

EXPLORATIONS DIVERSITY OF *Dioscorea* spp. VARIETIES FROM PASURUAN, EAST JAVA: INVENTORY AND CHARACTERIZATION

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ABSTRACT

Dioscorea spp. is the edible tubers from *Dioscoreaceae* family. *Dioscorea* is also an important crop which serves as a staple food and medicine. *Dioscoreaceae* exploration collecting mission had been conducted in 10 Districts of Pasuruan, East Java. Forty-four accessions were obtained during the exploration. It comprised of 5 species and 29 varieties i.e. 17 varieties of *Dioscorea alata* L., 8 varieties of *Dioscorea hispida* Dennst., 2 varieties of *Dioscorea esculenta* (Lour.) Burkill., 1 variety of *Dioscorea pentaphylla* L. and 1 variety of *Dioscorea bulbifera* L. The results showed that morphological characteristic features of *Dioscorea* spp. tubers were broadly varied among species and even within varieties at the same species. *Dioscorea* spp. varieties originated from Pasuruan were mostly characterized by its tuber shape, tuber flesh colour, outer and inner skin colour and tubers skin texture. Based on the interviews to local farmers, *D. alata* and *D. hispida* varieties were still widely grown because of its high tuber yields and its most acceptable taste than other *Dioscorea* species.

Keywords: *Dioscorea*; diversity; Pasuruan; varieties

INTRODUCTION

Yam, the edible tubers of various species of the genus *Dioscorea* (*Dioscoreaceae* family), are heterogeneous perennials with many shared morphological, physiological and chemical attributes. *Dioscorea* genus consists of about 600 species comprises of 50-60 species cultivated for food and medicine (Coursey, 1976). Yam tubers are valuable source of carbohydrates, fibers, and low level of fats, which makes them a good dietary source and could be eaten as boiled yam, or fried in oil (Osman, 1990). It has

been suggested to have nutritional superiority when compared to other tropical root crops. They are reported as good sources of dietary essential nutrients (Baquar and Oke, 1976; Bhandari *et al.*, 2003; Maneenoon *et al.*, 2008; Shanthakumari *et al.*, 2008; Arinathan *et al.*, 2009). The energy value of each portion per 100 g yam tubers ranges from 320 to 470 calories and contains of approximately 2.0 g - 2.7 g protein (French, 2006; Fahmi and Antarlina, 2007).

There are some advantages of yam, i.e. (a) its potential production could reach 40 t ha⁻¹, (b) cultivation conditions are very wide from sea level to an altitude of more than 1500 m above sea level, and ranging from moist soil (swamp) to dry land, (c) yams are relatively tolerant of shade, (d) yams are generally resistant to soil borne diseases, (e) tubers can be stored for relative long term period, and (f) yams have antioxidant and medicinal values (French, 2006; Fahmi and Antarlina, 2007).

Yams are common tubers that can be found in Indonesia, but somehow recently it is rather difficult to find in the market. Its total planted areas in Southeast Asia reached almost 19,000 ha with total productions of 249,000 tons. In particular, in Indonesia, the total planted areas were less than 1,000 ha (FAO, 1993). Based on those data, it can be assumed that yam has not got any serious attention yet as a potential agricultural commodity in Indonesia. In the past, traditionally, Yams have been used as supplementary food to rice, especially for people in Java. It has been abandoned even it has great potential as an alternative food source. In East Java, there are about 6 different varieties of edible Yam species i.e. *D. alata*, *D. bulbifera*, *D. esculenta*, *D. hispida*, *D. nummularia* and *D. pentaphylla* (Solikin, 1997).

Yam explorations had been conducted in some areas of Pasuruan, East Java. Conservation

efforts to yam germplasm is needed since its existence becoming rarely to find. Such basic researches are needed to provide scientific information that can be used as the basis for further development of yam. Some yam specimens were collected from the sites to be *ex-situ* conserved in Purwodadi Botanic Garden, Pasuruan. This paper presents the results of diversity inventory and morphological characterization of yam tubers from Pasuruan including its potential utilization by local farmers.

MATERIALS AND METHODS

Yam explorations and collecting missions were conducted in July-August 2011 and 2013 with areas covered of some areas in Pasuruan Regencies which consists of 9 Districts i.e. Purwodadi, Tukur, Prigen, Rembang, Purwosari, Kejayan, Pasrepan, Wonorejo and Puspo. Those locations were chosen based on informations from the local and traders in the local markets as the center of yam-producing areas.

