Economic potential and local varieties registration of Bacan Avocado from South Halmahera Regency, North Maluku

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Abstract. Avocados in Bacan Island, South Halmahera Regency, and North Maluku are local accessions with advantages and the potential to be used as local superior varieties. Efforts to preserve and manage avocados in Bacan Island are carried out by characterization, identifying their uses, and documenting them. Variety protection involves a registration process at the Center for Plant Variety Protection and Agricultural Licensing (PPVTPP) of the Ministry of Agriculture to obtain a certificate of local variety ownership. The aim of this research is to determine the morphological characteristics and economic value of Bacan avocado. The characterization and inventory process were carried out from April to October 2021 in Kampung Makian Village, South Halmahera Regency. Morphological identification includes quantitative and qualitative characteristics of plant parts, stems, leaves, flowers, fruits, and seeds based on IPGRI avocado description guidelines. Complete data and information on plant characteristics are recorded in standard forms and registered to PPVTPP. The results show that the avocado with the local name Afokat Bacan was registered as a local variety on 23 December 2021 with ownership certificate number 1816/PVL/2021. Afokat Bacan has economic value and is prospective in business development in North Maluku as a source of income and providing employment opportunities for the community. The potential economic value of avocado production in North Maluku in IDR. 27,348,000,000/ year.

1 Introduction

Avocado is a tropical fruit with a unique taste, soft texture, and rich in nutrients such as vitamins, minerals, and healthy fats which have many health benefits [1]. This oil-rich fruit is prized worldwide for its nutritional benefits and bioactive ingredients [2]. The development of avocados in Indonesia has high consumption of avocados globally and market demand which continues to increase every year. In 2022, avocado production in

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North Maluku that reach 683,7 tons, this number has increased by 8,7% compared to production in 2021, that is 629,2 tons [3]. North Maluku has suitable agroecological conditions for avocado growth and production. One of the avocados producing centers in North Maluku is Bacan Island, South Halmahera Regency. The avocados were widely cultivated both in yards and gardens along with other plants. Based on 2023 BPS data, avocado production in South Halmahera Regency is 61,6 tons. Apart from agroecology, the development of avocados in North Maluku is supported by people's purchasing power. The selling price of avocados is quite expensive, making avocados a strategic and economically valuable commodity.

North Maluku, which is located in east of the Wallace line, is thought to have high genetic resource potential [4] and has a comparative advantage for the growth of horticultural plant diversity [5]. The existing avocado population on Bacan Island shows indications of genetic variation. The extensive genetic diversity in genetic resource provides great opportunities for improving plant genotypes [6]. Plant breeders can utility various genetic resources to produce new and improved cultivars with traits desired both farmers and breeders [7]. Increasing genetic diversity is one of the crucial factors in the process of plant breeding to produce superior varieties [8]. There are indications that the diversity of avocado on Bacan Island is a potential agricultural local genetic resource that is useful for developing new varieties. Information on the diversity and status for the management and use of agricultural local genetic resources to realize community welfare [5].

The existence of germplasm with wide genetic diversity is very necessary in efforts to genetically improve plants. Avocado on Bacan Island are one of the local accessions that have the advantage of being used as superior varieties. Efforts that can be made in managing local genetic resource of avocado on Bacan Island are by characterizing the plant, identifying its use by the community, and documenting it. According to [9], evaluating germplasm evaluating germplasm characters plays an important role in breeding programs that identify the characters and relationships of germplasm with differences in visual appearance, so that it can facilitate genetic handling. The morphological characteristics of plants can be qualitative or quantitative [8]. Morphological characterization plays a role in germplasm conservation efforts, so that continuity of information on avocado plant diversity can be documented. Bacan avocado holds unique potential such as distinct local variety, economic growth opportunity, agricultural innovation, branding, and support the environmental and sustainable development. The economic potential of Bacan avocado has not been widely disclosed, especially for local varieties of avocado from North Maluku and eastern Indonesia. Characterization and registration of avocado varieties on Bacan Island is very necessary to reveal the potential for species diversity and their economic value. Registering Bacan avocado as a local variety thus supports local agriculture, enhances marketability, and contributes to South Halmahera's economic and environmental sustainability. The aim of this research is to determine the morphological characters and economic value of avocados from Bacan Island, South Halmahera Regency.

