The commodity of *Curcuma* spp. sold in the traditional markets of Yogyakarta

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Abstract. *Curcuma* is a member of the Zingiberaceae family. In the traditional market, *Curcuma* sold by *empon-empon* trader. Previous research reported that some *Curcuma* species are rare to be found and were sold by traders. Therefore, there is a concern regarding the possibility of *Curcuma* spp. extinction. Research objectives are: (1) to find the number of *empon-empon* traders in Yogyakarta; (2) to know the percentage of the number of rhizomes found in traditional markets in Yogyakarta; and (3) to find whether the *Curcuma* species are found completely in the Yogyakarta traditional market. The research was conducted by exploration of traditional market in Yogyakarta. The data were analyzed by the Cochran test. Research results showed that the percentages of rhizomes are as follow: *temu ireng* (*C. aeruginosa*) (27.59%), *temu giring* (*C. heyneana*) (31.03%), turmeric (*C. domestica*) (93.10%), *temu mangga* (*C. mangga*) (27.59%), *temu glenyeh* (*C. soloensis*) (0%), *temu lawak* (*C. xanthorrhiza*) (64.29%), and *temu putih* (*C. zedoaria*) (17.86%), sold by *empon-empon* traders. Some *Curcuma* were rare in nature such as *C. mangga, C. heyneana, C. purpuracens, C. soloensis, C. euchroma, C. colorata, and C. borg.* The rhizome of *Curcuma* spp. is found to be incomplete in the traditional markets of Yogyakarta.

1. Introduction

*Curcuma* spp. is one of the largest genera in the Zingiberaceae tribe with approximately 80 species [1]. At different literature *Curcuma* spp. in the world was estimated as 110 species [2]. Backer said there were 16 species found in Java [3]. Until now, there has been no attempt to document the *Curcuma* spp. genera on Java Island. Inventory is carried out aiming to find out the existence of species that still survive or have been lost in the Yogyakarta Traditional Markets.

*Curcuma* spp. are characterized by lush annual Terna, pseudostem up to 2m, rhizome exist, the rhizome has nice odorous or sharp because of its essential oils content [4, 5]. Essential oil content and appearance of flowers in *Curcuma* spp. make these genera economically valuable [6]. Javanese people...
use *Curcuma* spp. as a spice, medicine, natural staining, food, perfume, tonic, and ornamental tree [6]. *Curcuma* spp. rhizome marked by nodes, branching to form a minor, and on average have second sapling shoots.

Extensive knowledge of the principle of benefit to certain *Curcuma* or *temu* (Indonesian) makes them exist in the market and species that are not yet known their potential is going to be endangered. Plant threats and extinction are caused by: (1) habitat extinction; (2) over-utilization; (3) invasive foreign species; (4) environmental pollution; (5) climate change; (6) biological factors and speciation [7]. Traders tend to sell marketable and known species such as tonic and spices. There are seven commonly known *Curcuma* in the community, namely turmeric, *temu ireng*, *temu putih*, *temu mangga*, and *temu lawak*. From those seven species, one of them is hard to find at *empon-empon* (kind of wild ginger plants or *temu*) traders in traditional markets. The results of an interview with a plant taxonomy professor from Universitas Gadjah Mada (UGM) stated that *temu glenyeh* had already shown signs of extinction (personal communication).

Therefore, it is important to check the survivorship of *Curcuma* genera through exploring several Traditional Markets in Yogyakarta. Traditional markets are a place of social interaction between traders and buyers and there is a bargaining process for commodity [8]. Traditional markets are less comfortable compare with modern markets, but traditional markets are generally characterized by dirty, dark, muddy and leaking when it rains [9]. However, the traditional market has the advantage of providing farm and agricultural products from local farmers, including selling various kinds of *empon-empon* such as *Curcuma* genera (*temu*) as the main ingredient in making herbal medicine (*jamu*) in the city of Yogyakarta.