Equipments used in this study were common equipments for plant explorations e.g. GPS, pH meter, Thermo-hygrometer, paper label, digital caliper, measuring scale, ruler, field books, stationery, digital cameras, hoes, knife, cutter, old newspaper, sack bag, plastic bag and raffia rope. Materials observed in this study were yam (*Dioscorea* spp.) tubers found on the sites.

Exploratory study was conducted through direct surveys and observations method at the targeted locations. Yam diversity found along the sites were noted, inventarized, characterized and documented. The first step was to identify the species of *Dioscorea* by characterizing the stem, leaves, and absence or presence of aerial tuber based on 'Descriptors for yam (*Dioscorea* spp.)' by IPGRI/IITA (1997). Then, the next step was to identify the varieties generally using the tuber shape, skin colour of tuber, and flesh colour of tuber. Documentation of accession was taken by digital camera. Direct interviews to local were carried out to obtain supporting informations regarding its potential utilization and consumption types. Some living specimens in form of tubers or bulbils were collected to be *ex-situ* conserved in Purwodadi Botanic Garden.

RESULTS AND DISCUSSIONS

Inventory of Yam (*Dioscorea* spp.) in Some Areas of Pasuruan, East Java

From this yam exploration collecting missions in 9 Districts of Pasuruan it was obtained 44 accessions of *Dioscorea* spp. It comprised of 5 species and 29 varieties i.e. 17 varieties of *Dioscorea alata* L., 8 varieties of *Dioscorea hispida* Dennst., 2 varieties of *Dioscorea esculenta* (Lour.) Burkill., 1 variety of *Dioscorea pentaphylla* L. and 1 variety of *Dioscorea bulbifera* L. (Table 1).

Yam diversity was most prevalent plant in Purwodadi, Rembang and Prigen Districts, especially from the species of *D. alata* and *D. hispida*. They are widely spread and commonly cultivated by local farmers and used as alternative food source for self consumption and economically valued for local trade. Whereas *D. esculenta*, *D. pentaphylla* and *D. bulbifera* were less spread, unpopular and rarely cultivated by local farmers.

Morphological Characteristics of Yam Tubers (*Dioscorea* spp.)

Morphological characteristic features of yam tubers were broadly vary among species and even within varieties at the same species. The tubers were different in characters including tubers shape, size, inner and outer skin colour, skin surface texture and tuber flesh colour. The morphological characterization results of yam tubers from Pasuruan were shown in Table 2.

Tuber morphological characters of *Dioscorea* were differentiated based on tuber shape characters, tuber flesh colour, outer and inner skin colour, and tuber skin texture. *D. alata* had the most variants compared to other species. Each variety of *D. alata* tubers had diverse morphological characteristics. It shapes was varies from regular-irregular rounded, flattened, oval, oblong to cylindrical shaped. Tubers outer skin colours were generally light brown, redish brown to dark brown, while inner skin colours varies from light brown, brown to dark brown, and light purple to dark purple. Tubers skin textures were also quite varied from smooth to roughed; grooved to un-grooved; absent, with short to long roots. Tuber flesh colours varies from white, off-white, and white with purple blotches (Table 2, Figure 1: A-F).

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D. hispida had high variation in tuber shape after *D. alata* which had round-oval-oblong and irregular shape. The number of the tuber of each varieties were more than 5 tubers, and outer skin colour were light brown to brown, inner skin colour were light brown and tuber flesh colour were dominantly yellowish to yellow. (Table 2, Figure 1: G-L).

D. esculenta tubers had oval to oblong shaped. Tubers outer and inner skin colours were varied light brown to brown. Tubers skin textures were mostly smooth-spininess and speckled with many roots. Tuber flesh colours were white (Table 2, Figure 1: M-N).

D. pentaphylla had the least variants, and it was only found one variety i.e. Uwi Sosohan.

Uwi Sosohan tubers had irregular shape with clustered and branched. Tubers skin outer colours were brown while tubers skin inner colours were light purple. Tuber skin textures were cracks and some were with many roots, while tubers flesh colours is white (Table 2, Figure 1: O).

D. bulbifera also had the least variants, only one variety i.e. Uwi Gantung (Kentang Gedubug). Uwi Gantung tubers had one tuber, with round to irregular shape. Tubers skin outer colours were brown while tubers skin inner colours were greyish. Tuber skin textures were cracks and few wrinkles with many roots, while tubers flesh colours is yellow (Table 2, Figure 1: P).