2 Research method

Inventory and characterization activities for avocados in South Halmahera Regency were carried out at the Bacan Experimental Garden from April – October 2021. Morphological identification is the main requirement for obtaining a variety ownership certificate based on avocado descriptions from the International Plant Genetic Resources Institute (IPGRI) [10] and guidelines for registration and descriptions of horticultural varieties from the Directorate General of Horticulture. The documentation refers to the Minister of

Agriculture Regulation No. 01/Pert/SR.120/2/2006 concerning naming requirements and procedures for registering plant varieties by including the nature and expression of each characteristic contained in the parts of the plant. Characters observed include the external appearance of the tree (plant height, type of tree and roots, crown, trunk circumference, and trunk texture), plant stem (type of branching, shape, branch angle, bark color, trunk texture, and branch distribution). Leaf morphology observations were carried out by observing leaves collected randomly from sample trees based on leaf length and width, leaf color, leaf shape, number and relief of leaf veins, texture, aroma and angle of leaf stalks. The flower characters observed include the beginning of the flowering season, flower type, color, stalk length and flowering time. The fruit character data observed consisted of fruiting time, fruit type, fruit shape, fruit size, fruit color, fruit stalk, fruit stalk color, fruit flesh color, fruit flesh thickness, fruit taste and texture. Seed observations were carried out by measuring the size and shape of the seeds, the position of the seeds in the fruit, the surface and attachment of the cotyledons, and the color of the seeds. Observations on the color of stem bark, leaves, flowers, fruit and seeds are determined using the RHS (Royal Horticultural Society) color chart.

Information obtained by observation and interviews is used as general data, while data on plant characteristics is obtained by direct observation and measurement of the research object. Complete general data and information on plant characteristics are recorded in a standard form and registered with the Center for Plant Variety Registration and Agricultural Licensing (PVTPP) of the Ministry of Agriculture. Economic potential data was calculated based on the production value multiplied by the selling price applicable in South Halmahera Regency and North Maluku during 2021. The production value was obtained based on data from the BPS of North Maluku Province in 2023.

Table 1. General information, plants and stems of Afokat Bacan

Group Determination	**Description**
General Information	
Common name	Avocado
Local name	Afokat Bacan
Propagation	Seed, grafting
Number of collections	42
Growing place	Gardens and yards
Agroecosystem	Lowland, dryland with wet climate
Distribution status	Developed since the 1980s and spread across Bacan Island
Site identification	Bacan Experimental Garden, Kampung Makian Village, South Bacan District, South Halmahera Regency, North Maluku Province
Plants Information	
Height	15 – 20 m
Tree type	Columnar
Rooting type	Tap root
Header width	5 – 7 m
Trunk circumference	124 cm
Trunk surface	Rough
Trunk	
Branching type	Intensive
Branching form	Ascendant
Branch angle	Acute
Branching distribution	Yellow green group 144
Color of young twigs	Smooth
Surface of young twigs	Ascendent

3 Results and discussion

3.1 Morphological characterization of Afokat Bacan

Morphological characters are the main requirement for obtaining a local variety ownership certificate. Delays in local genetic resources management could leave North Maluku province behind in the competition to maintain germplasm. According to [5] data and information related to the local genetic resources diversity of North Maluku has not been managed optimally. A small portion of the genetic resources are managed by AIAT North Maluku, universities and other agencies in a limited way in systems and databases that are still diverse and not integrated with each other, and cannot even be accessed by the public, even though this information has been managed for years. The lack of an access system raises concerns that the local genetic resources of North Maluku and the traditional knowledge that has existed in the community for generations will disappear. [8] stated that efforts to preserve plant genetic material were carried out through a number of activities in the form of exploration, characterization and documentation as guidelines for genetic resources management in breeding programs to anticipate the erosion of germplasm.

The results of the inventory and characterization (Table 1) show that avocado has been growing on Bacan Island since the 1980s and is known by the local name Afokat. Propagation of avocado seeds is done by seeds or grafts and is widely cultivated by people in their yards or gardens. [11] stated that the diversity of plant growth, both tree height and trunk diameter, is influenced by environmental factors. Afokat Bacan has a tree height of around 15-20 m with a canopy width of + 5-7 m. This type of tree is a columnnar type, has a tap root and a trunk circumference of up to 124 cm with a rough trunk surface. The branching type is intensive with an ascendant branching form. The quantitative characteristics of Bacan Avocado plant and stem parts are not too affected by environmental conditions so that visually they are not much different from other avocado varieties. Morphological identification of plants is often the first way to recognize plant types [12], wide variations in leaf shape and stem surface roughness, show the diversity of avocado trees in Tanzania [13].