Yogyakarta is identical to the Javanese kingdom which has long inherited the culture of herbal medicine (*jamu*) in its efforts to maintain health and beauty. The city of Yogyakarta is also close to several regencies including herbal medicine centers such as Sukoharjo, Wonogiri, Kulonprogo, and Karanganyar. The culture of drinking *jamu* still exists in some communities, which is marked by the presence of traders carrying *jamu*, depot *jamu*, and traveling herbalists selling *jamu* in Yogyakarta. Herbal medicine traders in Yogyakarta come from Wonogiri, Sukoharjo, Wonosari, Solo, and Yogyakarta themselves. Herbal medicine traders generally mix their ingredients that are obtained from traditional markets.

This exploration activity is expected to be able to uncover the rhizomes that still exist and are beginning to become extinct in the Yogyakarta Traditional Market. This study aims: (1) to determine the number of *empon-empon* traders in the city of Yogyakarta; (2) to know the percentage of the number of rhizomes found in the Yogyakarta Traditional Market; and (3) to determine whether the *Curcuma* spp. found completely in the traditional markets of Yogyakarta. This research will provide practical information that there is a need to preserve medicinal plants, especially wild *Curcuma* (*temu*) as the main ingredients for making traditional herbal medicine (*jamu*) in Javanese society.

2. Methods
This study was conducted by exploring Yogyakarta's Traditional Market. Sample determination was conducted with the purposive method. The research object consisted of seven traditional markets spread across Yogyakarta, namely Serangan Market, Legi Market, Beringharjo Market, Pingit Market, Kranggan Market, Demangan Market, and Lempuyangan Market. The plant identification was carried out in the Plant Systematic Laboratory at Faculty of Biology, Universitas Gadjah Mada.

Rhizome morphological data were analysed descriptively with images. The completeness of *Curcuma* spp. begins with the granting a score with 1 (one) for present and 0 (zero) for absent. The score is then analysed with the Cochran test. This statistical test will find out if there are differences between more than two related samples [10]. To ensure that all seven *Curcuma* species are found completely or incompletely in the Yogyakarta Traditional Markets, the following hypothesis is made:

\[ H_0 = \text{all seven } Curcuma \text{ species (complete) are found in the Yogyakarta's Traditional Markets} \]
\[ H_a = \text{not all seven } Curcuma \text{ species (incomplete) are found in Yogyakarta's Traditional Markets} \]
3. Results and discussion

3.1. The amount and percentage of empon-empon traders in Yogyakarta’s traditional market

Empon-empon traders in Yogyakarta’s Traditional Market are divided into two kinds. First are traders who specialize in selling *empon-empon*. Second are traders who selling *empon-empon* only as a companion to spices and fresh vegetables. The average number of *empon-empon* traders in the traditional market is four traders with the highest percentage in the Beringharjo Market and Kranggan Market (24.14%). *Empon-empon* traders at the traditional markets are centered on the east floor of the 1st floor. These traders are side by side with herbal medicine traders and *jama* traders. While other traders of *empon-empon* in Kranggan Market are located in the northern part of the 1st floor market. The percentage of the number of traders is presented in Table 1.

Table 1. Overview of traditional markets in Yogyakarta.