Table 1. Inventory of yam (*Dioscorea* spp.) found in some areas of Pasuruan

| No. | Origin Area (District) | Species and Varieties |
|-----|------------------------|---|
| 1 | Purwodadi | - <i>Dioscorea alata</i> : Uwi Kelopo (DA-1), Uwi Putih (DA-2), Uwi Bangkulit (DA-3), Uwi Jaran (DA-4), Uwi Ungu (DA-5), Uwi Ulo/ Jero (DA-6), Uwi Perti (DA-7), Uwi Gedek (DA-8) dan Uwi Ratu (DA-9) - <i>Dioscorea hispida</i> : Gadung (DH-1), Gadung Jahe (DH-2), Gadung Ketan (DH-3) - <i>Dioscorea esculenta</i> : Gembolo (DE-1) |
| 2 | Tutur | - <i>Dioscorea hispida</i> : Gadung Kuning (DH-4) |
| 3 | Rembang | - <i>Dioscorea alata</i> : Uwi Kelopo (DA-10), Uwi Jaran Ungu (DA-11), Uwi Elos (DA-12), Uwi Soso'an (DA-13) - <i>Dioscorea hispida</i> : Gadung Lumut (DH-5) |
| 4 | Prigen | - <i>Dioscorea alata</i> : Uwi Ulo (DA-14), Uwi Perti (DA-15), Uwi Alang-alang (DA-16) - <i>Dioscorea hispida</i> : Gadung Kripik (DH-6), Gadung Jahe (DH-7), Gadung Kripik (DH-13) - <i>Dioscorea pentaphylla</i> : Uwi Sosohan (DP-1) |
| 5 | Purwosari | - <i>Dioscorea alata</i> : Uwi Cemeng (DA-17), Uwi Putih (DA-18) - <i>Dioscorea hispida</i> : Gadung Kebo (DH-8) |
| 6 | Wonosari | - <i>Dioscorea alata</i> : Uwi Talas (DA-19), Uwi Jaran (DA-20) - <i>Dioscorea hispida</i> : Gadung Kuning (DH-9), Gadung Jahe (DH-10), Gadung Kuning (DH-14) |
| 7 | Kejayan | - <i>Dioscorea alata</i> : Uwi Ulo (DA-21), Uwi Ireng (DA-22) - <i>Dioscorea hispida</i> : Gadung Mentega (DH-11) - <i>Dioscorea esculenta</i> : Gembili (DA-2) - <i>Dioscorea bulbifera</i> : Uwi Gantung (DB-1) |
| 8 | Pasrepan | - <i>Dioscorea alata</i> : Obi/ Uwi Ratu (DA-23) - <i>Dioscorea hispida</i> : Gadung (DH-12), Gadung (DH-15) |
| 9 | Puspo | - <i>Dioscorea alata</i> : Uwi Tanduk Rusa (DA-24), Uwi Ulo (DA-25) |

Table 2. Morphological characteristics of Yam tubers from Pasuruan

| No | Species, Varieties | Underground tubers | | | | |
|----------------------------------|--------------------|--|-------------------------------|-------------------|---------------------------------------|---|
| | | Shape | Colour | Outer skin colour | Inner skin colour | Skin texture |
| <i>Dioscorea alata</i> L. | | | | | | |
| 1 | Uwi Kelopo | Several tubers (>5 tubers) rounded until flattened shape | White-offwhite | Brown | Light purple-offwhite | Many root, rough |
| 2 | Uwi Putih | Oval oblong-flattened, cylindrical shape, several tubers | White-offwhite | Brown | Light brown | Many wrinkles, cracks, few roots entire tuber |
| 3 | Uwi Bangkulit | Several tubers, irregular shape-flattened | White | Redish brown | Light purple | Few roots in entire tubers, cracks, many wrinkles |
| 4 | Uwi Jaran | Consists of few tubers with oval-oblong shape | Offwhite | Brown-dark brown | Light brown | Few roots entire tubers, few wrinkles, no cracks |
| 5 | Uwi Ungu | One tuber with flattened-irregular shape | White with purple blotches | Brown | Light purple | Few roots in upper of tubers, Many wrinkles and present of cracks |
| 6 | Uwi Ulo/ Jero | Few tuber (2-5), oval-cylindrical/elongated | White, Offwhite | Brown | Light purple-dark purple, Light brown | Few roots, many wrinkles |
| 7 | Uwi Perti | One tuber, cylindrical shape | White | Brown | Light brown | Few roots in upper tuber, smooth skin |
| 8 | Uwi Gedek | One tuber, oval-oblong shape | Offwhite | Light brown | Light brown with purple | Few roots entire tuber, many wrinkles |
| 9 | Uwi Ratu | Few tubers, cylindrical shape | Offwhite, White with purple | Brown | Light brown with purple, purple | Few roots entire tubers, many wrinkles and Cracks |
| 10 | Uwi Jaran Ungu | Few tubers with oval-oblong to irregular shape | White with purple | Dark brown | Dark purple | Few roots entire tubers, many cracks and wrinkleless |
| 11 | Uwi Elos | Few tuber with irregular-flattened shape | Offwhite | Dark brown | Light brown | Few roots in upper of tuber, many wrinkles |
| 12 | Uwi Soso'an | One tuber with elongated shape | Offwhite | Brown | Light brown | Roots in entire tuber, few wrinkle and cracks |
| 13 | Uwi Cemeng | Few tubers, oval-oblong to irregular shape | Offwhite with purple blotches | Brown | Light purple | Few roots in entire tubers, few wrinkles and cracks |
| 14 | Uwi Talas | Few tubers with irregular shape | Offwhite | Brown | Light brown | Few roots entire tuber, Many wrinkleless, prickly and cracks |

