Gmail Dani Saraswati <danysaraswati@gmail.com>

Call for reviewers

3 messages

Intl Conf Biodiv <biodiversitas@gmail.com> Fri, Jan 22, 2016 at 10:37 PM
To: endahrita@yahoo.co.id, Peni Pujiastuti <peni.usb@gmail.com>, mohammad masykuri <mmasykuri@yahoo.com>, Rohula Utami <rohula_utami@yahoo.com>, nurlita@bio.its.ac.id, dewi_hidayati@ymail.com, Nova Maulidina <maulidina.n@gmail.com>, esti_widowati@yahoo.com, Ida Indrawati <ida.indrawati81@gmail.com>, niarossiana@yahoo.com, kartiawati@yahoo.com, Desak Gede Sri Andayani <desakdewa2002@yahoo.com>, eko_suyono@mail.ugm.ac.id, tiarasakimura@yahoo.com, Asep Zainalmutaqin <abah.alifanadiarifki@gmail.com>, budi_irawan73@yahoo.co.id, Azifah an amillah <azifah.anamillah@gmail.com>, "Prof. Johan Iskandar, MSc, PhD" <jiskandar@unpad.ac.id>, pur_bagus@yahoo.co.id, Ratri Tri Hapsari <ratri.3hapsari@gmail.com>, Apri Sulistyo <apri.sulistyo@gmail.com>, Sumartini Ir ms <sumartiniputut@yahoo.co.id>, Danar Praseptiangga <dpraseptiangga@yahoo.com>, andr002@lipi.go.id, desak_malini@yahoo.com, "Dr. Suharsono" <shar@indo.net.id>, yopi001@lipi.go.id, Alifah Mafatikhul Jannah <alifah.mj@gmail.com>, Dani Saraswati <danysaraswati@gmail.com>, graham.lyons@adelaide.edu.au, giek_bb@yahoo.com, dewigunawatiuns@yahoo.co.id, Agnes Audina <agnesa003@gmail.com>, Riani Resianingrum <rianiresia@gmail.com>, Dwiningrum Rachel Mayasita Sitorus <dwiningrumrachel@gmail.com>, asri.peni@unpad.ac.id, yusyaa@yahoo.com, kawiji_kawiji@yahoo.co.id, arum setiawan <setiawanarum@gmail.com>, elvi rusmiyanto <elvirusm1971@gmail.com>, Laila Hanum <lailahanum@ymail.com>, mohamad.amin.fmipa@um.ac.id, heru sasongko <herusasongkoapt@gmail.com>, Fea Prihap <feapri87@gmail.com>, cecilia_sari@yahoo.com, sinta maharani <sinta.maharani.lipi@gmail.com>, Sandy Leo <sandy.leo@sci.ui.ac.id>

Dear Bapak/Ibu,

Kami telah menghubungi lebih dari 10 peneliti yang kami anggap potensial untuk mengulas naskah anda, namun hingga kini tidak ada satupun yang berkenan membari masukan yang signifikan.

Untuk itu Bapak/Ibu dimohon untuk mengirimkan 5 nama yang berpotensi sebagai reviewer, mohon dua diantaranya telah dipastikan kesediaannya untuk mereview. Untuk menjaga netralitas dan obyektivitas penilaian, maka dimohon untuk tidak mengirimkan nama teman sekantor. Lebih disukai bila yang bersangkutan telah memilliki Scopus ID atau derajat Dr.

Demikian pemberitahuan kami.

Thank you,
Regards,

Ahmad Dwi Setyawan

Managing Editor,
- Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id) (SCOPUS, DOAJ)
- Nusantara Bioscience (biosains.mipa.uns.ac.id/nusbioscience.htm) (Web of Science, DOAJ)

Co-Chairman
International Conference on Biodiversity
- Yogyakarta, 19-20 March 2016; http://biodiversitas.mipa.uns.ac.id/S/2016/jogja/home.html

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Department of Biology,
Faculty of Mathematics and Natural Sciences, Sebelas Maret University,
Jl. Ir. Sutami 36A Solo 57126, Central Java, Indonesia,
Tel. & Fax. +62-271-663375,
Mobile phone: +62-8122989467,
e-mail: unsjournals@gmail.com

Dani Saraswati <danysaraswati@gmail.com> Sun, Jan 24, 2016 at 1:36 PM
To: Intl Conf Biodiv <biodiversitas@gmail.com>

Yth. Bapak Ahmad Dwi Setyawan
Managing Editor Biodiversitas

Terima kasih atas pemebritahuannya. Saya akan mencari 5 nama reviewer dan submit ke Bapak secepanya.

Salam hormat,
Saraswati Prabawardani
[Quoted text hidden]

Dani Saraswati <danysaraswati@gmail.com> Thu, Feb 4, 2016 at 8:41 AM
To: Intl Conf Biodiv <biodiversitas@gmail.com>

Kepada yth. Bapak Ahmad Dwi Setyawan
Managing Editor Biodiversitas

Selamat pagi pak, maaf saya telat merespon email karena baru kembali tugas dari wilayah pedalaman Papua, dimana akses internet sulit.
Bersama ini saya sampaikan daftar nama-nama untuk mereview paper saya, sebagai berikut:

1. Dr. Tania Paul, Senior Lecturer, School of Primary Industries, Charles Darwin University, Darwin: Email : Tania.Paul@cdu.edu.au

2. Dr Mary Taylor, germplasm, biodiversity, climate consultant, England: Email: maryt@oxalis.plus.com

3. Dr Danny Hunter, Bioversity, FAO: Email : d.hunter@cgiar.org

4. Dr. Graham Lyons. Adelaide University Email: graham.lyons@adelaide.edu.au

Sebenarnya paper ini sudah direview oleh Dr. Graham Lyons ketika akan dipresentsikan pada symposium biodioversity di Solo pada November 2015. Sehingga sebagai bentuk ucapan terima kasih kami untuk Dr. Graham Lyons,maka kami mencantumkan nama beliau di artikel ini sebagai co author, dan beliau sudah menyetujuinya. Beliau sangat berpengalaman dalam penelitian selain di Australia dan negara-negara maju lainnya, area penelitian beliau juga di wilayah Papua New Guiniea, negara-negara di wilayah Pasifik Selatan dan Papua. Beliau juga pernah meneliti dan menerbitkan artikel tentang tanaman gedi di bawah kerjasama ACIAR.

Demikian penyampaian kami, atas perhatian Bapak kami ucapkan terima kasih.

Salam hormat,
Saraswati Prabawardani
[Quoted text hidden]

Gmail Dani Saraswati <danysaraswati@gmail.com>

Comments on your mss

5 messages

Intl Conf Biodiv <biodiversitas@gmail.com> Thu, Dec 31, 2015 at 2:43 PM
To: Dani Saraswati <danysaraswati@gmail.com>, graham.lyons@adelaide.edu.au

Dear Authors,

Please, find the attached file for comments on your mss.

Thank you,
Best Regards,

Ahmad Dwi Setyawan
Editor
International Conference on Biodiversity
(in collaboration with Agriculture and Agricultural Science Procedia of Elsevier)

> Sebelas Maret University, 5-6 November 2015
http://acb.uns.ac.id/international-2
> Mulawarman University, 14-16 January 2016
http://www.globaleventslist.elsevier.com/events/2016/01/international-conference-on-biodiversity
http://biodiversitas.mipa.uns.ac.id/S/2016/samarinda/home.html

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Department of Biology, Faculty of Mathematics and Natural Sciences, Sebelas Maret University,
Jl. Ir. Sutami 36A Solo 57126, Central Java, Indonesia, Tel. & Fax. +62-271-663375, Mobile phone: +62-8122989467,
e-mail: unsjournals@gmail.com

---------- Forwarded message ----------
From: **.....**
Date: Thu, Dec 31, 2015 at 2:33 PM
Subject: Re: Fwd: Invitation to review -- International Conference on Biodiversity
To: biodiversitas@gmail.com

Dear Sir,

I have reviewed the manuscripts. This may be acceptable for the International Conference on Biodiversity. My corrections and concerns are highlighted in track change mode in the attached file.

The receipt may kindly be acknowledged.

Once again thank you very much for giving me such a responsibility.

Regards,
.....

Survey Selection & Mass Production unit

Bidhan Chandra Krishi Viswavidyalaya

Mohanpur, Nadia, West Bengal-741252

+ 91 9432010595 (M)

2 attachments

63._Saraswati_Prabawardani.doc
1687K

ICB-Guidance-for-Authors.pdf
140K

Graham Lyons <graham.lyons@adelaide.edu.au> Wed, Jan 6, 2016 at 7:37 AM
To: Dani Saraswati <danysaraswati@gmail.com>

Dear Dani,

Here are revisions to the ms, as suggested by the reviewer. The Abstract has been reduced to 207 words, and the shaded section on p2 by over half. Just the table, aibika with capital A and a couple of other points (eg counties/regions in Abstract; reference for Aibika flowers in the Introduction) for you to do and it will be very good,

Best wishes from Graham

Dr Graham Lyons
Research Fellow
Discipline of Plant & Food Science
School of Agriculture, Food & Wine
University of Adelaide
Waite Campus
Glen Osmond, South Australia 5064
Ph (08) 8313 6533
Fax (08) 8313 7109

http://www.adelaide.edu.au/directory/graham.lyons

[Quoted text hidden]

Dani et al Aibika4.doc
1699K

Dani Saraswati <danysaraswati@gmail.com> Mon, Jan 18, 2016 at 11:17 PM
To: Graham Lyons <graham.lyons@adelaide.edu.au>

Dear Graham,

I already corrected the paper. Thank you so much for your helps. Hope it will published soon.

Best regards,
Dani

[Quoted text hidden]

Graham Lyons <graham.lyons@adelaide.edu.au> Tue, Jan 19, 2016 at 6:40 AM
To: Dani Saraswati <danysaraswati@gmail.com>

Dear Dani, well done. Always happy to help you and your group,

All the best,

Graham

Dr Graham Lyons
Research Fellow
Discipline of Plant & Food Science
School of Agriculture, Food & Wine
University of Adelaide
Waite Campus
Glen Osmond, South Australia 5064
Ph (08) 8313 6533
Fax (08) 8313 7109

http://www.adelaide.edu.au/directory/graham.lyons

CRICOS Provider Number 00123M

[Quoted text hidden]

Dani Saraswati <danysaraswati@gmail.com> Fri, Jan 22, 2016 at 1:22 PM
To: Graham Lyons <graham.lyons@adelaide.edu.au>

Thanks Graham !

