
11	*Etlingera elatior*	Kecombrang	*Zingiberaceae*	7 clumps
12	*Lavandula angustivolia*	Lavender	*Lamiaceae*	7 clumps
13	*Euphorbia tirucalli*	Patah tulang	*Euphorbiaceae*	10 clumps
14	*Anredera cordifolia*	Binahong merah	*Basellaceae*	5
15	*Basella alba*	Binahong hijau	*Basellaceae*	7
16	*Dracaena angustifolia*	Daun suji	*Liliaceae*	9
17	*Gynura procumbens*	Sambung nyowo	*Asteraceeaee*	8 clumps
18	*Orthosiphon aristatus*	Kumis kucing	*Lamiaceae*	25
19	*Justicia gendarussa*	Gandarusa	*Euphorbiaceae*	5 clumps
20	*Cymbopogon citratus*	Sereh	*Poaceae*	9 clumps
21	*Smallanthus sonchifolius*	Insulin	*Asteraceae*	5 clumps
22	*Sauropus androgynus*	Katuk	*Euphorbiaceae*	5
23	*Centella asiatica*	Begagang	*Apiaceae*	255
24	*Syzygium polyanthum*	Salam	*Myrtaceae*	9
25	*Ziziphus mauritiana*	Bidara	*Rhamnaceae*	3
26	*Cuminum cyminum*	Jinten	*Apiaceae*	15
27	*Piper nigrum*	Lada	*Piperaceae*	18 clumps
28	*Sapindus rarak*	Lerak	*Sapindaceae*	8
29	*Tamarindus indica*	Asem jawa	*Fabaceae*	3
30	*Murraya koenigii*	Salam koja	*Rutaceae*	5
31	*Graptophyllum pictum* L.	Daun ungu	*Acanthaceae*	5
32	*Eleutherine bulbosa*	Bawang Dayak	*Iridaceae*	7 clumps
33	*Vanilla planifolia*	Vanili	*Orchidaceae*	11
34	*Curcuma zanthorrhiza*	Temu lawak	*Zingiberaceae*	5
35	*Curcuma heyneana*	Temu giring	*Zingiberaceae*	32
36	*Curcuma aeruginosa*	Temu ireng	*Zingiberaceae*	4 clumps
37	*Zingiber zerumbet*	Lempuyang	*Zingiberaceae*	7 clumps
38	*lsotoma longiflora* Presi.	Ki Tolod	*Campanuiaceae*	7 clumps
39	*Zingiber purpureum*	Bangle	*Zingiberaceae*	8 clumps
40	*Amomum cardamomum* L.	Kapulaga merah	*Zingiberaceae*	94
41	*Tinospora cordifolia*	Brotowali	*Menispermaceae*	5
42	*Curcuma zedoaria*	Kunir putih	*Zingiberaceae*	6 clumps
43	*Talinum paniculatum*	Gingseng jawa	*Portulacaceae*	8
44	*Elettaria cardamomum* (L.) Manton	Kapulaga putih	*Zingiberaceae*	6 clumps
45	*Alpinia purpurata*	Lengkuas merah	*Zingiberaceae*	5 clumps
46	*Kaempferia galangal* L.	Kencur	*Zingiberaceae*	
47	*Drimiopsis maculata*	Keladi katak	*Asparagaceae*	9
48	*Andrographis paniculata*	Sambiloto	*Acanthaceae*	6 clumps
49	*Murraya koenigii* (L.) Spreng.	Daun kari	*Rutaceae*	5
50	*Gaylussacia frondosa*	Blue huckleberry	*Ericaceae*	9
51	*Artemisia scoparia*	Ganjo lalai	*Asteraceae*	45
52	*Mentha piperita* L.	Mint	*Lamiaceae*	200
53	*Aloe vera*	Lidah buaya	*Xanthorrhoeaceae*	1