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| No | Species, Varieties | Underground tubers | | | | |
|---|------------------------------|--|----------------------------|-------------------|-------------------|---|
| | | Shape | Colour | Outer skin colour | Inner skin colour | Skin texture |
| 16 | Uwi Tanduk Rusa | One tuber, irregular shape | White with purple blotches | Brown | Dark purple | Few roots entire tubers, many wrinkles, cracks, |
| 17 | Uwi Alang-alang | Few tubers, cylindrical/elongated shape | Offwhite | Brown | Light brown | Few roots entire tuber, few wrinkles and cracks |
| <i>Dioscorea hispida</i> Denisst. | | | | | | |
| 1 | Gadung | Several ntubers >5 tubers, round until oval-oblong | Yellowish | Light brown | Light brown | Many roots entire tubers, few wrinkles and cracks |
| 2 | Gadung Jahe | Several tubers (>5), Oval-oblong shape and irregular shape (Rhizome look like) | Yellowish - yellow | Light brown | Light brown | Many roots entire tubers, few wrinkles and cracks |
| 3 | Gadung Ketan | Several tubers (>5), rounded to oval | Yellowish | Light brown | Light brown | Smooth and speckled, many roots |
| 4 | Gadung Kuning | Several tubers (>5), Round until oval- oblong shape | Yellowish- yellow | brown | Light brown | Many roots entire tubers, absent of wrinkles and cracks |
| 5 | Gadung Kripik | Several tubers (>5), oval-oblong until irregular in shape | Yellow | Light brown | Light brown | Many roots in entire tuber, non-prickly, non-wrinkless, no cracks |
| 6 | Gadung Lumut | Several tubers (>5), oval-oblong | Yellowish | Brown | Light brown | Smooth and speckled, many roots |
| 7 | Gadung Kebo | Several tubers (>5), round until oval-oblong shape | Yellow | Brown | Light brown | Roots entire tubers, few wrinkleless |
| 8 | Gadung Mentega | Several tubers (>5), oval oblong | Yellow | brown | Light brown | Many root entire tubers, few wrinkles and cracks |
| <i>Dioscorea esculenta</i> (Lour.) Burkill | | | | | | |
| 1 | Gembolo | 2-5 tuber with oval to oblong shape | White | Light brown | Brown | Smooth and speckled, many roots |
| 2 | Gembili | >5 tuber, oval to oblong | White | Light brown | Light brown | Spiness root |
| <i>Dioscorea pentaphylla</i> L. | | | | | | |
| 1 | Uwi Sosohan | One tuber, irregular shape | White | Brown | Light purple | Many roots entire tuber, cracks |
| <i>Dioscorea bulbifera</i> L. | | | | | | |
| 1. | Uwi Gantung/ Kentang Gedubug | One tuber, round to irregular shape | Yellow | Brown | Greyish | Few wrinkles and cracks |



Figure 1. Morphological Variation of Yam tubers from Pasuruan e.g. *D. alata* variants: (A) Uwi Kelapa, (B) Uwi Putih, (C) Uwi Tanduk Rusa, (D) Uwi Ulo, (E) Uwi Jaran Ungu and (F) Uwi Ireng; *D. hispida* variants: (G) Gadung Keripik, (H) Gadung Ketan, (I) Gadung Lumut, (J) Gadung Jahe, (K) Gadung Mentega and (L) Gadung Kebo; *D. esculenta* variants (M) Gembili and (N) Gembolo; *D. pentaphylla* variant: (O) Uwi Sosohan; *D. bulbifera* variant: (P) Uwi Gantung/Kentang Gedubug.