Cheers,
Dani
[Quoted text hidden]

Fwd: review comments - Tania Paul

1 message

Intl Conf Biodiv <biodiversitas@gmail.com> Sat, Feb 20, 2016 at 11:23 AM
To: Dani Saraswati <danysaraswati@gmail.com>

Bu Dani,

Terlampir adalah komentar kedua atas naskah anda.
Mohon diperbaiki sesuai dengan saran.
Naskah yang telah diperbaiki mohon langsung ditempatkan pada template yang kami kirimkan kemarin siang.

Thank you,
Regards,

Ahmad Dwi Setyawan

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Department of Biology,
Faculty of Mathematics and Natural Sciences, Sebelas Maret University,
Jl. Ir. Sutami 36A Solo 57126, Central Java, Indonesia,
Tel. & Fax. +62-271-663375,
Mobile phone: +62-8122989467,
e-mail: unsjournals@gmail.com

---------- Forwarded message ----------
From: **.....**
Date: Sat, Feb 20, 2016 at 11:19 AM
Subject: review comments - Tania Paul
To: "biodiversitas@gmail.com" <biodiversitas@gmail.com>

Dear Dr Ahmad,

I hope you receive it this time,

Kind regards

.....

63._Saraswati_Prabawardani-R1 completed.doc
1697K

Morphological diversity and the cultivation practice of *Abelmoschus manihot* in West Papua, Indonesia

Abstract

Aibika (*Abelmoschus manihot* L. Medik), a local green leafy vegetable, plays an important nutritional role for most Papuan people. In Indonesia, it is commonly called "Gedi". This plant is widely cultivated in the lowland of Papua and other parts of eastern Indonesia. Aibika is reported to be high in nutrients, especially protein, Fe, K, Mg, Ca, folic acid and flavonoid compounds. Papua is considered to be the second diversity centre of this plant; however, its diversity is declining, due to habitat destruction for regional development or land fragmentation, and hence aibika preservation is a priority. This study aimed to assess the status of aibika diversity by collecting, preserving, conducting aibika morphological characterization and preliminary assessment of its cultivation technique. Diverse germplasm can then be used to improve aibika. The study was conducted between April and June 2015 in Mandopi, Warmare, Prafi of Manokwari Regency and in Minyambouw of Arfak Mountain Regency. Descriptive method was used in this study, and the relationships among cultivars were analyzed according to Cluster Analysis using Excel Stat. Phenotypes, comprising 29 morphological characters, were recorded for cluster analysis. There were 39 aibika cultivars collected from 4 locations of West Papua. Based on the UPGMA dendrogram, it was revealed that two primary clusters (A and B) separating the cultivars. Cluster A clearly separated from Cluster B at a dissimilarity value of about 0.57 (57%). Around 3.3 (33%) of variance separated the cultivars into four groups, consisting of cluster A, B1, B2, B3. Location IV is the most diverse area which consisted of cultivars of three different clusters. In Papua, aibika is cultivated in a traditional mixed-cropping system, without appropriate planting distance, fertilizer and pesticide application. This has resulted in suboptimal growth and high susceptibility to pests.

Keywords: *Abelmoschus manihot* L. Medik, aibika, gedi, leafy vegetable, morphology, diversity.

INTRODUCTION

Papua is known to have enormous crop diversity; however, there has been a lack of scientific study in this area. Among the biodiversity that has received little attention is aibika or gedi in Indonesian language. Aibika is perennial tropical shrub and belong to the family Malvaceae.

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This plant originated in China, then spread through India, Papua, South Pacific islands, and northern Australia (Zeven and Zhudwosky 1980). The greatest diversity is found in Papua New Guinea, Solomon Islands and Vanuatu (Kambuou et al. 2003). The plants show great variability in leaf shape and size, petiole and stem colour, branching and flowering characteristics. Therefore, the land of Papua is estimated to have a wide variety of this plant. Most Papuan food gardens are planted with a number of gedi cultivars, which can be distinguished by leaf shape and petiole colour differences.

Aibika is among the popular leafy vegetables consumed by Papuan people and communities in other eastern parts of Indonesia. The edible part of aibika is the young shoot tip or succulent young leaves. It is cultivated extensively and throughout the year in some Melanesian countries for its highly nutritious leaves and shoots tips (Kambuou et al. 2003). Aibika is reported to contain high nutrients; especially protein and micronutrients (Westwood and Kesavan 1982; Yalambing et al. 2015). Nutritionist (Susan Parkinson) in her personal communication with Westwood and Kesavan (1982) suggested that every household in the South Pacific region cultivate this plant. This plant is also used as traditional medicines by indigenous Papuan for relieving kidney pain, reducing high cholesterol, treating pregnant women to ease childbirth, to stimulate lactation. Aibika can help to reduce bone loss and thus provide some protection against osteoporosis (Puel et al. 2005). Aibika is also used as a traditional medicinal plant in Pacific islands regions, Vanuatu, Papua New Guinea, because of the secondary metabolites that produce important compound in supporting health function, especially of antioxidants which are efficacious in preventing some diseases, reducing the risk of cardiovascular disease, hypertension, atherosclerosis (Hodgson et al. 2006), treating sore throats, stomach aches, diarrhea, increasing milk production, and preventing bone loss (Goebel et al. 2010).

In some parts of India, Aibika is used as a source of traditional medicine such as for kidney pain, heartburn, high cholesterol, osteoporosis, as well as induce delivery baby in pregnant women (Todarwal, et al. 2011). The flowers of *A. manihot* have been used as a traditional Chinese medicine for the treatment of chronic renal disease and diabetic nephropathy (An et al. 2011). Aibika has drawn much attention recently due to its potential beneficial health effects. Study on aibika has led to the isolation of two main kinds of plant secondary metabolites, flavonoids and alkaloids. Aibika contains quercetin-3-O-robinoside, hyperin, Isoquercetin, gossipetin-8-O-glucuronide, and myricetin (Liu et al. 2006). The flowers contain quercetin-3-robinoside, quercetin-3'-glycosides, hyperin, myrecetin, anthocyanins, and hyperoside. Leaves of Aibika has been tested to prevent ovariectomy-induced femoral ostopenia (condition of bone mineral density lower than normal range in the joints limbs as a result of surgical removal of the uterus / ovaries) (Lin-lin et al. 2007; Jain et al. 2009). Aibika can also improve the function of glomerular filtration, reduced proteinuria, hyperplasia messangium which can reduce the damage of kidney tissue (Shao-Yuetal., 2006). Flavonoids in Aibika has many important functions for health, among others in reducing the risk of cardiovascular disease, hypertension, atherosclerosis, and as an antioxidant (Hodgson et al., 2006), and it is an important cash crop in local markets in Melanesia (Preston, 1998).

According to Westwood and Kesavan (1982), aibika is a highly productive plant vegetables which is very adapt to the lands in the lowlands and up to an altitude of 800 m height above sea level. It is also cultivated in higher altitude areas more than 2000 m above sea level and with annual rainfall of more than 2000 mm (Paofa and Kambuouw 2006). The aibika plant grows throughout the year and provides a continuous supply of highly nutritious leaves and shoot tips. Karafir and Vokames (2003) reported that there are 7 cultivars of Aibika in Nimboran district

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and 6 cultivars in Kemtuk district of Papua. This diversity can be seen from the shape and size of leaf, petiole and stem colour, branching and flower characters. However, it was reported to decline in recent years, probably due to rapid development, land fragmentation and global climate change (Kayadu 2013). Comprehensive studies on Aibika need to be done, as research on this plant is still limited.

The objectives of the study were to observe the morphological diversity of Aibika through exploration, identification and collection. Research was also aims to assess the cultivation technique applied on aibika by the local farmers. This study is expected to enrich the diversity of aibika and prevent the lost of the genetic base of this plant.

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MATERIALS AND METHODS

Study area

Exploration of aibika was carried out from May to June 2015 in the lowland of Mandopi, Warmare, Prafi and the highland of Arfak (Minyambouw) of West Papua, Indonesia (Figure 1). Exploration on every area of distribution was done to collect all cultivars of aibika.

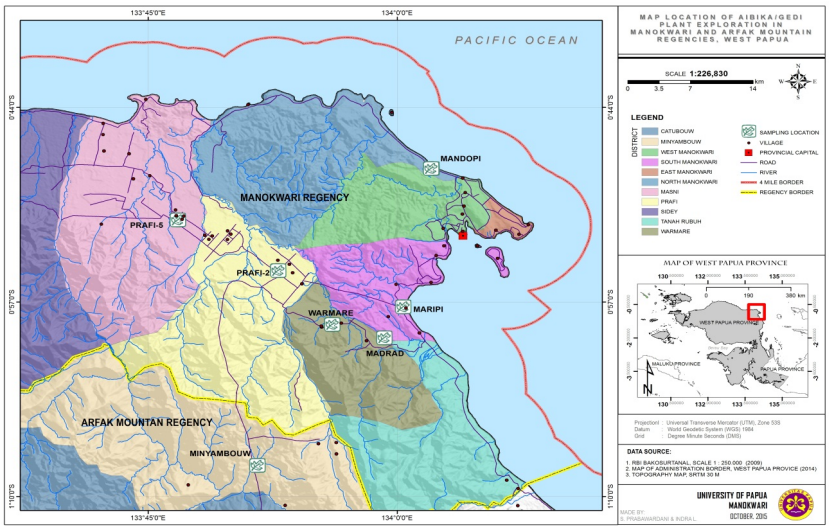

Figure 1. Map of exploration sites of aibika in Mandopi, Warmare, Prafi (lowland areas of Manokwari) and Minyambouw (highland area of Arfak), West Papua

Methods

Descriptive method with direct observation technique was applied in this research. Additionally, an interview with residents and local tribe leaders was conducted to determine the cultivars of aibika, local names and cultivation of aibika. Traditional aibika cultivation methods (including land preparation, planting and maintenance) were recorded.