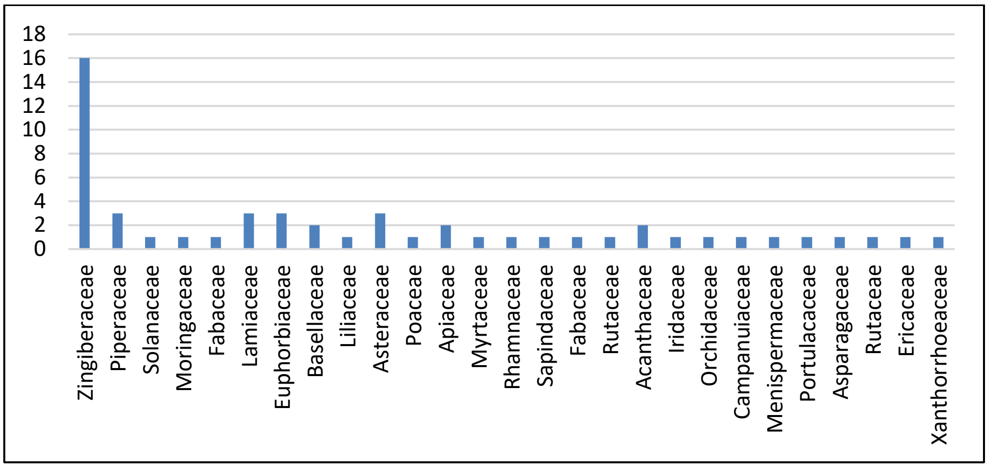

Figure 1. Grouping of spice plants in Botanical Smartpark based on family

3.1. *Zingiberaceae* family

Zingiberaceae is a diverse family of plants with about 1,400 species grouped under 47 genera, mostly found in tropical regions [34]. The morphological characteristics of plants in the *Zingiberaceae* family group, among others, are herbaceous, which have rhizomes below the soil surface, pseudo stems, complete leaf types, and single leaves. The *Zingiberaceae* family has broad leaves with thick mother bones and branch bones that are parallel and close to one another in an oblique direction upwards. It has either short petiole or no petiole. The separate flowers are arranged in single or multiple compound flowers. Flower decorations are characterized by its three petals and a crown consisting of three petals attached to the bottom to form a reed [35]. Organ flowers/inflorescences have a distinctive shape and unique color that can distinguish genera from species of this family. The fruit is a *kendaga* fruit with three valves, or the flesh does not open. The seed is round and ribbed and it has a seed coat [36]. The rhizomes of this family have different morphological forms and different rhizome colors.

Figures 2(a) to (p) shows the morphology of spice plants in *Zingiberaceae* family that found in Botanical Smartpark. The *Zingiberaceae* family (16 species) has different morphology in leaves (leaf shape), root, including rhizome color. Red ginger, *emprit* ginger, and elephant ginger are examples of genetic level diversity. *Zingiber officinale* var. Rubrum (red ginger), and *Zingiber officinale* var. Amarum (*emprit* ginger) shows genetic diversity [37]. These genetic differences can be detected by using morphological characters and profiles of RAPD bands on DNA. In addition, the three gingers (red ginger, *emprit* ginger, and elephant ginger) have morphological differences in the size and color of the rhizome skin as shown in Figures 2(a) to (p) [38].

Red ginger has red rhizomes, while *emprit* ginger and elephant ginger have yellowish white rhizomes. The rhizomes are red or light orange and small, and the fibers are coarse. Because this type of ginger has a high essential oil content, the aroma and taste are very sharp and spicy. *Emprit* ginger has a medium-sized rhizome, slightly flat shape, and white color. Its fiber is soft, and the smell and taste are not very sharp and spicy. Elephant ginger has light yellow or yellow rhizomes and is large and fat with soft and few fibers, and the smell and taste are not sharp. In addition, they have different roots, stems, essential oil content, starch content, and fiber content [39]. Red ginger and *emprit* ginger have small leaves, while elephant ginger has large leaves. The three different variants of ginger can be seen in Figures 3(a) to (c).

Ginger plants contain essential oils that can also be used as medicine, cooking spices, flavorings, perfume ingredients, and ornamental plants. Various symptoms of diseases, such as heartburn, can be treated with *Zingiber officinale* var. Roscoe (elephant ginger) or *Zingiber officinale* var. Amarum *(emprit* ginger). The concoction is made by cutting ginger into small pieces, pounding it, squeezing it, and adding a little sugar to it. After that, the potion is drunk. The ginger concoction will give a warm and comfortable stomach effect, due to the presence of derivatives of non-volatile phenylpropanoid compounds such as gingerol and shogaol that make ginger have a spicy or warm taste [40].