Table 2. Leaves and flower information of Afokat Bacan

Group Determination	Description
Leaves	
Leaf length	17.88 cm
Leaf width	11.20 cm
Old leaf color	Green group NN 137
Leaf shape	Oblong – lancelote
Leaf base shape	Acute
Leaf petiole shape	Acute
Leaf margins	Entire
Number of leaf vines	13
Leaf vein relief	Raised
Leaf tip shape	Very acute
Leaf texture	Rather rough
Leaf aroma	Medium
Flowers	
Beginning of flowering time	October
Flowering time	October – November
Flower type	Type – A
Flower color	Yellow green group 150 B
Flower stalk length	± 2.1 cm

Diversity within one plant species can occur due to genetic and environmental factors [14]. The appearance of the quantitative characters of Bacan Avocado in Table 2 shows the difference in flowering and harvest times with avocados in other regions in Indonesia. Bacan Afokat flowers in October-November with the main harvest season ranging from March-April. The difference in flowering time is due to differences in climatic conditions which are related to the time the flowers appear. [15] stated that temperature conditions influence the time cycle of avocado flowering.

The qualitative character appearance of Bacan Avocado in the leaves (color, shape, texture, stem angle, and aroma) and flower parts (type and color) in Figure 1 shows a visual appearance that is relatively the same as avocados in general. In line with [16] who stated that genetics in a plant can be expressed optimally if the plant grows in a suitable environment. This can be seen from the condition of Afokat Bacan which can grow optimally on Bacan Island supported by suitable agroecosystem conditions.

Fig. 1. Appearance of Afokat Bacan (a) and (b) leaves, (c) flower, (d) fruit and seed, (e) the tree

Plant characters that fall into narrow variability include fruit size, while characters that fall into rather narrow variability include leaf length and fruit weight [17]. Afokat Bacan has a fruit weight and size that is characterized by a rather narrow variability. The average weight of Afokat Bacan fruit ranges from 541 - 991.6 g, with a fruit length of 17.54 cm and a width of 11.15 cm (Table 3). The fruit found and characterized was relatively not much different, however, there were 2 forms of fruit found at the location, namely obovate (Afokat Bacan) and round. [18] stated that if the variability of a character is narrow, then the individuals in the population are almost uniform and there is little possibility that character improvement can be carried out through selection.

3.2 Morphological characterization of Afokat Bacan

Local varieties spread throughout Indonesia are genetic resources as assembly material to obtain new superior varieties and quality seeds [19]. Utilizing good local varieties will encourage the emergence of new superior varieties that farmers need. The active role of all parties is needed in efforts to preserve and protect germplasm nationally. AIAT North Maluku and related stakeholders have carried out an inventory and characterization of Bacan avocados which have superior characteristics and potential for development. Afokat Bacan is a local superior variety that has been registered with the PPVTPP. The certificate of ownership of the local variety Afokat Bacan (Figure 2) belonging to the regional government of South Halmahera Regency was issued on December 23, 2021, with number 1816/PVL/2021. The existence of this certificate is very important to protect local varieties from illegal names and to fulfill the requirements for variety release.

Table 3. Fruit and seeds information of Afokat Bacan

Group Determination	Description	Group Determination	Description
Fruits		**Fruits**	
Beginning of fruit time	4 years	Fruit flesh texture	Watery
Fruit ripening time	± 3 – 4 months	Fruit sweetness level	Intermediate
Fruit timing	March – April	Fruit bitterness level	Low
Fruit type	Clusters	Nut taste on fruit	Low
Fruit shape	Obovate	Fruit fiber	Low
Plot on fruit	Partial	General fruit taste	Good
Fruit length	17.54 cm	Fruit color change	Light olive brown B
Fruit diameter	11.15 cm	Fruit color changes after 4 hours	Light olive brown B
Fruit weight	541 – 991.6 g	Shelf life	± 1 week
Base shape of fruit	Depressed	Ripening time in storage	± 2 weeks
Fruit tip shape	Rounded	Flesh color near the seeds	Yellow group 5
Fruit tip position	Central	Color of ripe fruit flesh	Brilliant greenish yellow A
Rind	Very shiny		
Fruit stalk position	Asymmetric	**Seed**	
Fruit stalk shape	Conical	Seed shape	Ovate
Stalk diameter	1 cm	Seed diameter	4.5 cm
Stalk length	20 – 21 cm	Seed length	6.5 cm
Presence of an apex shape	Presence	Position of seeds in fruit	Central
Stalk color	Yellow green group 144 A	Empty space between seeds and fruits	Presence
Fruit surface texture	Rather rough	Seed coat	Seed coats attach on fruit
Fruit skin thickness	1 mm	Cotyledon surface	Rather rough
Fruit lenticel size	Small	Cotyledon attachment	Attached
Lenticel density	Dense	Cotyledon color	Red group yellow 49 C