Procedures

Characterization was performed in the field at each location. The identification of aibika was based on morphological characters, using descriptor list by Kambuou et al. (2003). The morphological characters of aibika consisted of stem (pith, hairiness, internode length, diameter, primary stem colour, secondary stem colour, stem pigmentation, branch number); leaf (leaf shape, leaf segment shape, margin, leaf tip, leaf base, leaf shape variability, leaf lustre, leaf vein colour, petiole colour, petiole length. However, no flowers were observed, due to frequent pruning. Morphological characters were taken from aibika plant samples which aged from 6 to 9 months (plants were still in productive age).

The collected cultivars were taken from farmer's gardens for the purpose of *ex situ* collection or preservation at the experimental field of the Agriculture Faculty, the University of Papua, Manokwari.

Data analysis

Data on the morphological diversity were analyzed using UPGMA method using Excel stat program.

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RESULTS AND DISCUSSION

Morphological diversity of aibika

During the exploration, 36 aibika cultivars were collected from 4 locations. Location I was Mandopi where 16 cultivars were found, denoted Man-01 - 16. Location II was Warmare, where 9 aibika cultivars were collected, namely MARI-01 - 05, MAD-01 - 04. Location III was the transmigration area of Prafi, where 5 cultivars were found, namely SP1-01 - 03, SP5-01 - 02. Location IV was the highland area of Arfak (Minyambouw), where 6 cultivars were collected; Imbenti-01, Imbenti-02, Minyambouw-01, Minyambouw-02, Minyambouw-03, Ungga-01.

Based on the identification at 4 locations, the diversity of morphological characters of aibika was not only revealed at the individual among different locations (among population), but it was also observed in individuals at the same locations (within population).

The magnitude of morphological characters within population and between aibika populations was perceived based on similarity or dissimilarity levels of morphological characters using cluster analysis with Unweighted Pair Group Method with Arithmetic (UPGMA). Based on this method, individuals, or population that have similar morphological characters was in collectively or closely cluster. The cluster pattern of individuals or population is based on the similarity matrix, which is described by dendogram with the characters dissimilarity distance lay between 0.00 (0%) and 1.00 (100%).

The UPGMA dendrogram resulting from the fusion matrix based on dissimilarity model revealed two primary clusters (A and B) separating the cultivars (Figure 1). It is evident that Cluster A (Mad-01, Man-09, Man-11—Minyam-03, Imbenti-02, SP1-020 clearly separated from Cluster B at a dissimilarity value of about 0.57 (57%). Around 3.3 (33%) of variance separated the cultivars into four groups, consisting of cluster A, B1, B2, B3. However, if 0.2 (20%) dissimilarity was used to distinguish the cultivars, eight groups were recognized. The groups were A1, A2, A3, B1a, B1b, B2, B3a and B3b. The member of Cluster A was the most widely distributed cultivars which can be found in all locations including I, II, III, and IV. The cultivars of cluster B3 spread out in three locations (II, III, IV). Meanwhile, the cultivars of cluster B1 only grow in location I. It also can be noted that location IV is the most diverse area which consisted of cultivars of three different cluster which were Imbenti-02, Minyambouw-03 (cluster A), Minyambouw-01, Minyambou-02 and Ungga-01 (cluster B2), and Imbenti-01 (cluster B3).

The diversity of aibika occured as a consequence of differences in morphological characters of plant organs.

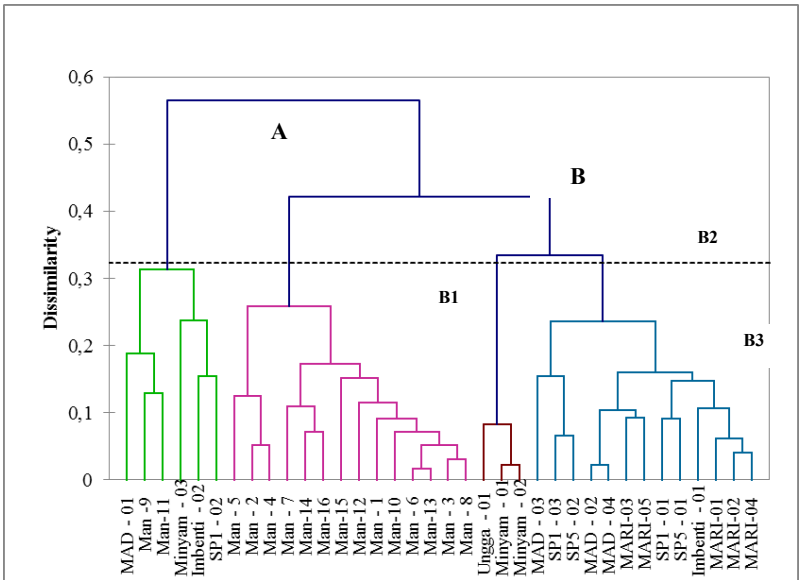

Figure 2. Dendogram showing the dissimilarity relationship of Aibika cultivars collected from 4 different locations in Mandopi, Warmare, Prafi (lowland areas of Manokwari) and Minyambouw (the highland area of Arfak)

Based on the identification, the most prominent diversity of morphological characters among locations or among population within a location were leaf shape characters and length, plant height, stem colour and diameter, internode length, petiole length and colour. Each cluster generated sub clusters of population based on the same growth location, except cluster A. It shows that individuals came from the same location or closer location was clusters in proximity or in a close distance. This cluster pattern suggests a closer genetic relation among population of similar areas compared to the different location. It means that each location had unique plant characters, and therefore 3 populations of aibika were indigenous in each original location. This phenomenon supports the theory that the closer the geographical areas between two individuals or population, the shorter the genetic distance between those individuals and population. However, cluster A consisted of cultivars from diverse areas, this probably was due to the migration of people who brought the genetic material of aibika from one location to another locations, resulting in diverse cultivars in cluster A.

The different characters of aibika among locations were due most likely to the ecological and geographical isolation (ecogeographic). Ecogeographic isolation is induced by the external

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factors such us climate, water, soil and topography. These factors function as a catalyst in inducing a barrier for gene exchange among population, and hence each population in particular ecosystems provides unique characters in each region.

Individuals or plant populations that separated because of the ecological isolation have specific habitat and specific environment. From this point of view, succeeded population will not be adaptive if it is grown at a different habitat from those of the parents. They will only grow at the similar parent habitat or in between habitat of both parent populations (Grant, 1971).

Different characters among individuals in one species apart from the environmental factors or geographical isolation are also induced by migration, mutation, and hybridization. The migration of individuals or plant population from one continent to other continents or from one location to other location, and followed by geographical isolation and hybridization may result to the gene flow. Gene flow among plant population increases the consequences of evolution and also may increase the character diversity. These create new gene combinations and raising the adaptability in location from one to other population (Nagi, 1997).

Traditional cultivation of aibika

In general, aibika is traditionally cultivated, and has not been grown in accordance with common agronomical practice. The cultivation system observed during the study consisted of land clearing, preparation of planting material, planting method, maintenance, and harvesting.

Land clearing was usually carried out when farmers make a new garden, as they practised shifting cultivation. This activity was done by cooperation of the family members. The gardens which are located 2-3 km from their home generally belong to the family members. The crop field area is divided among members of the nuclear family or relatives but still have a blood relation. So, plot size for each family member in one field crop area depends on the size of a field crop area. For field crop areas, farmers first clear grass or shrubs, then large trees are burned, which takes about 5 days for large gardens or 2-3 days for smaller gardens. Summer is a good time to dry the remaining plants, as they will dry and decompose more quickly. Farmers believe that the ash remaining after burning increase the soil nutrient availability. When a new garden is opened, the previous land was rested (fallowed) after being used several times.

Minimum tillage is practiced by Arfak people in their field crop area, where after completing burning and cleaning trees, farmers directly plant aibika by using wooden drill. Equipment such as axes and machetes used to cut wood and make fence. A crowbar was used to move large rocks and remnants of the roots of trees that remain in the field.

Preparation and Planting Material

Aibika is generally propagated using stem cuttings. Some farmers also cut old or unproductive aibika and leave the primary stem in the field to regrow a new shoot. According to farmers, all parts of the trunk or branches can be used as planting materials, but it is best to use a stem or branch that is not too young and not too old. If the cuttings are taken from the old trunk or branch the plant will grow slowly. The length of cuttings used by farmers was 30-40 cm (with 4-6 nodes). Cuttings were usually taken from the top and middle portions of healthy, mature stems. Stems are planted directly in the field. Between 2 and 3 nodes are buried, depending on the length of the cutting. The number of cutting per hole is around 3-4 cuttings. Irrigation depends on rainfall.

Planting

Aibika is cultivated in subsistence and semi-subsistence gardens. When planting time

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coincides with the beginning of the rainy season, aibika growth will be faster. However, waterlogged soils will slow aibika growth.

Cultivation system practised by the local farmers in all studied locations was mix-cropping. Aibika was commonly intercropped with a number of other food crops such as root crops, banana and various vegetable crops. With a cropping pattern like this, plant spacing is not applied on a regular basis, but a few farmers used spacing of 100 × 100 cm for aibika. The tools used to make holes for planting was made from a wood stick with a length of about one metre. No fertilizer was used for improving the growth of aibika.

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Maintenance

Aibika plants were not intensively maintained since cuttings were planted. Plant maintenance generally was done earlier when stem is newly planted. Cuttings will begin to produce shoots about 2 weeks after planting. Once the plants grow up, farmers rarely maintain them, except for clearing grass at uncertain time intervals. Pruning was done to produce more young leaves and with an intention that aibika plants do not grow too high to facilitate harvesting. Pruned leaf was taken for home consumption. Farmers usually only clean weeds around aibika plants.

Aibika pests that attack crops were mostly grasshoppers, caterpillars and aphids. Grasshoppers damage the surface of the leaves by eating the leaves aibika while the caterpillars cause shoots to curl. The level of damage caused by pests is very high under shaded conditions so reduced the quality of aibika leaf. Most farmers did not regularly clean up the aibika garden to prevent pest infestation.