Genetic diversity of Uwi and Gadung in Pasuruan were high enough. Genetic diversities related to genetic source were very useful for plant breeding program. Substantial morphological variation within and between the various accessions may be attributed to cross-pollination and sexual recombination, and perhaps mutation followed by intensive selection by isolated human communities in diverse environments (Martin, 1976). In fact, Uwi in Pasuruan was flowering rarely, and when it was found there was male flower only, so the new type of Uwi produced from cross pollination was rarely found, same as Gadung. Morphological variations among species we-

re affected mostly by its genotypes than environmental factors. Whilst morphological variations within varieties at the same species were dominantly affected by the environmental factors than its genotypes e.g. altitude, latitude, temperature, humidity, soil conditions, etc. Adaptations process of one particular plant species to such local environmental conditions then will arise many varied varieties (Suranto, 2001).

Consumption Type by Local Farmers and Organoleptic Test

Table 3 presents the data of soil depth when the tubers were harvested, texture and

flavour of steamed yam tubers and interviews results of its consumption type by local farmers in Pasuruan.

D. alata is the most favorite and popular yam in Pasuruan. The interviews results to local farmers noted that *D. alata* type was still widely grown because of its high tuber yields and its taste which were are the most acceptable than other *Dioscorea* species, with smooth and grainy textures and medium sweet and savory tastes (Table 3). Uwi Kelapa variety can be a safe food for diabetics because it has carbohydrates with low glucose levels. Tubers of Uwi Kelapa were generally self-consumed by boiling, steaming or frying. But it can also be diversified into a variety of food products processed which is firstly made into flours. Processing into flours can be made traditionally without any complicated techniques. Tubers were shredded and then soaked in lime water to clean up the gums, then sun dried and grounded into flours. The flours taste plain, so it can be easily processed into varied products such as cakes, noodles, etc. While its gums can be used as environmentally friendly natural pesticides (Arifin, 2008).

D. hispida tubers were harvested in shallow soil depth (5 to 25 cm). Its tastes and textures were not observed since the tubers contains of anti-nutrition or poison compounds that may cause nausea and dizziness if tubers were not well-processed. Antinutrition compounds that exist in *D. hispida* were alkaloid compounds such as Dioscorine, Dihydrodioscorine and Hydrogen Cyanide in free or bound forms, and if they were in bound form known as Cyanogenic Glucosides, moreover when they were hydrolyzed they would release Hydrogen Cyanide (Webster *et al.*, 1984). Type of *D. hispida* was high in economic values; they were widely grown by local farmers to be processed into chips for local trade. So there were still many local farmers who were interested to cultivate these types of yam even though the processing techniques were complicated. Local *D. hispida* varieties were common to be made into chips i.e. Gadung Kripik, Gadung Ketan and Gadung Kuning while Gadung Lumut and Gadung Jahe were not commonly used to be made into chips because of its small sized ± 2 to 4 cm in diameters. Due to high carbohydrates content of *D. hispida*, it considerably had high potential to be processed into varies food products beside of chips. Apart of as a food source, *D. hispida* tubers

could be used as medicinal plants to reduce obesity, diabetes and other related diseases (Aprianita *et al.*, 2009). In addition, as carbohydrate source, Gadung tubers did not contain any gluten, which made Gadung tubers became an important substance in the reduction of incidence of celiac disease (CD) or other allergic reactions (Rekha and Padmaja, 2002). With these benefits in mind, efforts on Gadung processing into edible food materials were need to undertake.

D. esculenta found in Pasuruan comprised of two varieties with local names; Gembili and Gembolo, which were currently rare. The tubers of Gembili were harvested in shallow soil depth (5 to 25 cm), while Gembolo were harvested in medium soil depth (26 to 45 cm). Steamed Gembili tubers textures were grainy, while steamed Gembolo tubers textures were much smoother. Steamed Gembili and Gembolo tubers tend to have savory tastes with medium sweet. Local farmers cultivated Gembili for both self-consumption and trade, whereas Gembolo were cultivated only for personal consumption. Tubers of Gembolo and Gembili were covered by thorns that make the harvesting process become difficult. They made farmers unwilling to cultivate them, although they had sweet and good tuber quality. They mostly grow wild in the backyards and intercropped with bamboo plants. *D. esculenta* had low economic values, so that these types was rarely cultivated by farmers, in addition, it was also due to the lack of information about its nutrition contents.