| No | Location         | Address                                                                 | Number of *empon-empon* traders | Percentage number of traders | Rhizome founded                                      | Number of species | Percentage number of species |
|----|------------------|-------------------------------------------------------------------------|---------------------------------|-------------------------------|------------------------------------------------------|-------------------|-------------------------------|
| 1  | Serangan Market  | Pakuncen, Wirobrajan, Yogyakarta City, Special Region of Yogyakarta, 55253 | 4                               | 13.79%                        | *temu lawak* (C. xanthorrhiza), turmeric (C. domestica), *temu ireng* (C. aeruginosa), *temu giring* (C. heyneana) | 4                 | 16%                           |
| 2  | Legi Market      | Bugisan road No. 128 Wirobrajan, Yogyakarta City, Special Region of Yogyakarta, 55251 | 3                               | 10.34%                        | *temu lawak*, *temu ireng*, *temu giring*             | 4                 | 16%                           |
| 3  | Beringharjo Market | Margo Mulyo road No. 16 Ngupasan, District Gondomanan, Yogyakarta City, Special Region of Yogyakarta, 55122 | 7                               | 24.14%                        | *temu lawak*, *temu ireng*, *temu giring*, *temu putih* (C. zedoaria) | 5                 | 20%                           |
| 4  | Pingit Market    | Kyai Mojo road, Bumijo, District Jetis, Yogyakarta City, Special Region of Yogyakarta, 55231 | 3                               | 10.34%                        | *temu lawak*, turmeric                                | 2                 | 8%                            |
| 5  | Kranggan Market  | Poncowinatan road, Gowongan, District Jetis, Yogyakarta City,            | 7                               | 24.14%                        | *temu lawak*, *temu ireng*, *temu giring*             | 5                 | 20%                           |
In Pingit and Demangan Markets, we found two species (8%), namely temu lawak and turmeric. This market is small and only provides Curcuma species commonly sought by in the community, namely turmeric and temu lawak. This two empon-empon can easily found because they can also be used as spices and herbs. Lempuyangan, Serangan, and Legi markets, which is in the middle category, have quite diverse Curcuma commodities. The Kranggan and Beringharjo Market are considered as the center and largest empon-empon trader in Yogyakarta. Beringharjo Market is located near the Yogyakarta Palace, while Kranggan Market is close to the Yogyakarta Tugu Monument.

3.2. Characters of Curcumaspp. rhizome

Rhizomes are most likely to be sold at the traditional market because these plants are identical to the traits inherent in temu plants which have functioned as traditional medicines. The percentage of rhizomes that were not found and found in 29 traders is presented in Table 2. The most common rhizomes found in Yogyakarta Traditional Markets is turmeric (Curcuma domestica) 93.10% and totally found in 29 traders. Java is known as the highest turmeric production and more than half of the total national turmeric production is contributed from Java Island [11]. Details of turmeric production in Indonesia area as follow Central Java (42.4 thousand tons), West Java (7.37 thousand tons), North Sumatra (5.96 thousand tons), West Nusa Tenggara (NTB) (5.76 thousand tons), and other provinces (29.7 thousand tons).

The main rhizome of Curcuma genera is ellipsoid (Figure 1), length between 2.5-5cm [2], and orange in cross-section. Figure 1 shows the shape of Curcuma rhizome and its cross section. Whits this characteristic, Curcuma can easily be found in traditional market. Turmeric is the most common Curcuma species found because of its high demand. Turmeric can be used in many ways as medicine and spices. Turmeric is used by local people of Grobogan Regency [12], for healing post-natal wounds, anti-inflammatory drugs after being bitten by a snake, and used for various cooking.

The second most easily found rhizomes is temu lawak (64.29%), a common plant in Java. Temu lawak is a biopharma cultivation plant needed in the traditional medicine industry. It demands reach 3000 tons/year [11] and the average domestic consumption of temu lawak reached 11,836.02 tons. The diversity of temu lawak in Indonesia is high, of the 32 accessions of temu lawak have high genetic diversity [13].

Temu lawak in Java can be divided into three clusters based on the appearance of DNA fragments using the RAPD method [19]. The main rhizome (empu) is oval-shaped, darkish-yellow and the rhizome has a sharp aroma (Figure 1). The taste of rhizome is bitter and spicy [20]. Rhizome branches (saplings)
have a long-trimmed shape with 3-4 saplings [21]. Traditionally, this plant is used as a medicine for spleen, kidney pain, back pain, asthma, headaches, colds, stomach ulcers, stomach aches, breast milk production, increase appetite, overcome constipation, egg shell, chickenpox, mouth ulcer, and eliminate acne [22]. *Temu lawak* is also used in the animal husbandry sector. Adding *temu lawak* to animal feed can increase the growth and weight of *baung fish*, and increase the fish body's defence system [23].

**Figure 1.** Rhizome and cross section of *Curcuma* spp.: TGL = *temu glenyeh*; P-TGL = cross section of *temu glenyeh*; TL = *temu lawak*; P-TL = cross section of *temu lawak*; TK = *temu kunyit* (tumeric); P-TK = cross section of *temu kunyit* (tumeric); TP = *temu putih*; P-TP = cross section of *temu putih*; TM = *temu mangga*; P-TM = cross section of *temu mangga*; TG = *temu giring*; P-TG = cross section of *temu giring*, TI = *temu ireng*; P-TI = cross section of *temu ireng*.