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Aibika plants have the advantage of being able to be grown throughout the year, and hence it is classified as annual plant. As stated by Goebel et al (2010), this plant can be grown all year in most tropical locations but growth often slows with cooler, shorter days and drier conditions.

Based on information from respondents, aibika is usually first harvested at 3 months after planting in the lowland areas, and about 6 months after planting in the Arfak highland. Aibika grown in the highland generally had shorter stem, narrower leaf, shorter internode and petiole length than found in lowland location.

Aibika is generally harvested by picking young shoots and directly processed (cooked or sold in the local market). Storage for too long will cause aibika leaves to wither and suffer damage. The productivity of aibika plants usually declines after 2 years.

Figure 3. Aibika cultivars with deep lobe leaf was marketed as leafy vegetable (A), and less marketed cultivar due to highly sap content (B)

CONCLUSIONS

Aibika grew widely in the lowland of Manokwari. Of 39 cultivars collected from 4 areas, 16 cultivars were present, particularly in the northern part of Manokwari, West Papua. Aibika was also grown in the highland area of Arfak as shown by 6 cultivars collected from this area. Aibika was traditionally cultivated in most of the garden of local Papuan farmers. There was no agronomic input and maintenance in cultivating this plant, resulting in suboptimal growth and high susceptibility to pests. Further research is needed to develop this plant, particularly in cultivation techniques and nutritional aspects.

ACKNOWLEDGEMENTS

Thanks go to the Ministry of Research, Technology and Higher Education (Kemenristek Dikti) for funding this research through DP2M DIPA DGHE 2015, in accordance with the "grant competition scheme", with the contract number: 150/SP2H/PL/Dit.Lipabmas/II/2015. The authors also thank Indra F. Luhulima, Nouke L. Mawikere, and Ni Made Gari for their invaluable helps during the exploration and map formation.

REFERENCES

An Y, Zhang Y, Li C, Qian Q, He W, Wang T. 2011. Inhibitory effects of flavonoids from *Abelmoschus manihot* flowers on triglyceride accumulation in 3T3-L1 adipocytes. Fitoterapia 82: 595–600. doi:10.1016/j.fitote.2011.01.010

Goebel R, M. Taylor M, Lyons G. 2010. Leafy green vegetables in the tropics. Feasibility study on increasing the consumption of nutritionally-rich leafy vegetables by indigenous communities in Samoa, Solomon Islands and Northern Australia. Factsheet No. 1. The Australian Centre for International Agricultural Research (ACIAR). Canberra.

Grant, V. 1971. Plant speciation. New York: Columbia University Press.

Hodgson JM, Kevin DC. 2006. Review dietary flavonoids: effects on endothelial function and blood pressure, Journal of Science of Food and Agriculture. 86:2492-2498. DOI: 10.1002/jsfa.2675.

Jain PS, Bari SB, Surana SJ. 2009. Isolation of stigmasterol and (-sitosterol from petroleum ether of woody stem of *Abelmoschus manihot*, Asian Journal of Biological Sciences. 2(4): 112-117. doi: 10.1590/S0102-695X2010005000009

Kambuou R, Paofa J, Wisnton R. 2003. Passport information and minimum descriptor list for Albika (*Abelmoschus manihot* L. Medik). Crop Descriptor List No. 1. National Agricultural Research Institute (NARI). Papua New Guinea.

Karafir, YP, Vokames J. 2003. Mengenal sayur lilin dan sayur gedi serta pemanfaatannya dalam diversifikasi menu oleh penduduk distrik Nimboran dan sekitarnya. Prosiding Lokakarya Pangan Spesifik Lokal Papua.

Kayadu N. 2013. Karakterisasi agroekologi dan analisis nutrisi tanaman gedi (*Abelmoschus manihot* L. Medik) asal Distrik Sentani dan Distrik Kemtuk, Kabupaten Jayapura. Skripsi. Fakultas Pertanian dan Teknologi Pertanian. Universitas Negeri Papua Manokwari (In Indonesian Language).

Lin-lin W, Xin-bo Y, Zheng-ming H, He-zhi L, Guang-xia W. 2007. In vivo and in vitro antiviral activity of hyperoside extracted from *Abelmoschus manihot* (L) Medik. Acta Pharmacologica Sinica. 28(3):404-409. doi:10.1111/j.1745-7254.2007.00510.x.

Liu Y, Xianyin L, Xiaomei L, Yuying Z, Jingrong C. 2006. Interactions between thrombin with flavonoids from *Abelmoschus manihot* (L.) medicus by CZE. Chromatographia. 64: 45. doi:10.1365/s10337-006-0841-7.

Nagy ES. 1997. Frequency-dependent seed production and hybridization rates: Implications for gene flow between locally adapted plant populatian. Evolution. 51(3):703-714. doi: 10.2307/2411147

Preston SR. 1998. Abika / Bele. *Abelmoschus manihot* (L.) Medik. Promoting the conservation and use of underutilized and neglected crops. 24. Institute of Plant Genetics and Crop Plant Research, Gatersleben/International Plant Genetic Resources Institute, Rome, Italy.

Puel C, Mathey J, Kati-Coulibaly S, Davicco MJ, Lebecque P, Chanteranne B, Horcajada MN, Coxam V. 2005. Preventive effect of *Abelmoschus manihot* (L.) Medik on bone loss in the ovariectomised rats. Journal of Ethnopharmacology. 99: 55–60. doi:10.1016/j.jep.2005.01.047.

Shao-Yu Z, Nai-Ning S, Wen-Yuan G, Wei J, Hong-Quan D, Pei-Gen X. 2006. Progress in the treatment of chronic glomerulonephritis with traditional Chinese medicine. Asian Journal of Pharmacodynamic and Pharmacokinetics. 6(4): 317-325.

Todarwal A, Jain P, Bari S. 2011. *Abelmoschus manihot* Linn: ethnobotany, phytochemistry and pharmacology. Traditional Medicines. 6:1-7.

Westwood V, Kesavan V. 1982. Traditional leafy vegetables of Papua New Guinea. Aibika (*Hibiscus manihot* L.). In: RM Bourke and V Kesavan (eds). Proceeding of the Second Papua New Guinea Food Crops Conference, 1980. Part 2

Yalambing LR, Arcot J, Greenfield H, Holford P. 2015. Aibika (*Abelmoschus manihot* L.): Genetic variation, morphology and relationships to micronutrient composition. Food Chemistry (2015). http://dx.doi.org/10.1016/j.foodchem.2014.08.058.

Zaven, AC, Zhukovsky PM. 1980. Dictionary of cultivated plants and their centres of diversity. New York.

Morphological diversity and the cultivation practice of *Abelmoschus manihot* in West Papua, Indonesia

Abstract

Aibika (*Abelmoschus manihot* L. Medik) or "Gedi" in Indonesia, is an important, nutritious, green leafy vegetable, and is widely cultivated in the lowland of Papua and in other parts of eastern Indonesia. Aibika is reportedly high in nutrients, especially protein, Fe, K, Mg, Ca, folic acid and flavonoids. Although Papua is considered to be Aibika's second diversity centre, its diversity is declining due to habitat destruction for regional development or land fragmentation, hence its preservation is a priority. This study aimed to assess Aibika diversity by collecting, preserving, conducting morphological characterization and preliminary assessment of cultivation methods. Diverse germplasm can then be used for improvement. Cultivars (n=39) were collected in the Mandopi, Warmare, Prafi [regions/counties?]of Manokwari Regency and in the Minyambouw [region/county?]of Arfak Mountain Regency. Phenotypes, comprising 29 morphological characters, were recorded for cluster analysis. The UPGMA dendrogram revealed two primary clusters (A and B) separating the cultivars, with 57% variance. Around 33% of variance separated the cultivars into four groups: A, B1, B2 and B3. Location [Minyambouw?]was the most diverse area, with cultivars of three different clusters recorded. In Papua, Aibika is cultivated in a traditional mixed-cropping system, without appropriate planting distance, fertilizer and pesticide application. This has resulted in suboptimal growth and high susceptibility to pests.

Keywords: *Abelmoschus manihot* L. Medik, aibika, gedi, leafy vegetable, morphology, diversity.

INTRODUCTION

Papua is known to have enormous crop diversity; however, there has been a lack of scientific study in this area. Among the biodiversity that has received little attention is aibika or gedi in Indonesian language. Aibika is perennial tropical shrub and belong to the family Malvaceae. This plant originated in China, then spread through India, Papua, South Pacific islands, and northern Australia (Zeven and Zhudwosky 1980). The greatest diversity is found in Papua New Guinea, Solomon Islands and Vanuatu (Kambuou et al. 2003). The plants show great variability in leaf shape and size, petiole and stem colour, branching and flowering characteristics.

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Therefore, the land of Papua is estimated to have a wide variety of this plant. Most Papuan food gardens are planted with a number of gedi cultivars, which can be distinguished by leaf shape and petiole colour differences.

Aibika is a popular, nutritious leafy vegetable consumed by Papuan people and communities in other eastern parts of Indonesia. The edible parts are the young shoot tips and succulent young leaves. It is cultivated extensively and throughout the year in Melanesian countries (Kambuou et al. 2003). Aibika is reported to be nutritious, being high in protein and micronutrients (Westwood and Kesavan 1982; Yalambing et al. 2015). It is also used as a traditional medicine by indigenous Papuans for treating kidney disease and relieving kidney pain, reducing high cholesterol, hypertension and cardiovascular disease risk, treating pregnant women to ease childbirth, and to stimulate lactation. Aibika can help to reduce bone loss and thus reduce risk of osteoporosis and osteopenia (Puel et al. 2005; Hodgson et al. 2006; Shao-Yu et al. 2006; Lin-lin et al. 2007; Jain et al. 2009; Goebel et al. 2010; Todarwal et al. 2011). In addition, Aibika flowers have been used as a traditional Chinese medicine for the treatment of chronic renal disease and diabetic nephropathy (An et al. 2011). Aibika leaves contain beneficial flavonoids and alkaloids, including quercetin-3-O-robinoside, hyperin, isoquercetin, gossipetin-8-O-glucuronide, and myricetin (Liu et al. 2006), and flowers contain quercetin-3-robinoside, quercetin-3'-glycosides, hyperin, myrecetin, anthocyanins, and hyperoside [Reference: (Lin-lin et al. 2007 or Liu et al. 2006)?]. Moreover, Aibika is an important cash crop in local markets in Melanesia (Preston, 1998).

