

# Morphological Diversity of Avocados (*Persea americana* Mill.) in Central Aceh, Indonesia

Ismadi Yunus, Rd. Selvy Handayani, Hafifah, Rahmiyati

**Abstract:** Central Aceh is known as a center of avocado production in Indonesia. The information about the morphology of avocados in Central Aceh is still very few due to the lack of researches on avocados in Central Aceh. This study aimed to evaluate the morphology of avocado in Central Aceh, Indonesia. The study was conducted using the description method using an avocado descriptor from the International Plant Genetic Resources Institute (IPGRI, 1995) and data were analyzed using the NTSYSpc. The results revealed that the diversity of avocados in Central Aceh Regency was formed with diversity values ranging from 45-81%, at the level of similarity coefficient 46% of the two main groups: first group consisting of 11 accessions and second group consisting of 4 accessions. In general, the avocado morphology of Central Aceh has similarities in the outer appearance of fruits, stalks, flesh, skin, and seeds.

**Index terms :** fruit shape, pedicel, skin color, seed, gloss

## I. INTRODUCTION

Central Aceh is known as a center of Aceh avocado production. Avocado plantation in Central Aceh District has not been optimally developed and the preservation is unwell preserved even though avocado plants considered as a source of livelihood and economy of the community in Central Aceh. Avocados are widely cultivated in the Gayo highlands, Center Aceh and Bener Meriah at an altitude between 800-1400 m above sea level. Avocado plants have high genetic diversity [1, 2, 3]. This diversity is also believed to be found in Indonesian avocados and it is very beneficial for the cultivation. Unfortunately, the information about the existence of this genetic diversity is still poor because the researches about it are still scanty. Researches on avocado plants in Central Aceh have only been carried out on the characterization of vegetative parts where avocado plants have very diverse characters [4]. Researches on other local Acehnese fruit plants is still very few and so far has been done in durian plants only [5, 6]. The purpose of this study was to analyze the morphological diversity of avocados in Bintang District, Central Aceh Regency.

**Revised Manuscript Received on December 22, 2018.**

**Ismadi Yunus**, Department of Agroecotechnology, Universitas Malikussaleh, Kampus Cot Tgk. Nie Reuleut, Kecamatan Muara Batu, Kabupaten Aceh Utara, Indonesia, 24355. Corresponding author : [ismadi@unimal.ac.id](mailto:ismadi@unimal.ac.id)

**Rd. Selvy Handayani**, Department of Agroecotechnology, Universitas Malikussaleh, Kampus Cot Tgk. Nie Reuleut, Kecamatan Muara Batu, Kabupaten Aceh Utara, Indonesia

**Hafifah**, Department of Agroecotechnology, Universitas Malikussaleh, Kampus Cot Tgk. Nie Reuleut, Kecamatan Muara Batu, Kabupaten Aceh Utara, Indonesia

**Rahmiyati**, Department of Agroecotechnology, Universitas Malikussaleh, Kampus Cot Tgk. Nie Reuleut, Kecamatan Muara Batu, Kabupaten Aceh Utara, Indonesia

## II. MATERIALS AND METHODS.

### A. Place and Time

This research was conducted in Bintang District, Central Aceh, Indonesia from March to June 2017.

### B. Material

The materials used were mature avocados, distilled water, refractometers, analytic scales, scales, vernier caliper, and cameras.

### C. Research Methods

The avocados used were the avocados collected from the previous research which have been characterized and explored in 2016. Observations were done referring to guidelines Descriptors for Avocado (*Persea* spp.) From the International Plant Genetic Resource Institute (IPGRI) [7].

## III. RESULTS AND DISCUSSIONS

### A. Fruit characters

There were 5 forms of avocados found in Central Aceh. The most common form was narrowly obovate. The length was between 7.25 cm - 12.45 cm with an average length of 10.80 cm. The fruit had a width of 7.45-10.57 cm with an average of 9.12 cm. Fruit weight between 374-590 grams with an average weight of 471.85 grams. The uniformity of the fruit form was categorized as medium, with the basic shape was flattened. The apex was generally slightly flattened with the position of apex fruit was symmetrical (Table 1).