*Temu giring* is in the 3rd place which is mostly found in empon-empon traders in Yogyakarta’s Traditional Market (31.03%). The inner rhizome is greenish-yellow and tastes bitter [21]. The results of previous studies report that essential oil from *temu giring* contains acetophenone (C₈H₈O) (18.93%) and camphor (C₁₀H₁₆O) (17.89%) as the main component [24]. Acetophenone is an active compound for the perfumes industry, as an organic solvent, and is used for the synthesis of several pharmaceutical ingredients. Camphor is widely used in the pharmaceutical industry as a counter-irritant (causing inflammation to prevent deeper inflammation) and as an anti-itch drug [25].

*Temu giring* rhizome is yellow (figure 1) and has higher starch and protein density value compared to turmeric and *temu ireng* [26]. Traditionally, *temu giring* is used for stomach aches medicine, changing appetite, strengthening the stomach and digestive tract [27]. This rhizome is also useful as a deworming medicine and can heal wounds. Previous study reported that *temu giring* had the same quality of ointment as turmeric and *kencur* (*Kaempferia galanga*) [28]. *Temu giring* ointment has dark cream color, typical smell of ointment, soft cold feeling, and homogeneous characteristic.
Table 2. Percentage of *Curcuma* spp. rhizome trader in Yogyakarta’s Traditional Market.

| No | Species Synonym | Local name Part used | Benefit | Number of traders | Percentage of traders |
|----|----------------|----------------------|---------|-------------------|-----------------------|
| 1  | *Curcuma aeruginosa* Roxb. | Temu ireng Rhizome | Reduce inflammation, increases appetite, and treat aches [11] | 8 | 27.59% |
| 2  | *Curcuma heyneana* Valeton and van Zijp | - Temu giring Rhizome | Deworming medicine, slimming, stomach-ache medicine, and smooth digestion [11] | 9 | 31.03% |
| 3  | *Curcuma domestica* Val. *Curcuma longa* Koen. | Kunir, kunyit Rhizome | As one of the ingredients for making traditional herbal medicine (*jamu*), turmeric has antibacterial, antifungal, and antiviral properties [14] | 27 | 93.10% |
| 4  | *Curcuma mangga* Valeton and van Zijp *Curcuma amada* Roxb. | Temu mangga Rhizome | Medication for stomach ache [15] | 8 | 27.59% |
| 5  | *Curcuma soloensis* | - Temu glenyeh, blenyeh Rhizome | Treat itching in the form of ointments [16] | 0 | 0% |
| 6  | *Curcuma xanthorrhiza* Roxb. | Temu lawak, koneng gede, teto labak Rhizome | To increase bile removal, medication for skin ache, reduce fever and convulsions, facilitate the smooth release of breast milk, diarrhea, dysentery, bloating, haemorrhoids medicine [15] | 18 | 64.29% |
| 7  | *Curcuma zedoaria* (Christmann) Roscoe *Anomum latifolium* Lam. *Curcuma pallida* Lour. | Temu putih Rhizome | Disables the development of cancer cells [17]. Impotence drug, smoothing blood circulation, increase appetite, smoothing menstruation, stomach ache, toothache and antidote [18] | 5 | 17.86% |
Temu ireng was in fourth place (27.59%), only 3.44% difference with the acquisition of temu giring. Temu ireng is distributed in several countries including Cambodia, Myanmar, Thailand, Vietnam, Indonesia, Malaysia, and Japan [2]. The rhizome length can reach 16 cm and 3 cm thick [29]. The outer rhizome is gray and slippery and the inside part has blue-green color with a white cortex [29]. The rhizome shape and its cross section can be seen in Figure 1. Phytochemically, temu ireng shows a positive value on the starch, protein, lipids, alkaloids, flavonoids, and tannins content [26]. Temu ireng is one of the ingredients used for making jamu cekok [30], the known as jamu for children who lose their appetite. Traditionally temu ireng is trusted to reduce inflammation, increase appetite and treat rheumatic pain [11].