According to Westwood and Kesavan (1982), Aibika is highly productive and well adapted to the lowlands and up to an altitude of 800 m above sea level. It is also cultivated in higher altitude areas more than 2000 m above sea level and with annual rainfall of more than 2000 mm (Paofa and Kambuouw 2006). Karafir and Vokames (2003) reported that there are 7 cultivars of Aibika in the Nimboran district and 6 cultivars in Kemtuk district of Papua. This diversity can be seen from the shape and size of leaf, petiole and stem colour, branching and flower characters. However, it was reported to decline in recent years, probably due to rapid development, land fragmentation and global climate change (Kayadu 2013). Comprehensive studies on Aibika need to be done, as research on this plant is still limited.

The objectives of the study were to observe the morphological diversity of Aibika through exploration, identification and collection. Research also aimed to assess the cultivation methods applied to Aibika by local farmers. This study is expected to enrich the diversity of aibika and prevent the lost of the genetic base of this plant.

MATERIALS AND METHODS

Study area

Exploration of aibika was carried out from May to June 2015 in the lowland of Mandopi, Warmare, Prafi and the highland of Arfak (Minyambouw) of West Papua, Indonesia (Figure 1). Exploration on every area of distribution was done to collect all cultivars of aibika.

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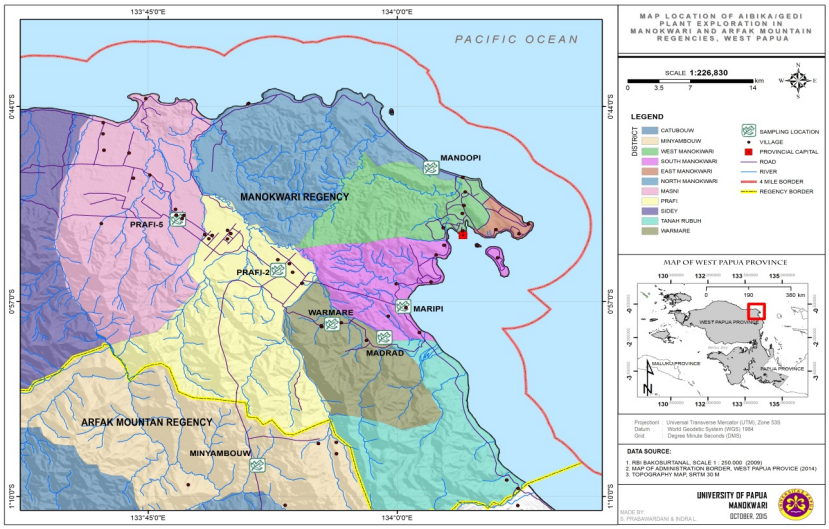

Figure 1. Map of exploration sites of aibika in Mandopi, Warmare, Prafi (lowland areas of Manokwari) and Minyambouw (highland area of Arfak), West Papua

Methods

Descriptive method with direct observation technique was applied in this research. Additionally, an interview with residents and local tribe leaders was conducted to determine the cultivars of aibika, local names and cultivation of aibika. Traditional aibika cultivation methods (including land preparation, planting and maintenance) were recorded.

Procedures

Characterization was performed in the field at each location. The identification of aibika was based on morphological characters, using descriptor list by Kambuou et al. (2003). The morphological characters of aibika consisted of stem (pith, hairiness, internode length, diameter, primary stem colour, secondary stem colour, stem pigmentation, branch number); leaf (leaf shape, leaf segment shape, margin, leaf tip, leaf base, leaf shape variability, leaf lustre, leaf vein colour, petiole colour, petiole length. However, no flowers were observed, due to frequent pruning. Morphological characters were taken from aibika plant samples which aged from 6 to 9 months (plants were still in productive age).

The collected cultivars were taken from farmer's gardens for the purpose of *ex situ* collection or preservation at the experimental field of the Agriculture Faculty, the University of Papua, Manokwari.

Data analysis

Data on the morphological diversity were analyzed using the Unweighted Pair group Method with Arithmetic(UPGMA)method using Excel statistical program.

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RESULTS AND DISCUSSION

Morphological diversity of aibika

During the exploration, 36 aibika cultivars were collected from 4 locations. Location I was Mandopi where 16 cultivars were found, denoted Man-01 - 16. Location II was Warmare, where 9 aibika cultivars were collected, namely MARI-01 - 05, MAD-01 - 04. Location III was the transmigration area of Prafi, where 5 cultivars were found, namely SP1-01 - 03, SP5-01 - 02. Location IV was the highland area of Arfak (Minyambouw), where 6 cultivars were collected; Imbenti-01, Imbenti-02, Minyambouw-01, Minyambouw-02, Minyambouw-03, Ungga-01.

Based on the identification at 4 locations, the diversity of morphological characters of aibika was not only revealed at the individual among different locations (among population), but it was also observed in individuals at the same locations (within population).

The magnitude of morphological characters within population and between aibika populations was perceived based on similarity or dissimilarity levels of morphological characters using cluster analysis with UPGMA. Based on this method, individuals, or population that have similar morphological characters was in collectively or closely cluster. The cluster pattern of individuals or population is based on the similarity matrix, which is described by dendogram with the characters dissimilarity distance lay between 0.00 (0%) and 1.00 (100%).

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The UPGMA dendrogram resulting from the fusion matrix based on dissimilarity model revealed two primary clusters (A and B) separating the cultivars (Figure 1). It is evident that Cluster A (Mad-01, Man-09, Man-11—Minyam-03, Imbenti-02, SP1-020 clearly separated from Cluster B at a dissimilarity value of about 0.57 (57%). Around 3.3 (33%) of variance separated the cultivars into four groups, consisting of cluster A, B1, B2, B3. However, if 0.2 (20%) dissimilarity was used to distinguish the cultivars, eight groups were recognized. The groups were A1, A2, A3, B1a, B1b, B2, B3a and B3b. The member of Cluster A was the most widely distributed cultivars which can be found in all locations including I, II, III, and IV. The cultivars of cluster B3 spread out in three locations (II, III, IV). Meanwhile, the cultivars of cluster B1 only grow in location I. It also can be noted that location IV is the most diverse area which consisted of cultivars of three different cluster which were Imbenti-02, Minyambouw-03 (cluster A), Minyambouw-01, Minyambou-02 and Ungga-01 (cluster B2), and Imbenti-01 (cluster B3). The diversity of aibika occured as a consequence of differences in morphological characters of plant organs.

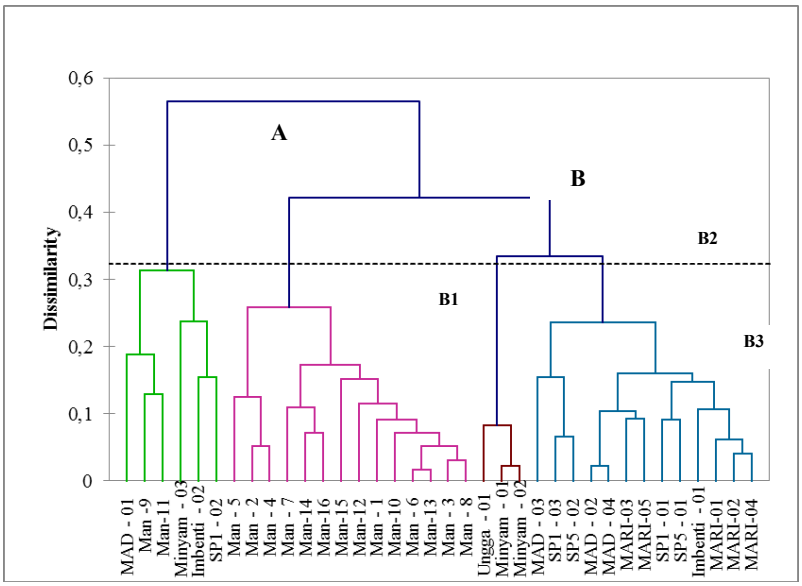

Figure 2. Dendogram showing the dissimilarity relationship of Aibika cultivars collected from 4 different locations in Mandopi, Warmare, Prafi (lowland areas of Manokwari) and Minyambouw (the highland area of Arfak)

Based on the identification, the most prominent diversity of morphological characters among locations or among population within a location were leaf shape characters and length, plant height, stem colour and diameter, internode length, petiole length and colour. Each cluster generated sub clusters of population based on the same growth location, except cluster A. It shows that individuals came from the same location or closer location was clusters in proximity or in a close distance. This cluster pattern suggests a closer genetic relation among population of similar areas compared to the different location. It means that each location had unique plant characters, and therefore 3 populations of aibika were indigenous in each original location. This phenomenon supports the theory that the closer the geographical areas between two individuals or population, the shorter the genetic distance between those individuals and population. However, cluster A consisted of cultivars from diverse areas, this probably was due to the migration of people who brought the genetic material of aibika from one location to another location, resulting in diverse cultivars in cluster A.

The different characters of aibika among locations were due most likely to the ecological and geographical isolation (ecogeographic). Ecogeographic isolation is induced by the external factors such us climate, water, soil and topography. These factors function as a catalyst in inducing a barrier for gene exchange among population, and hence each population in particular ecosystems provides unique characters in each region.

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Individuals or plant populations that separated because of the ecological isolation have specific habitat and specific environment. From this point of view, succeeded population will not be adaptive if it is grown at a different habitat from those of the parents. They will only grow at the similar parent habitat or in between habitat of both parent populations (Grant, 1971).