Diseases such as fever can also be treated with ginger. Ginger extract can reduce fever up to 38%, while aspirin can reduce fever up to 44% in infants, children, and adults [41]. This is because ginger contains methanol compounds that have an analgesic activity or pain relief. Bruises can also be healed by using *Zingiber officinale* var. Roscoe (elephant ginger). Ginger plants (family *Zingiberaceae*) can be used as external wound medicine, such as *Alpinia galanga L.* (*laos*) which contains alkaloids, flavonoids, steroids, quinone tannins, and essential oils that can reduce symptoms and cure wounds for fungal infections of *Trichophyton mentagrophytes* [42].

Figure 2. Morphology of spice plants in *Zingiberaceae* family: (a) *Zingiber officinale* var. Rubrum (red ginger), (b) *Zingiber officinale* var. Amarum, (c) *Zingiber officinale* Rosc., (d) *Curcuma longa*, (e) *Alpinia galangal*, (f) *Etlingera elatior*, (g) *Curcuma zanthorrhiza*, (h) *Curcuma heyneana*, (i) *Curcuma aeruginosa*, (j) *Zingiber zerumbet*, (k) *Zingiber purpureum*, (l) *Amomum cardamomum* L., (m) *Curcuma zedoaria*, (n) *Elettaria cardamomum* (L.) Manton, (o) *Alpinia purpurata*, and (p) *Kaempferia galangal* L

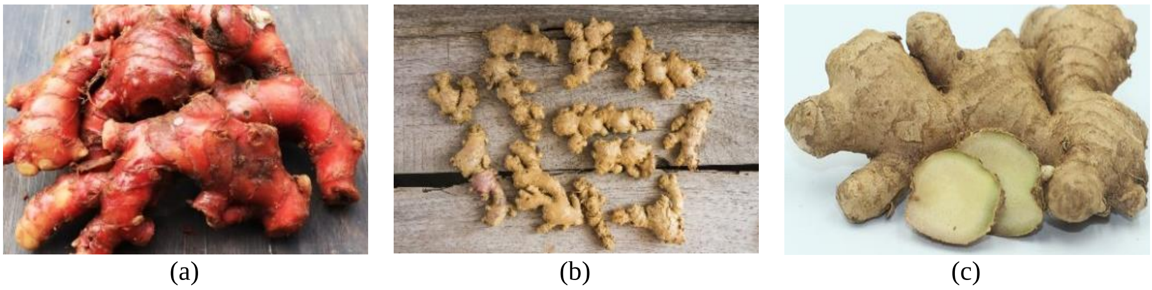

Figure 3. Different rhizomes of (a) red ginger, (b) *emprit* ginger, and (c) elephant ginger

3.2. *Piperaceae* family

The *Piperaceae* family in general has a taproot system, with the characteristics of twisted stems (Volubilis) accompanied by the appearance of nodes (nodes) on the stem accompanied by the presence of tendrils, but there are also herbaceous trunks that grow upright with monopodial stem branches. The other general characteristics of this *Piperaceae* family plant are single leaves with alternate leaves that grow on each internode. Leaf spines are curved with leaf edges usually wavy and flat. The *Piperaceae* family has flowers found on plagiotrophic (horizontal) branches arranged in spikes (spica) or strands (amentum) [34].

Figures 4 (a) to (c) shows the morphology of *famili Piperaceae* and the types of spice plants belonging to the *Piperaceae* family found at the Botanical Smartpark. The differences of the three species of the *Pipericeace* family are found in variations in the morphological characteristics of the three plants belonging to the genus *Piper* found in plant height, stem color, distance between segments on the stem, shape of the leaf blade, tip of the leaf blade, base of the leaf blade, color of the upper surface of the leaf, color the lower surface of the leaf, the length of the leaf blade, the width of the leaf blade, the texture of the upper and lower surface of the leaf, the texture of the leaf stalk, the length of the leaf stalk, the color of the leaf stalk, and the aroma of the leaves.

(a) (b) (c)

Figure 4. Morphology of family *Piperaceae* (a) *Piper retrofractum* (Javanese chili), (b) *Piper betle* (green betel), and (c) *Piper nigrum* (pepper)

3.3. ***Lamiaceae* family**

The *Lamiaceae* family is generally herbaceous and shrubs, most of which are ground cover. The stem is rectangular (in cross‒section). The stems and branches are rectangular, the leaves are opposite or crossed opposite each other, and there is no supporting leaf. Single leaves, rarely compound, sitting opposite or rocky, without supporting leaves, usually have essential oil glands, which give a pleasant smell. In compound flowers, flower petals do not fall, the number of petals is 4‒5, and the flower crown is attached in the shape of a lip. The fruit is divided into four parts, each resembling a bracket fruit or hard fruit, rarely resembling a stone fruit [35]. Figures 5 (a) to (c) shows the morphology of family *Lamiaceae*, the spices plants belonging to the family *Piperaceae*.