Temu mangga (27.59%) is one of Indonesia's indigenous plants [31]. Temu mangga, Curcuma mango, is synonymous with C. amada [2]. It has a hard main rhizome, globous or ellipsoids, while its side rhizomes are cylindrical [29]. The skin color of temu mangga rhizome is white with light yellow rhizome cortex (figure 1), it has a root nodule and the taste is not bitter [32,21].

The last is C. zedoaria (17.86%) or known as.Temu putih. This Curcuma species has a firmly branched rhizomes, cone and fleshy. The outside part of the rhizome is greyish brown, until brown, the inside part is yellowish-white to pale (figure 1) [29]. In Indonesia, temu putih or white turmeric has another name i.e., koneng tegal, temu kuning, koneng bodas. In Yakushima Island Japan, this species known as gajutsu [33]. Many traders in traditional market cannot distinguished temu putih, white turmeric and temu mangga. They often consider it as same species. There are few reports on the use of temu putih. Some studies [34] reported that temu putih rhizome contains n-hexane which shows gram-negative antibacterial activity. Temu putih also reported to contains curcuzedoalide which is a strong candidate to develop chemotherapeutic against gastric cancer [35], curcumemon and curcumenol which show antiproliferation activity against 4 cancer cell lines (MCF-7, Ca Ski, PC-3, and HT-29) [36].

3.3 Cochran Test
This test is used to count more than two interconnected samples. Calculations for the seven most popular Curcuma species on Java Island are shown in figure 2.

| Test Statistics |
|-----------------|
| a. | Assmp. Sig. |
| | df |
| Cochran's Q | .000 |
| N | 6 |
| 29 |

Figure 2. Cochran statistical test

Value of 0.000 is obtained, therefore, Ho is rejected (0.000<0.05). Thus, the decision taken is that not all seven species of Curcuma are found (incomplete) in Yogyakarta’s traditional markets. This result is following the initial hypothesis that Ho will be rejected. Based on the interview to 29 traders, Curcuma soloensis (temu glenyeh) is difficult to found (Table 2). Based on the interviews with empon-empon traders at Lempuyangan Market, the benefits of temu glenyeh are unknown, so that people tend not to take advantage of this temu plant. The traders admit that demand for temu glenyeh in the last few years is indeed almost non-existent, so that they tend not to sell temu glenyeh.

Pharmacologically, temu glenyeh provides several benefits for it contains various phytochemicals compound that are beneficial to the human body [37,38]. Temu glenyeh has reported to contains curcumin, bisacurone [37] and sesquiterpene sar-turmeron (2 methyl-6 (4-methyl phenyl) hept-2-en-4-on) that was isolated from acetone extract of the rhizome [38].
4. Conclusions

The number of *empon-empon* traders in the City of Yogyakarta is 29 sellers. The percentages of rhizomes existence based on 29 *empon-empon* traders in Yogyakarta Traditional Markets are 93.10% turmeric, 64.29% *temu lawak*, 31.03% *temu giring*, 27.59% *temu mangga*, 27.59% *temu ireng*, 17.86% *temu putih*, and 0% *temu glenyeh*. Color of the cross-section of *temu glenyeh* is light orange, *temu lawak* is dark orange, turmeric is orange, *temu putih* is white, *temu mangga* is yellow on the inner layer and white on the outer layer, *temu giring* is yellow, *temu ireng* is blue. *Curcuma* spp. rhizomes are found incomplete in Yogyakarta Traditional Markets. Study in the wild habitat needs to be carried out, to ascertain whether *temu glenyeh* (*C. soloensis*) is still found or not since this *Curcuma* is no longer sold in Yogyakarta Traditional Market.

Acknowledgments

This research was supported by the Plant Systematics Laboratory, and Genetics and Breeding Laboratory, Faculty of Biology, Universitas Gadjah Mada (UGM) Yogyakarta, Indonesia. Special thanks to the UGM Research Directorate for research funding through the Final Assignment Recognition (RTA) Program in 2020, number: 2607/UN1/DITLIT/DIT-LIT/PT/2020.

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