Different characters among individuals in one species apart from the environmental factors or geographical isolation are also induced by migration, mutation, and hybridization. The migration of individuals or plant population from one continent to other continents or from one location to other location, and followed by geographical isolation and hybridization may result to the gene flow. Gene flow among plant population increases the consequences of evolution and also may increase the character diversity. These create new gene combinations and raising the adaptability in location from one to other population (Nagi, 1997).

Traditional cultivation of aibika

In general, aibika is traditionally cultivated, and has not been grown in accordance with common agronomical practice. The cultivation system observed during the study consisted of land clearing, preparation of planting material, planting method, maintenance, and harvesting.

Land clearing was usually carried out when farmers make a new garden, as they practised shifting cultivation. This activity was done by cooperation of the family members. The gardens which are located 2-3 km from their home generally belong to the family members. The crop field area is divided among members of the nuclear family or relatives but still have a blood relation. So, plot size for each family member in one field crop area depends on the size of a field crop area. For field crop areas, farmers first clear grass or shrubs, then large trees are burned, which takes about 5 days for large gardens or 2-3 days for smaller gardens. Summer is a good time to dry the remaining plants, as they will dry and decompose more quickly. Farmers believe that the ash remaining after burning increase the soil nutrient availability. When a new garden is opened, the previous land was rested (fallowed) after being used several times.

Minimum tillage is practiced by Arfak people in their field crop area, where after completing burning and cleaning trees, farmers directly plant aibika by using wooden drill. Equipment such as axes and machetes used to cut wood and make fence. A crowbar was used to move large rocks and remnants of the roots of trees that remain in the field.

Preparation and Planting Material

Aibika is generally propagated using stem cuttings. Some farmers also cut old or unproductive aibika and leave the primary stem in the field to regrow a new shoot. According to farmers, all parts of the trunk or branches can be used as planting materials, but it is best to use a stem or branch that is not too young and not too old. If the cuttings are taken from the old trunk or branch the plant will grow slowly. The length of cuttings used by farmers was 30-40 cm (with 4-6 nodes). Cuttings were usually taken from the top and middle portions of healthy, mature stems. Stems are planted directly in the field. Between 2 and 3 nodes are buried, depending on the length of the cutting. The number of cutting per hole is around 3-4 cuttings. Irrigation depends on rainfall.

Planting

Aibika is cultivated in subsistence and semi-subsistence gardens. When planting time coincides with the beginning of the rainy season, aibika growth will be faster. However, waterlogged soils will slow aibika growth.

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Cultivation system practised by the local farmers in all studied locations was mix-cropping. Aibika was commonly intercropped with a number of other food crops such as root crops, banana and various vegetable crops. With a cropping pattern like this, plant spacing is not applied on a regular basis, but a few farmers used spacing of 100 × 100 cm for aibika. The tools used to make holes for planting was made from a wood stick with a length of about one metre. No fertilizer was used for improving the growth of aibika.

Maintenance

Aibika plants were not intensively maintained since cuttings were planted. Plant maintenance generally was done earlier when stem is newly planted. Cuttings will begin to produce shoots about 2 weeks after planting. Once the plants grow up, farmers rarely maintain them, except for clearing grass at uncertain time intervals. Pruning was done to produce more young leaves and with an intention that aibika plants do not grow too high to facilitate harvesting. Pruned leaf was taken for home consumption. Farmers usually only clean weeds around aibika plants.

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Harvest

Aibika plants have the advantage of being able to be grown throughout the year, and hence it is classified as annual plant. As stated by Goebel et al (2010), this plant can be grown all year in most tropical locations but growth often slows with cooler, shorter days and drier conditions.

Based on information from respondents, aibika is usually first harvested at 3 months after planting in the lowland areas, and about 6 months after planting in the Arfak highland. Aibika grown in the highland generally had shorter stem, narrower leaf, shorter internode and petiole length than found in lowland location.

Aibika is generally harvested by picking young shoots and directly processed (cooked or sold in the local market). Storage for too long will cause aibika leaves to wither and suffer damage. The productivity of aibika plants usually declines after 2 years.

Figure 3. Aibika cultivars with deeply lobed leaves are marketed as a leafy vegetable (A), while this cultivar is marketed less less due to its high sap content (B) [Need to put "A" and "B" in boxes]

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CONCLUSIONS

Aibika grows widely in the lowland of Manokwari, West Papua. Of 39 cultivars collected from 4 areas, 16 cultivars were present, particularly in the northern part of Manokwari. Aibika was also grown in the highland area of Arfak as shown by 6 cultivars collected from this area. Aibika is traditionally cultivated in most gardens of local Papuan farmers. There is no [or minimal?] agronomic input and maintenance in cultivating this plant, resulting in suboptimal growth and high susceptibility to pests. Further research is needed to develop Aibika, particularly on improved cultivation methods and nutritional aspects.

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REFERENCES

An Y, Zhang Y, Li C, Qian Q, He W, Wang T. 2011. Inhibitory effects of flavonoids from *Abelmoschus manihot* flowers on triglyceride accumulation in 3T3-L1 adipocytes. Fitoterapia 82: 595–600. doi:10.1016/j.fitote.2011.01.010

Goebel R, M. Taylor M, Lyons G. 2010. Leafy green vegetables in the tropics. Feasibility study on increasing the consumption of nutritionally-rich leafy vegetables by indigenous communities in Samoa, Solomon Islands and Northern Australia. Factsheet No. 1. The Australian Centre for International Agricultural Research (ACIAR). Canberra.

Grant, V. 1971. Plant speciation. New York: Columbia University Press.

Hodgson JM, Kevin DC. 2006. Review dietary flavonoids: effects on endothelial function and blood pressure, Journal of Science of Food and Agriculture. 86:2492-2498. DOI: 10.1002/jsfa.2675.

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Kayadu N. 2013. Karakterisasi agroekologi dan analisis nutrisi tanaman gedi (*Abelmoschus manihot* L. Medik) asal Distrik Sentani dan Distrik Kemtuk, Kabupaten Jayapura. Skripsi. Fakultas Pertanian dan Teknologi Pertanian. Universitas Negeri Papua Manokwari (In Indonesian Language).

Lin-lin W, Xin-bo Y, Zheng-ming H, He-zhi L, Guang-xia W. 2007. In vivo and in vitro antiviral activity of hyperoside extracted from *Abelmoschus manihot* (L) Medik. Acta Pharmacologica Sinica. 28(3):404-409. doi:10.1111/j.1745-7254.2007.00510.x.

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Morphological diversity and the cultivation practice of *Abelmoschus manihot* in West Papua, Indonesia

Abstract

Papua is considered to be the second diversity centre of this plant; however, its diversity is declining, due to habitat destruction for regional development or land fragmentation, and hence aibika preservation is a priority. This study aimed to assess the status of aibika (*Abelmoschus manihot* L. Medik) diversity by collecting, preserving, conducting aibika morphological characterization and preliminary assessment of its cultivation technique. Diverse germplasm can then be used to improve aibika. The study was conducted between April and June 2015 in Mandopi, Warmare, Prafi of Manokwari Regency and in Minyambouw of Arfak Mountain Regency. Descriptive method was used in this study, and the relationships among cultivars were analyzed according to Cluster Analysis using Excel Stat. Phenotypes, comprising 29 morphological characters, were recorded for cluster analysis. There were 39 aibika cultivars collected from 4 locations of West Papua. Based on the UPGMA dendrogram, it was revealed that two primary clusters (A and B) separating separate the cultivars. Cluster A clearly separated from Cluster B at a dissimilarity value of about 0.57 (57%). Around 3.3 (33%) of variance separated the cultivars into four groups, consisting of cluster A, B1, B2, B3. Location IV (MAD-01, Man-9, Man-11, Minyam-03, Imbenti-02, SP-02) is the most diverse area which consisted of cultivars of three different clusters. In Papua, aibika is cultivated in a traditional mixed-cropping system, without appropriate planting distance, fertilizer and pesticide application. This has resulted in suboptimal growth and high susceptibility to pests.

Keywords: *Abelmoschus manihot* L. Medik, aibika, gedi, leafy vegetable, morphology, diversity.

INTRODUCTION

Papua is known to have enormous crop diversity; however, there has been a lack of scientific study in this area. Among the biodiversity that has received little attention is Aibika or Gedi in Indonesian language. Aibika is perennial tropical shrub and belongs to the family Malvaceae. This plant originated in China, then spread through India, Papua, South Pacific islands, and northern Australia (Zeven and Zhudwosky 1980). The greatest diversity is found in Papua New Guinea, the Solomon Islands and Vanuatu (Kambuou et al. 2003). The plants show great variability in leaf shape and size, petiole and stem colour, branching and flowering characteristics. Therefore, the island of Papua is estimated to have a wide variety of this plant. Most Papuan food gardens are planted with a number of gedi cultivars, which can be distinguished by leaf shape and petiole colour differences.

Aibika is among the popular leafy vegetables consumed by Papuan people and communities in other eastern parts of Indonesia. The edible part of aibika is the young shoot tip or succulent young

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leaves. It is cultivated extensively and throughout the year in some Melanesian countries for its highly nutritious leaves and shoots tips (Kambuou et al. 2003). Aibika is reported to contain high nutrients; especially protein and micronutrients (Westwood and Kesavan 1982; Yalambing et al. 2015). Nutritionist (Susan Parkinson) in her personal communication with Westwood and Kesavan (1982) suggested that every household in the South Pacific region cultivate this plant. This plant is also used as a traditional medicine by indigenous people throughout the island of Papua and the Pacific islands region, for relieving kidney pain, reducing high cholesterol, treating pregnant women to ease childbirth, stimulating lactation, treating diarrhea, and protecting against osteoporosis. Because of the secondary metabolites present in the plant, particularly antioxidants, it is efficacious in contributing to the prevention of some diseases (Hodgson et al. 2006; Puel et al. 2005; Goebel et al. 2010).