REPUBLIK INDONESIA
KEMENTERIAN PERTANIAN
PUSAT PERLINDUNGAN VARIETAS TANAMAN DAN PERIZINAN PERTANIAN

Tanda Daftar Varietas Tanaman

VARIETAS LOKAL
NOMOR : 1816/PVL/2021

Berdasarkan Undang-undang Nomor 29 Tahun 2000 tentang Perlindungan Varietas Tanaman; Peraturan Pemerintah Nomor 13 Tahun 2004 tentang Penanaman, Pendaftaran dan Penggunaan Varietas Asal untuk Pembuatan Varietas Turunan Esensial; Peraturan Menteri Pertanian Nomor 01 Tahun 2006 tentang Syarat Penanaman dan Tata Cara Pendaftaran Varietas Tanaman, bersama ini kami memberikan Tanda Daftar Varietas Lokal Kepada :

Nama Pemohon	:	**BUPATI HALSEL**
Alamat	:	Jl. Kebun Karet, Kampung Makian, Bacan Selatan, Kabupaten Halmahera Selatan, Maluku Utara
Tanggal Penerimaan Pendaftaran	:	20 Desember 2021
Jenis Tanaman	:	**Alpukat**
Nama Varietas	:	**Afokat Bacan**

Dengan Demikian varietas tersebut telah terdaftar di Pusat Perlindungan Varietas Tanaman dan Perizinan Pertanian, dan menjadi milik masyarakat di wilayah yang bersangkutan sesuai dengan Peraturan Perundang-undangan yang berlaku dan dicatat dalam Daftar Umum PVT, serta diumumkan dalam Berita Resmi PVT.

Jakarta, 23 Desember 2021
Kepala Pusat,

Prof(Riset). Dr. Ir. Erizal Jamal, M.Si.
NIP 196303011989031002

Note: This certificate only available in Indonesian

Fig. 2. Certificate of registration of Afokat Bacan

The lack of attention of policy makers to the role of SDG plant diversity in sustainable agricultural development is more due to the loss of SDGs which have a cumulative and invisible impact on the economy [20]. [21]state that preserving SDG diversity is the responsibility of all parties, including the community and the private sector. Emerging knowledge and new technology have revolutionized the possibilities for collecting, conserving, and utilizing genetic resources for agriculture [22]. For avocados to be grown commercially, accessions or types with better yield and quality must be collected, characterized, and chosen from the existing genetics [23]. Having an economic valuation of the local genetic resources is important as a reference for breeders in developing new superior varieties that meet the preferences of farmers and society. Afokat Bacan is one of the registered local superior varieties from Bacan Island which has economic value and is prospective in business development in North Maluku. Horticultural commodities have high economic value and can be a source of income for farmers, traders and industrial groups [24] in line with increasing demand and public awareness of the importance of fulfilling adequate nutrition [25]. The business potential of avocado agribusiness in North Maluku is very wide open, not only the production of the fruit can be used as a business opportunity, but the provision of superior seeds is a market opportunity in relation to the development of avocados. These business opportunities can be used to open new jobs and increase people's income.

Bacan Avocados, which are a horticultural commodity, provide economic benefits to society and are also ecologically beneficial. Avocado farming has enormous potential for expanding the rural economy [26]. Economically, the development of avocado agribusiness has the opportunity to become a source of income and provide jobs for the community. In traditional markets in North Maluku, the price of avocado is around IDR 15.000 – IDR 20,000 per fruit depending on the size of the avocado, while the selling price of avocado per kg is on average IDR. 40,000- /kg. The average weight of Bacan Afokat ranges from 541 – 991.6 g/fruit and is generally sold in the market at an average of 2 pieces per kg. However, the Bacan Afokat fruit can weigh 1.5 kg per fruit. The Halmahera, Ternate, and Tidore Islands are home to the avocado production centres in North Maluku, according to BPS data from 2023. The estimated economic value of avocado commodities based on total production data [3] is generally shown in Table 4. If the amount of avocado production refers to data for 2023 in North Maluku, then the total estimated economic value of avocado production is IDR. 27,348,000,000. -/year.

Table 4. Estimated economic value of avocado based on production number in North Maluku in 2022

Description	Unit	Information	Value (IDR)
Production	kg	A	683,000
Avocado price	IDR/kg	B	40,000
Total economic value	**IDR/year**	**C = A x B**	**27,348,000,000**

4 Conclusion and recommendation

Afokat Bacan is a local variety from Bacan Island registered with the PPVTPP on 23 December 2021 with number 1816/PVL/2021. The certificate of ownership of the local variety Afokat Bacan is registered in the name of the Regional Government of South Halmahera Regency. Afokat Bacan has economic value and is prospective for business development in North Maluku as a source of income and providing employment opportunities for the community. The potential economic value of avocado production is IDR. 27,348,000,000. /Year.

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