(a) (b) (c)

Figure 5. Morphology of family *Lamiaceae* (a) *Lavandula angustivolia* (lavender), (b) *Orthosiphon aristatus* (cat's whiskers), and (c) *Mentha piperita* L. (mint)

3.4. ***Euphorbiaceae* family**

Euphorbiaceae family has single or compound leaves, sitting scattered or opposite the supporting leaves which often resemble glands. The flowers are almost always unisexual, and they have one or two 'houses', with various shapes and arrangements, some without flower decorations, with double or single flower decorations, usually in multiple compound chains. The fruit is in the form of a cowrie fruit, which when ripe breaks into three-piece fruit. The seeds have a large endosperm. Figures 6 (a) to (c) shows the morphology of family *Euphorbiaceae*. Three species of *Euphorbiaceae* family have different morphologies found in plant height, stem color, distance between segments on the stem, shape of the leaves. *Euphorbia tirucalli* (broken bone) has long cylindrical leaves, *Justicia gendarussa* (*gandarusa*) has leaves that are long pinnate and form clusters, and *Sauropus androgynus* (*katuk*) has small, short pinnate leaves.

(a) (b) (c)

Figure 6. Morphology of family *Asteraceae* (a) *Euphorbia tirucalli* (broken bone), (b) *Justicia gendarussa* (*gandarusa*), and (c) *Sauropus androgynus* (*katuk*)

3.5. *Asteraceae* family

Asteraceae have members of the subclass *Asteridae* of the class *Magnoliopsida* [43]. This family consists of more than 1,100 genera, 13 tribes, and about 20,000 species, widely distributed throughout the world, but is best distributed in open areas [44]. The plant species from the *Asteraceae* family found in the Botanical Smartpark shown in Figures 7 (a) to (c) which is differentiated based on the shape of leaves, flowers and stems.

(a) (b) (c)

Figure 7. Morphology of family *Asteraceae* (a) *Gynura procumbens* (*sambung nyowo*), (b) *Smallanthus sonchifolius (insulin)*, and (c) *Artemisia scoparia* (*ganjo lalai*)

3.6. Species of spices plants in the Botanical Smartpark

3.6.1. *Zingiber officinale* var. Amarum

Zingiber officinale var. Amarum (*emprit* ginger) has morphological characteristics such as ginger stems in general, which are pseudo stems with a height of 30‒100 cm, perpendicular, round, flat, unbranched, composed of sheaths and leaf sheaths that close together to form a stem. The outside of the stem is waxy and shiny. *Rhizomes* with white, yellow, to reddish roots and a pungent odor form the roots. The ginger plant has pinnate leaves that are 15‒23 mm long and 8‒15 mm long. The petiole has a downy appearance. The ginger flower emerges from the ground in an ovoid shape, measuring 3.5–5 cm in length and 1.5–1.75 cm in width. Scaly flower handles are made up of 5 to 7 pieces. The fresh flowers are yellowish green in color. The stigma and flower lips are purple. Two pistil stalks are present [36]. Figure 8 shows the morphology of *Zingiber officinale* var. Amarum.

3.6.2. *Piper retrofractum*

Piper retrofractum (Javanese chili) has a round stem and can reach 5‒10 m in length. Its color is red when ripe or green to yellowish when young. The fruit size is 3.5–4 cm long, with a long round shape. The leaves are dark green, 12–14 cm long, 4–5 cm wide. The leaves are elongated in shape, with a pointed tip, rounded bases, flat edges, and slightly glossy surface [36]. Figure 9 shows the morphology of *Piper retrofractum* that has buni fruit, round shape, the color of the young fruit is reddish green, the color of the ripe fruit is blackish red.

Figure 8. *Zingiber officinale* var. Amarum

Figure 9. *Piper retrofractum*

3.6.3. *Orthosiphon aristatus*

This *Orthosiphon aristatus* (cat's whiskers) plant has a height of up to two meters with leaves that are oval or rhombic. It has flowers in the form of bunches that come out at the ends of a branch with a white or pale purple crown that is 13–27 mm long. This plant has dark brown fruit with a length of 1.75–2 mm and round long seeds with blackish white color that will turn blackish brown when ripe. People in several Southeast Asian countries consume *Orthosiphon aristatus* leaves in the form of traditional herbs that function as a treatment for kidney disease, gout, hypertension, and diabetes mellitus [45]. Figure 10 shows the morphology of *Orthosiphon aristatus* that has the characteristic of the *Orthosiphon aristatus* plant is that it has flowers arranged in bunches in large numbers, covered with a short hair-like part resembling a white or purple cat's whiskers.