In some parts of India, Aibika is used as a source of traditional medicine for kidney pain, heartburn, high cholesterol, osteoporosis, as well as to induce labour in pregnant women (Todarwal, et al. 2011). The flowers of *A. manihot* have been used as a traditional Chinese medicine for the treatment of chronic renal disease and diabetic nephropathy (An et al. 2011). Aibika has drawn much attention recently due to its potential beneficial health effects. Studies on aibika have led to the isolation of two main kinds of plant secondary metabolites, flavonoids and alkaloids. Aibika contains quercetin-3-O-robinoside, hyperin, Isoquercetin, gossipetin-8-O-glucuronide, and myricetin (Liu et al. 2006). The flowers contain quercetin-3-robinoside, quercetin-3'-glycosides, hyperin, myrecetin, anthocyanins, and hyperoside. Leaves of Aibika when tested, have been shown to prevent ovariectomy-induced femoral ostopenia (condition of bone mineral density lower than normal range in the joints limbs as a result of surgical removal of the uterus / ovaries) (Lin-lin et al. 2007; Jain et al. 2009). Aibika can also improve the function of glomerular filtration, reduced proteinuria, hyperplasia messangium which can reduce the damage of kidney tissue (Shao-Yuetal., 2006). Flavonoids in Aibika have many important functions for health, including reducing the risk of cardiovascular disease, hypertension, atherosclerosis, and as an antioxidant (Hodgson et al., 2006), and it is an important cash crop in local markets in Melanesia (Preston, 1998).

According to Westwood and Kesavan (1982), aibika is a highly productive plant vegetable which is highly adapted to the lowlands up to an altitude of 800 m height above sea level. It is also cultivated in higher altitude areas above 2000 m with annual rainfall of more than 2000 mm (Paofa and Kambuou 2006). Aibika grows throughout the year and provides a continuous supply of highly nutritious leaves and shoot tips. Karafir and Vokames (2003) reported that there are 7 cultivars of aibika in Nimboran district and 6 cultivars in Kemtuk district of Papua. This diversity can be seen from the shape and size of leaf, petiole and stem colour, branching and flower characters. However, it has been reported to be in decline in recent years, probably due to rapid development, land fragmentation and global climate change (Kayadu 2013). Comprehensive studies on Aibika need to be done, as research on this plant is still limited.

The objective of the study was to observe the morphological diversity of Aibika through exploration, identification and collection. This study is expected to enrich the understanding of the diversity of aibika and prevent the loss of the genetic base of this plant. The research was also aims to assess the cultivation techniques applied on aibika by the local farmers.

MATERIALS AND METHODS

Study area

Exploration of aibika was carried out from May to June 2015 in the lowland areas of Mandopi, Warmare, Prafi and the highland areas of Arfak (Minyambouw), West Papua, Indonesia (Figure 1). Exploration in each of these areas of known distribution was done to collect all cultivars of aibika.

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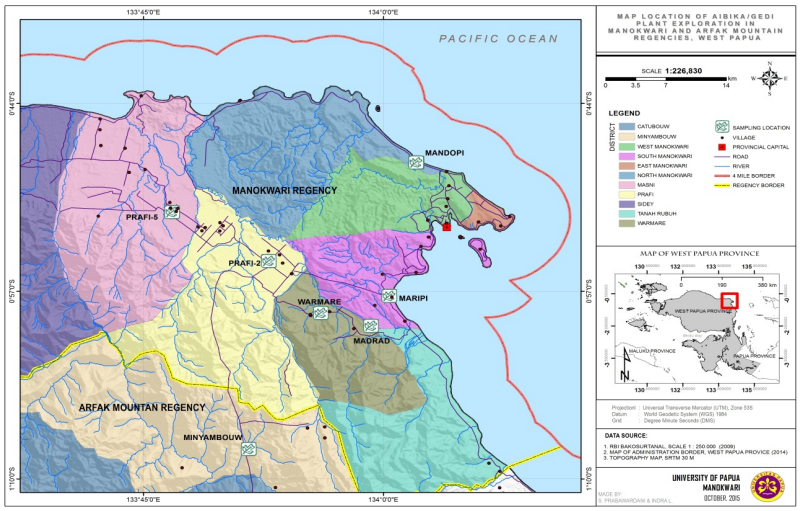

Figure 1. Map of exploration sites of aibika in Mandopi, Warmare, Prafi (lowland areas of Manokwari) and Minyambouw (highland area of Arfak), West Papua

Methods

Descriptive method with a direct observation technique was applied in this research. Additionally, interviews with residents and local tribe leaders were conducted to determine the cultivars of aibika, local names and cultivation of aibika. Traditional aibika cultivation methods (including land preparation, planting and maintenance) were recorded.

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Procedures

Characterization was performed in the field at each location. The identification of aibika was based on morphological characters, using descriptor list by Kambuou et al. (2003). The morphological characters of aibika consisted of stem (pith, hairiness, internode length, diameter, primary stem colour, secondary stem colour, stem pigmentation, branch number); leaf (leaf shape, leaf segment shape, margin, leaf tip, leaf base, leaf shape variability, leaf lustre, leaf vein colour, petiole colour, petiole length. However, no flowers were observed, due to frequent pruning. Morphological characters were taken from aibika plant samples which aged from 6 to 9 months (plants were still in productive age).

The collected cultivars were taken from farmer's gardens for the purpose of *ex situ* collection or preservation in the experimental field of the Agriculture Faculty, the University of Papua, Manokwari.

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Data analysis

Data on the morphological diversity were analyzed using Unweighted Pair Group Method with Arithmetic UPGMA method using Excel stat program.

RESULTS AND DISCUSSION

Morphological diversity of aibika

During the exploration, 36 aibika cultivars were collected from 4 locations. Location I was Mandopi where 16 cultivars were found, denoted Man-01 - 16. Location II was Warmare, where 9 aibika cultivars were collected, namely MARI-01 - 05, MAD-01 - 04. Location III was the transmigration area of Prafi, where 5 cultivars were found, namely SP1-01 - 03, SP5-01 - 02. Location

IV was the highland area of Arfak (Minyambouw), where 6 cultivars were collected; Imbenti-01, Imbenti-02, Minyambouw-01, Minyambouw-02, Minyambouw-03, Ungga-01.

Based on the identification at 4 locations, the diversity of the morphological characters of aibika was not only revealed at the individual among different locations (among population), but it was also observed in individuals at the same locations (within population).

The magnitude of morphological characters within population and between aibika populations was perceived based on similarity or dissimilarity levels of morphological characters using cluster analysis with Unweighted Pair Group Method with Arithmetic (UPGMA). Based on this method, individuals, or population that have similar morphological characters were collectively or closely clustered. The cluster pattern of individuals or population is based on the similarity matrix, which is described by dendrogram with the character's dissimilarity distance lay between 0.00 (0%) and 1.00 (100%).

The UPGMA dendrogram resulting from the fusion matrix based on dissimilarity model revealed two primary clusters (A and B) separating the cultivars (Figure 1). It is evident that Cluster A (Mad-01, Man-09, Man-11—Minyam-03, Imbenti-02, SP1-020 clearly separated from Cluster B at a dissimilarity value of about 0.57 (57%). Around 3.3 (33%) of variance separated the cultivars into four groups, consisting of cluster A, B1, B2, B3. However, if 0.2 (20%) dissimilarity was used to distinguish the cultivars, eight groups were recognized. The groups were A1, A2, A3, B1a, B1b, B2, B3a and B3b. The members of Cluster A were the most widely distributed cultivars which can be found in all locations including I, II, III, and IV. The cultivars of cluster B3 were spread out in three locations (II, III, IV). Meanwhile, the cultivars of cluster B1 only grow in location I. It also can be noted that location IV is the most diverse area which consisted of cultivars of three different clusters which were Imbenti-02, Minyambouw-03 (cluster A), Minyambouw-01, Minyambou-02 and Ungga-01 (cluster B2), and Imbenti-01 (cluster B3). The diversity of aibika occured as a consequence of differences in morphological characters of plant organs.

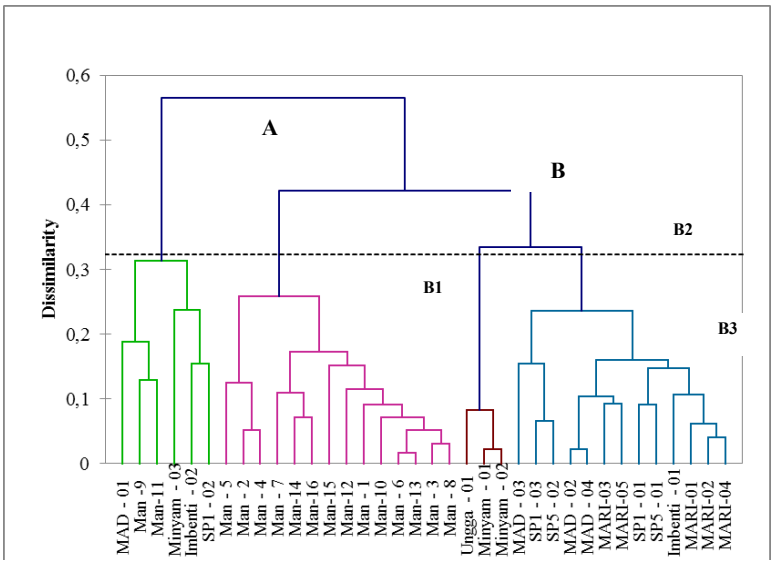

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Figure 2. Dendogram showing the dissimilarity relationship of Aibika cultivars collected from 4 different locations in Mandopi, Warmare, Prafi (lowland areas of Manokwari) and Minyambouw (the highland area of Arfak)

Based on the identification, the most prominent diversity of morphological characters among locations or among population within a location were leaf shape characters and length, plant height, stem colour and diameter, internode length, petiole length and colour. Each cluster generated sub clusters of population based on the same growth location, except cluster A. It shows that individuals from the same location or close location were clustered in proximity or in a close distance. This cluster pattern suggests a closer genetic relation among population of similar areas compared to different locations. It means that each location has unique plant characters, and therefore 3 populations of aibika are indigenous in each original location. This phenomenon supports the theory that the closer the geographical areas between two individuals or population, the shorter the genetic distance between those individuals and population. However, cluster A consisted of cultivars from diverse areas, probably was due to the migration of people who brought the genetic material of aibika from one location to another, resulting in diverse cultivars in cluster A.