D. pentaphylla tubers were harvested in shallow soil depth (5 to 25 cm). Its steamed tubers had smooth, sticky texture and sweet taste though the tubers were in small size. It had no economic values, and it was rarely for trade, only for self consumption, and many people were not familiar with this type.

D. bulbifera, well known as Uwi Gantung or Kentang Gedubug was harvested on 5-25 cm soil depth. Their steamed tubers were not grainy and flavorless. Now, they were not cultivated or used. *D. bulbifera* had higher levels of carbohydrate and energy with appreciable levels of minerals that made them nutritious and could be used as reliable food and energy security crops (Polycarp *et al.*, 2012). Continuous experiment was needed to determine nutritional content and identify the benefit of *D. bulbifera*.

Table 3. Soil depth at harvest, organoleptic test results and utilization by local farmers in Pasuruan

| No. | Species | Variety | Origin | Soil depth at harvest (cm) | Texture and Flavour of steamed tuber | Utilization |
|-----|-----------------|----------------|-----------|----------------------------|---|----------------------------------|
| 1 | <i>D. alata</i> | Uwi Kelapa | Purwodadi | 5 – 25 | - Smooth - Savory, medium sweet | Self consumed and locally traded |
| 2 | <i>D. alata</i> | Uwi Kelapa | Rembang | 5 – 25 | - Smooth and sticky - Savory | Self consumed |
| 3 | <i>D. alata</i> | Uwi Putih | Purwodadi | 5 – 25 | - Smooth and sticky - Savory, medium sweet | Self consumed and locally traded |
| 4 | <i>D. alata</i> | Uwi Putih | Purwosari | 26 – 45 | - Grainy - Flavourless | Self consumed |
| 5 | <i>D. alata</i> | Uwi Bangkulit | Purwodadi | 5 – 25 | - Grainy - Savory | Self consumed |
| 6 | <i>D. alata</i> | Uwi Jaran | Purwodadi | 5 – 25 | - Grainy - Savory | Self consumed |
| 7 | <i>D. alata</i> | Uwi Jaran | Wonosari | 5 – 25 | - Not grainy - Flavourless | Self consumed |
| 8 | <i>D. alata</i> | Uwi Jaran Ungu | Rembang | 5 – 25 | - Grainy - Flavourless | Rarely consumed |
| 9 | <i>D. alata</i> | Uwi Ungu | Purwodadi | 5 – 25 | - Grainy - Savory | Self consumed |
| 10 | <i>D. alata</i> | Uwi Cemeng | Purwosari | 26 - 45 | - Grainy - Savory | Self consumed |
| 11 | <i>D. alata</i> | Uwi Ireng | Kejayan | 26 - 45 | - Not grainy - Flavourless | Self consumed |
| 12 | <i>D. alata</i> | Uwi Ulo/Jero | Purwodadi | > 45 | - Grainy - Savory | Self consumed |
| 13 | <i>D. alata</i> | Uwi Ulo | Prigen | > 45 | - Medium smooth and sticky - Flavourless | Not used for consumption |
| 14 | <i>D. alata</i> | Uwi Ulo | Kejayan | > 45 | - Not grainy - Flavourless | Self consumed |
| 15 | <i>D. alata</i> | Uwi Ulo | Puspo | > 45 | - Grainy - Medium savory | Not used for consumption, |
| 16 | <i>D. alata</i> | Uwi Perti | Purwodadi | 5 – 25 | - Smooth and sticky - Savory | Self consumed |
| 17 | <i>D. alata</i> | Uwi Perti | Prigen | 5 – 25 | - Smooth and sticky - Savory | Self consumed and locally traded |
| 18 | <i>D. alata</i> | Uwi Elos | Rembang | 26 – 45 | - Smooth and sticky - Savory | Self consumed |
| 19 | <i>D. alata</i> | Uwi Ratu | Purwodadi | 26 - 45 | - Grainy - Medium savory | Self consumed |
| 20 | <i>D. alata</i> | Uwi Ratu | Pasrepan | > 45 | - Grainy - Medium savory | Self consumed and locally traded |
| 21 | <i>D. alata</i> | Uwi Gedek | Purwodadi | 26 – 45 | - Grainy - Medium savory | Self consumed |