Figure 10. *Orthosiphon aristatus*

3.6.4. *Euphorbia tirucalli*

Euphorbia tirucalli (broken bone) is a shrub that grows upright, has a height of 2–6 m with a woody base, many branches, and a milky gummy but is toxic to the skin, eyes, and some pests/insects as shown in Figure 1. *Euphorbia tirucalli* has cylindrical, pencil-shaped branches, smooth longitudinal grooves, and green color. The twig fracture after growing about one span will soon be forked in two which are located transversely and so on, so that it looks like a broken branch [46]. The leaves are rare, found at the tips of young twigs, small, lanceolate in shape, 7–25 mm long, and fall off quickly. *Euphorbia tirucalli* has flowers and fruit, but in Indonesia, it rarely blossoms because of different irradiation and soil factors. Figure 11 shows the morphology of *Euphorbia tirucalli* which is characterized by its leaves being elongated stems and green in color.

3.6.5. *Gynura procumbens*

Gynura procumbens (*sambung nyawa*) is an upright shrub when it is young, and propagates when it is old enough, with a fleshy herbaceous appearance. It has rectangular stems with green segments with purple spots. The leaves are single in the form of an elongated ellipse and scattered, with incised leaf edges, smooth hair, 0.5–3.5 cm long stalk, 3.5–12.5 cm leaf blade with a shiny light green top, pinnate leaf bones, and prominent lower leaf surface, and 1.5–5 cm wide leaves. The composition of the compound flowers is orange-yellow, with the green or orange tubular crown, needle-shaped stamens, yellow color, one-sided anthers, and the *bractea involucralis* lined with pointed or blunt ends [47]. *Gynura procumbens* has several secondary metabolites, including alkaloids, flavonoids, anthraquinones, saponins, glycosides, and essential oils [48]. Figure 12 shows the morphology of *Gynura procumbens*, characterized by having elongated green leaves, upright plants forming clumps.

Figure 11. *Euphorbia tirucalli*

Figure 12. *Gynura procumbens*

3.7. Determination key

In biology teaching, the process of grouping living things needs to be done in order to make it easier for students to recognize and study the diversity of living things. The way of grouping living things based on the characteristics they have is called the classification. The key to determination is the description of the characteristics of living things that are arranged sequentially from general to specific characteristics to find a type of living thing [33]. The simplest determination key is the dichotomous key, which contains information that is arranged in pairs and shows opposite characteristics.

The method of determining the determination key is as: i) selecting plants according to the needs of the determination (choosing plants that are included in spice plants); ii) distinguishing plants based on morphology; iii) separating plants into certain groups based on distinctly different characteristics; iv) determining the opposite properties as distinguishing from each other, so as to form the opposite ratio; v) compiling traits (morphological traits) by indicating a certain taxon that is defined definitively; vi) setting the subject of plants in stanzas; vii) placing the plant subject of the stanza in the taxon; and viii) understanding the procedure for writing scientific names [40]. The determination key of several species of spice plants in the Botanical Smartpark as:

Determination key: several species of spice plants in the Botanical Smartpark

1. a. Fibrous root 4
2. b. Tap root 2b
   c. Rhizome-shaped roots underground 2a
3. a. Herbaceous root and upright stem 4
   b. Herbaceous stem and grow to cover the ground 5
4. a. Single leaf and oval shape .... *Gynura segetum*
   b. Single leaf and pinnate shape .... *Zingiber officinale* var. Amarum
   c. Single leaf and elongated round, pointed leaf tip .... *Piper retrofractum*
   d. Oval or rhombus-shaped leaves .... *Orthosiphon aristatus*
   e. Lanceolate compound leaves .... *Euphorbia tirucalli*
   f. Single leaf and elongated ellipse-shaped .... *Gynura procumbens*
5. a. Hairy-hump-shaped compound flowers 3a
   b. Single compound flower, oval shaped 3b
   c. Compound flowers in the form of bunches that come out at the end of the branch 3d
   d. Compound orange-yellow cup flowers 3e
6. a. Long-round fruits 3c
   b. Dark brown fruits 3d