The different characters of aibika among locations were due most likely to the ecological and geographical isolation (ecogeographic). Ecogeographic isolation is induced by the external factors such us climate, water, soil and topography. These factors function as a catalyst in inducing a barrier for gene exchange among populations, and hence each population in a particular ecosystem provides unique characters in each region.

Individuals or plant populations that are separated because of ecological isolation have specific habitats and specific environments. From this point of view, succeeding populations will not be adaptive if grown in a different habitat from those of the parents. They will only grow in a similar parent habitat or in between habitats of both parent populations (Grant, 1971).

Different characters among individuals in one species, apart from environmental factors or geographical isolation, are also induced by migration, mutation, and hybridization. The migration of individuals or plant populations from one continent to another, or from one location to another, and followed by geographical isolation and hybridization, may result in gene flow. Gene flow among plant populations increases the consequences of evolution and also may increase the character diversity. These create new gene combinations, raising the adaptability in location from one to other population (Nagi, 1997).

Traditional cultivation of aibika

In general, aibika is traditionally cultivated, and has not been grown in accordance with common agronomical practice. The cultivation system observed during the study consist of land clearing, preparation of planting material, planting method, maintenance, and harvesting.

Land clearing is usually carried out when farmers make a new garden, as they practise shifting cultivation. This activity is done by cooperation of the family members. The gardens which are located 2-3 km from their home generally belong to the family members. The crop field area is divided among members of the nuclear family or blood relatives. So, plot size for each family member in one field crop area depends on the size of a field crop area. For field crop areas, farmers first clear grass or shrubs, then large trees are burned, which takes about 5 days for large gardens or 2-3 days for smaller gardens. Summer is a good time to dry the remaining plants, as they will dry and decompose more quickly. Farmers believe that the ash remaining after burning increases the soil nutrient availability. When a new garden is opened, the previous land is rested (fallowed) after being used 3 to 4 times.

Minimum tillage is practiced by Arfak people in their field crop area, where after completing burning and cleaning trees, farmers directly plant aibika by using wooden drills. Equipment such as

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axes and machetes are used to cut wood and make fences. A crowbar is used to move large rocks and remnants of the roots of trees that remain in the field.

Preparation and Planting Material

Aibika is generally propagated using stem cuttings. Some farmers also cut old or unproductive aibika and leave the primary stem in the field to regrow a new shoot. According to farmers, all parts of the trunk or branches can be used as planting materials, but it is best to use a stem or branch that is not too young and not too old. If the cuttings are taken from the old trunk or branch the plant will grow slowly. The length of cuttings used by farmers is 30-40 cm (with 4-6 nodes). Cuttings are usually taken from the top and middle portions of healthy, mature stems. Stems are planted directly in the field. Between 2 and 3 nodes are buried, depending on the length of the cutting. The number of cutting per hole is around 3-4 cuttings. Irrigation depends on rainfall.

Planting

Aibika is cultivated in subsistence and semi-subsistence gardens. When planting time coincides with the beginning of the rainy season, aibika growth will be faster. However, waterlogged soils will slow aibika growth.

Cultivation system practised by the local farmers in all studied locations is mixed-cropping. Aibika is commonly intercropped with a number of other food crops such as root crops, banana and various vegetable crops. With a cropping pattern like this, plant spacing is not applied on a regular basis, but a few farmers use spacing of 100 × 100 cm for aibika. The tool used to make holes for planting is made from a wood stick with a length of about one metre. No fertilizer is used for improving the growth of aibika.

Maintenance

Aibika plants are not intensively maintained after cuttings are planted. Plant maintenance is generally done earlier when the stem is newly planted. Cuttings will begin to produce shoots about 2 weeks after planting. Once the plants grow, farmers rarely maintain them, except for clearing grass at uncertain time intervals. Pruning is done to produce more young leaves and with an intention that aibika plants do not grow too high to facilitate harvesting. Pruned leaves are taken for home consumption. Farmers usually only clean weeds around aibika plants.

Aibika pests that attack crops are mostly grasshoppers, caterpillars and aphids. Grasshoppers damage the surface of the leaves, while the caterpillars cause shoots to curl. The level of damage caused by pests is very high under shaded conditions and reduce the quality of aibika leaves. Most farmers do not regularly clean up the aibika garden to prevent pest infestation.

Harvest

Aibika plants have the advantage of being able to be grown throughout the year, and hence it is classified as an annual plant. As stated by Goebel et al (2010), this plant can be grown all year in most tropical locations but growth often slows with cooler, shorter days and drier conditions.

Based on information from respondents, aibika is usually first harvested at 3 months after planting in the lowland areas, and about 6 months after planting in the Arfak highland. Aibika grown in the highland generally have shorter stems, narrower leaves, shorter internodes and petiole lengths than those found in lowland locations.

Aibika is generally harvested by picking young shoots and directly processing (cooked or sold in the local market). Storage for too long will cause aibika leaves to wither and suffer damage. The productivity of aibika plants usually declines after 2 years.

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Figure 3. Aibika cultivars with deep lobe leaf was marketed as leafy vegetable (A), and less marketed cultivar due to highly sap content (B)

In conclusion, aibika is grown widely in the lowlands of Manokwari. Of the 39 cultivars collected from 4 areas, 16 cultivars were present in the northern part of Manokwari, West Papua. Aibika is also grown in the highland areas of Arfak as shown by the 6 cultivars collected from this area. Aibika is traditionally cultivated in most gardens of local Papuan farmers. There are no agronomic inputs and maintenance in cultivating this plant, resulting in suboptimal growth and high susceptibility to pests. Further research is needed to develop this plant, particularly in cultivation techniques and nutritional aspects.

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ACKNOWLEDGEMENTS

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REFERENCES

An Y, Zhang Y, Li C, Qian Q, He W, Wang T. 2011. Inhibitory effects of flavonoids from *Abelmoschus manihot* flowers on triglyceride accumulation in 3T3-L1 adipocytes. Fitoterapia 82: 595–600. doi:10.1016/j.fitote.2011.01.010

Goebel R, M. Taylor M, Lyons G. 2010. Leafy green vegetables in the tropics. Feasibility study on increasing the consumption of nutritionally-rich leafy vegetables by indigenous communities in Samoa, Solomon Islands and Northern Australia. Factsheet No. 1. The Australian Centre for International Agricultural Research (ACIAR). Canberra.

Grant, V. 1971. Plant speciation. New York: Columbia University Press.

Hodgson JM, Kevin DC. 2006. Review dietary flavonoids: effects on endothelial function and blood pressure, Journal of Science of Food and Agriculture. 86:2492-2498. DOI: 10.1002/jsfa.2675.

Jain PS, Bari SB, Surana SJ. 2009. Isolation of stigmasterol and (-sitosterol from petroleum ether of woody stem of *Abelmoschus manihot*, Asian Journal of Biological Sciences. 2(4): 112-117. doi: 10.1590/S0102-695X2010005000009

Kambuou R, Paofa J, Wisnton R. 2003. Passport information and minimum descriptor list for Albika (*Abelmoschus manihot* L. Medik). Crop Descriptor List No. 1. National Agricultural Research Institute (NARI). Papua New Guinea.

Karafir, YP, Vokames J. 2003. Mengenal sayur lilin dan sayur gedi serta pemanfaatannya dalam diversifikasi menu oleh penduduk distrik Nimboran dan sekitarnya. Prosiding Lokakarya Pangan Spesifik Lokal Papua.

Kayadu N. 2013. Karakterisasi agroekologi dan analisis nutrisi tanaman gedi (*Abelmoschus manihot* L. Medik) asal Distrik Sentani dan Distrik Kemtuk, Kabupaten Jayapura. Skripsi. Fakultas Pertanian dan Teknologi Pertanian. Universitas Negeri Papua Manokwari (In Indonesian Language).

Lin-lin W, Xin-bo Y, Zheng-ming H, He-zhi L, Guang-xia W. 2007. In vivo and in vitro antiviral activity of hyperoside extracted from *Abelmoschus manihot* (L) Medik. Acta Pharmacologica Sinica. 28(3):404-409. doi:10.1111/j.1745-7254.2007.00510.x.

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Nagy ES. 1997. Frequency-dependent seed production and hybridization rates: Implications for gene flow between locally adapted plant populatian. Evolution. 51(3):703-714. doi: 10.2307/2411147

Preston SR. 1998. Abika / Bele. *Abelmoschus manihot* (L.) Medik. Promoting the conservation and use of underutilized and neglected crops. 24. Institute of Plant Genetics and Crop Plant Research, Gatersleben/International Plant Genetic Resources Institute, Rome, Italy.

Puel C, Mathey J, Kati-Coulibaly S, Davicco MJ, Lebecque P, Chanteranne B, Horcajada MN, Coxam V. 2005. Preventive effect of *Abelmoschus manihot* (L.) Medik on bone loss in the ovariectomised rats. Journal of Ethnopharmacology. 99: 55–60. doi:10.1016/j.jep.2005.01.047.

Shao-Yu Z, Nai-Ning S, Wen-Yuan G, Wei J, Hong-Quan D, Pei-Gen X. 2006. Progress in the treatment of chronic glomerulonephritis with traditional Chinese medicine. Asian Journal of Pharmacodynamic and Pharmacokinetics. 6(4): 317-325.

Todarwal A, Jain P, Bari S. 2011. *Abelmoschus manihot* Linn: ethnobotany, phytochemistry and pharmacology. Traditional Medicines. 6:1-7.

Westwood V, Kesavan V. 1982. Traditional leafy vegetables of Papua New Guinea. Aibika (*Hibiscus manihot* L.). In: RM Bourke and V Kesavan (eds). Proceeding of the Second Papua New Guinea Food Crops Conference, 1980. Part 2

Yalambing LR, Arcot J, Greenfield H, Holford P. 2015. Aibika (*Abelmoschus manihot* L.): Genetic variation, morphology and relationships to micronutrient composition. Food Chemistry (2015). http://dx.doi.org/10.1016/j.foodchem.2014.08.058.

Zaven, AC, Zhukovsky PM. 1980. Dictionary of cultivated plants and their centres of diversity. New York.