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| No. | Species | Variety | Origin | Soil depth at harvest (cm) | Texture and Flavour of steamed tuber | Utilization |
|-----|-----------------------|-----------------|-----------|----------------------------|--------------------------------------|--------------------------------------|
| 22 | <i>D. alata</i> | Uwi Soso'an | Rembang | 5 – 25 | - Smooth and sticky - Sweet | Self consumed |
| 23 | <i>D. alata</i> | Uwi Alang-alang | Prigen | > 45 | - Grainy - Savory | Self consumed |
| 24 | <i>D. alata</i> | Uwi Talas | Wonosari | 26 - 45 | - Grainy - Medium savory | Self consumed |
| 25 | <i>D. alata</i> | Uwi Tanduk Rusa | Puspo | > 45 | - Not grainy - Flavourless | Not utilized |
| 26 | <i>D. hispida</i> | Gadung | Purwodadi | 5 – 25 | - Not observed | High economic value, traded as chips |
| 27 | <i>D. hispida</i> | Gadung | Pasrepan | 5 – 25 | - Not observed | Traded as chips |
| 28 | <i>D. hispida</i> | Gadung | Pasrepan | 5 – 25 | - Not observed | Traded as chips |
| 29 | <i>D. hispida</i> | Gadung Jahe | Purwodadi | 5 – 25 | - Not observed | Not used for consumption |
| 30 | <i>D. hispida</i> | Gadung Jahe | Prigen | 5 – 25 | - Not observed | Rarely consumed |
| 31 | <i>D. hispida</i> | Gadung Jahe | Wonosari | 5 – 25 | - Not observed | Rarely consumed |
| 32 | <i>D. hispida</i> | Gadung Ketan | Purwodadi | 5 – 25 | - Not observed | Self consumed and locally traded |
| 33 | <i>D. hispida</i> | Gadung Kuning | Tutur | 5 – 25 | - Not observed | High economic value, traded as chips |
| 34 | <i>D. hispida</i> | Gadung Kuning | Wonosari | 5 – 25 | - Not observed | Self consumed |
| 35 | <i>D. hispida</i> | Gadung Kuning | Wonosari | 5 – 25 | - Not observed | Self consumed |
| 36 | <i>D. hispida</i> | Gadung Kripik | Prigen | 5 – 25 | - Not observed | High economic value, traded as chips |
| 37 | <i>D. hispida</i> | Gadung Kripik | Prigen | 5 – 25 | - Not observed | High economic value, traded as chips |
| 38 | <i>D. hispida</i> | Gadung Lumut | Rembang | 5 – 25 | - Not observed | Rarely consumed |
| 39 | <i>D. hispida</i> | Gadung Kebo | Purwosari | 26 – 45 | - Not observed | Traded as tuber |
| 40 | <i>D. hispida</i> | Gadung Mentega | Kejayan | 5 – 25 | - Not observed | Self consumed, sometimes for traded |
| 41 | <i>D. esculenta</i> | Gembolo | Purwodadi | 26 – 45 | - Smooth - Savory | Self consumed |
| 42 | <i>D. esculenta</i> | Gembili | Kejayan | 5 - 25 | - Grainy - Medium sweet | Not utilized |
| 43 | <i>D. pentaphylla</i> | Uwi Sosohan | Prigen | 5 – 25 | - Grainy - Medium sweet | Self consumed |
| 44 | <i>D. bulbifera</i> | Uwi Gantung | Kejayan | 5 - 25 | - Not grainy - Flavourless | Not utilized |

CONCLUSIONS

About 44 accessions of *Dioscorea* spp. were obtained during yam explorations and collecting missions in 9 Districts of Pasuruan. They comprised of 5 species and 29 varieties i.e. 17 varieties of *Dioscorea alata* L., 8 varieties of *Dioscorea hispida* Dennst., 2 varieties of *Dioscorea esculenta* (Lour.) Burkill., 1 variety of *Dioscorea pentaphylla* L. and 1 variety of *Dioscorea bulbifera* L. Morphological characteristic features of yam tubers were broadly vary among species and even within varieties at the same species. *D. alata* and *D. hispida* were widely spread and commonly cultivated by local farmers and used as an alternative food source for self-consumption and economically valued for local trade. Furthermore, *D. esculenta*, *D. pentaphylla* and *D. bulbifera* were less spread, unpopular and rarely cultivated by local farmers.