3.8. Local potential of flower plants as biology learning resources

Spice plants in the Botanical Smartpark Bantul can be used as a source of learning biology due to their local potential. Local potential can be used to teach biology because it provides the significance of conservation and preservation of nature's resources, which must be acknowledged and maintained thru the education system in school. The Botanical Smartpark's spice plant diversity may be utilized as a learning resource for biology in high school materials for grade X, particularly biodiversity material with basic competency, there are analyzing different levels of biodiversity in Indonesia, as well as potential threat and conservation. Biodiversity with the local potential of spice plants in the Botanical Smartpark can be integrated and become a form of contextual approach that can train students to solve environmental problems, to shape the character of caring for the surrounding environment, and to develop the potential of the region. Local wisdom, including local potential, is a phenomenon that develops in the environment around the local community to be used as a source of learning biology, one of which is plants in the area [49].

One form of integrating the potential of spices in biodiversity materials at the species level can be arranged in a module, as well as other learning resources such as e-books, e-catalogs, and Internet-based learning resources (e-learning), which can be used by students as a source of learning biology. Learning resources are everything that is used to provide students with learning facilities. Local potential plays a role in contextual-based learning so that learning is more meaningful.

Learning materials on biodiversity can use the project based-learning (PjBL) method or use other learning models such as socio-scientific issues-based learning, where students are invited to make direct observations in the field (observe and identify spice plants) using the student worksheet that has been given. The student worksheet contains instructions for observing the diversity of spice plant species and contains articles on spice plants. Students can also compare the types of diversity of other flower plants in different areas. In addition, students are asked to identify problems that exist in the field and make projects (as a solution) related to spice plants (choose a project theme). It is expected that after students will know the diversity of gene levels and types of flower plants through modules, e-books, e-catalogs, and Internet-based learning resources (e-learning resources).

3.9. The role of local potential of spice plants to support education for sustainable development

Biology teaching aims to cultivate scientifically literate individuals who understand science content, can conclude scientific problems, and know how to evaluate scientific cases, by utilizing the local potential of spice plants. Students need to apply the concept of scientific knowledge they have to solve sustainability problems which consist of three aspects, namely social, environmental, and economic aspects [50]. ESD emphasizes life-long learning for sustainability in formal learning (school) [51]. Therefore, we agree that ESD should be integrated into science teaching to support and encourage students as future citizens who can have a globally responsive and environment-friendly attitude.

Spice plants can be used as the 'context' of biological material, namely the biodiversity in basic competencies 3.2 and 4.2 which can support environmental conservation. Environmental sustainability is in line with the goals of the SDGs through education. The application of learning by utilizing the local potential of spice plants at the Botanical Smartpark, which consists of 27 families, 53 types, and benefits of spices for health as medicine, can support ESD. ESD is a means to achieve SDGs by providing knowledge, skills, values, and the application of attitudes to make responsible actions towards the environment, economic sustainability, and social life of the community [52]. The values of respecting and preserving the environment can be developed through learning by utilizing local potential.

The application of ESD in learning can be supported by choosing the right learning model [53]. For example, the application of the PjBL model, in which students are asked to make a project. The project created is a solution to the problems of social-science issues and SDGs associated with spice plants in the Botanical Smartpark. The project was also created as a solution "it will also help improve farmers' livelihoods and enhance rural development" (to help spice farmers help improve farmers' livelihoods and improve rural development through the cultivation of environment-friendly spice crops). This is in accordance with one of the ESD themes, namely responsible consumption and production, good health, and well-being [51]. Student projects in learning biology using environment-friendly product packaging materials, and knowledge of environment-friendly agriculture (fertilization, plant care, plant cultivation).

4. CONCLUSION

Based on the research findings and the descriptions that have been presented, it can be concluded that the local potential of spice plants found at the Botanical Smartpark, Yogyakarta consists of 53 types of spice plants, with a total of 27 families showing species diversity and gene diversity that can be used as a source of learning biology based on local potential in Indonesia, which are materials for biodiversity at the species and gene levels. The form of integration of the potential of flower plants in biodiversity materials can be a learning resource, such as modules, e-learning materials, and the combination of project based-learning and socio-scientific issues-based learning models in future research. The local potential of spice plants can be used to support education for sustainable development through the teaching of biology that emphasizes aspects of environmental sustainability.

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