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REFERENCES

- Aprianita, A., U. Purwandari, B. Watson and T. Vasiljevic. 2009. Physico-chemical properties of flours and starches from selected commercial tubers available in Australia. *Int. Food Res. J.* 16: 507-520.
- Arifin, Z. 2008. Diversification of *Dioscorea* flour as food alternative source (in Indonesian). *Biological Opus Fair*. Departement of Biology. Institute Teknologi Sepuluh Nopember. Surabaya.
- Arinathan, V., V.R. Mohan and A. Maruthupandian. 2009. Nutritional and anti-nutritional attributes of some under-utilized tubers. *Trop. Subtrop. Agroecos.* 10: 273-278.
- Baquar, S.R. and Oke O.L. 1976. Protein Nigerian yam (*Dioscorea* spp.). *Nutr. Report Int.* 14: 237-248.
- Bhandari, M.R., T. Kasai and J. Kawabata. 2003. Nutritional evaluation of wild yam (*Dioscorea* spp.) tubers of Nepal. *Food Chem.* 82 (4): 619-623.
- Coursey, D.G. 1976. Yams. *Dioscorea* spp. (*Dioscoreaceae*). In: Evolution of crop plants. N.W. Simmonds (ed.). Longman group limited. London, New York. Chap. 23. p. 70-74.
- Fahmi, A. and S.S. Antarlina. 2007. Alabio yams -new food resources from swampland (in Indonesian). Indonesian Agency for Agricultural Research and Development. Jakarta. <http://www.litbang.pertanian.go.id/artikel/one/153/pdf/Ubi%20Alabio%20Sumber%20Pangan%20Baru%20dari%20Lahan%20Rawa.pdf>. Accessed on January 24, 2015.
- FAO (Food and Agriculture Organization of the United Nations). 1993. Plant resources of South East Asia. Statistical database. Bogor. <http://faostat.fao.org/faostat/collections?subset=agriculture>. Accessed on August 9, 2012.
- French, B.R. 2006. Food plants of Papua New Guinea-A compendium. Revised edition. Australia and Pacific Science Foundation. Ashgrove. pp. 408.
- IPGRI/IITA. 1997. Descriptors for yam (*Dioscorea* spp.). International Plant Genetic Resources Institute, Rome, Italy/ International Institute of Tropical Agriculture, Ibadan, Nigeria.
- Maneenoon, K., P. Sirirugsa and K. Sridith. 2008. Ethnobotany of *Dioscorea* L. (*Dioscoreaceae*), a major food plant of the Sakai Tribe at Banthad Range, Peninsular Thailand. *Ethno. Res. Appl.* 6: 385-394.
- Martin, F.W. 1976. Tropical yams and their potential-Part 3: *Dioscorea alata*. *Agriculture Handbook No. 495*. Agricultural Research Service. United State Dept. of Agriculture. Washington. pp. 40.
- Osman, H. 1990. Dietary fiber composition of common vegetables and fruits in Malaysia. *Food Chem.* 37 (1): 21-26.
- Polycarp, D., E.O. Afoakwa, A.S. Budu and E. Otoo. 2012. Characterization of chemical composition and anti-nutritional factors in seven species within the Ghanaian yam (*Dioscorea*) germplasm. *Int. Food Res. J.* 19 (3): 985-992.
- Rekha, M.R. and G. Padmaja. 2002. Alpha-amylase inhibitor changes during processing of sweet potato and taro tubers. *Plant Food Hum. Nutr.* 57: 285-294.

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- Shanthakumari, S., V.R. Mohan and J. de Britto. 2008. Nutritional evaluation and elimination of toxic principles in wild yam (*Dioscorea* spp.). *Trop. Subtrop. Agroecos.* 8: 319-325.
- Solikin. 1997. Inventory of eatable *Dioscorea* in district of Pasuruan (in Indonesian). Proceeding National Conference: Conservation of Indonesian Flora. Botanical Garden Development Center Indonesian Institute of Sciences. Bogor. p. 190-193.
- Suranto. 2001. Studies on *Ranunculus* population: isozymic pattern. *Biodiversitas* 2 (1): 85-91.
- Webster, J., W. Beck and B. Ternai. 1984. Toxicity and bitterness in Australian *Dioscorea bulbifera* L. and *Dioscorea hispida* Dennst. from Thailand. *J. Agric. Food Chem.* 32 (5): 1087-1090.