### B. Fruit Stalk Characters

For the green fruits, its stalk positions were divided into two types, asymmetrical and central with almost the same amount of stalk. The fruit stalks were almost had conical shape although there were also 2 of 15 of them had rounded stalks and generally the fruit stalks had *nail heads*. The fruit stalk had a length of between 5.60-15.40 cm with an average length of 9.57 cm. The fruit stalk was between 4.10-7.42 cm in diameter and the average diameter is 5.49 cm (Table 2).

## Morphological Diversity of Avocados (*Persea americana* Mill.) in Central Aceh, Indonesia

### C. Fruit Skin Character

The surface of avocado skin in Central Aceh Regency is generally shiny enough although it is also found smooth and rough. The skin color of immature fruits is green and it turns into purple, dark green, red and black when they are mature enough. The lenticel density on the rind divided into three: dense, intermediate, sparse. The skin thickness was between 0.63 to 1.45 cm with an average thickness of 1.18 mm (Table 3). The weight of fruit skin was between 30.79-57.54 grams with an average weight of 43.04 grams. The immature and mature fruits could have the same color, but it could be also different according to the variety of plants [8].

Table 1. Characters of Avocados in Central Aceh, Indonesia

Accession	Fruit Shapes	Lengths (cm)	Width (cm)	Fruit base shape	Fruit apex shape	Fruit apex position	Weight (g)
Gayo BT01	Spheroid	11,48	10,57	Flattened	Slightly depressed	Asymmetric	469,00
Gayo BT02	narrowly obovate	7,25	8,62	Flattened	Slightly depressed	Asymmetric	400,00
Gayo BT03	narrowly obovate	11,25	9,28	depressed	Slightly depressed	Asymmetric	518,00
Gayo BT04	narrowly obovate	12,34	9,91	depressed	Slightly depressed	Asymmetric	590,00
Gayo BT05	Flattened	7,53	8,81	Flattened	Slightly depressed	Asymmetric	397,00
Gayo BT06	Clavate	11,63	9,40	Flattened	Slightly depressed	Asymmetric	514,40
Gayo BT07	narrowly obovate	10,09	7,4	Flattened	Slightly depressed	Asymmetric	405,00
Gayo BT08	narrowly obovate	12,13	8,28	Flattened	flattened	Central	374,00
Gayo BT09	Spheroid	10,46	9,20	Flattened	Slightly depressed	Asymmetric	457,00
Gayo BT10	Flattened	10,26	9,54	Flattened	Slightly depressed	Asymmetric	484,00
Gayo BT11	Spheroid	10,44	8,82	depressed	Slightly depressed	Asymmetric	449,00
Gayo BT12	Spheroid	12,14	9,65	depressed	Flattened	Central	589,00
Gayo BT13	Pyramidal	12,42	8,49	Flattened	Flattened	Central	413,40
Gayo BT14	Spheroid	11,61	10,19	Flattened	Slightly depressed	Asymmetric	540,00
Gayo BT15	Spheroid	10,90	8,65	Flattened	Flattened	Central	478,00
Average/Dominant	narrowly obovate	10,80	9,12	Flattened	Slightly depressed	Asymmetric	471,85

Table 2. Characters of pedicels of Avocados in Central Aceh, Indonesia

Accession	Pedicel position on fruit	Pedicel shape	Nailhead	Pedicel Color	Pedicel Length (cm)	Diameter (mm)
GayoBT01	Asymmetrical	Conical	present	Green	14,20	5,35

Accession	Accession	Shape	Color	Texture	Thickness (mm)	Weight (g)
GayoBT02	Central	Conical	present	Green	10,13	5,09
GayoBT03	Asymmetrical	Conical	present	Green	8,88	5,55
GayoBT04	Asymmetrical	Conical	present	Green	9,40	6,41
GayoBT05	Asymmetrical	Conical	present	Green	8,20	4,91
GayoBT06	Asymmetrical	Conical	present	Green	9,60	4,32
GayoBT07	Central	Conical	present	Green	8,84	4,59
GayoBT08	Central	Conical	Absent	Yellow	9,68	5,61
GayoBT09	Central	Conical	present	Yellow	9,42	5,93
GayoBT10	Asymmetrical	Conical	present	Green	11,94	5,39
GayoBT11	Asymmetrical	Conical	present	Green	5,94	7,42
GayoBT12	Central	Round	Present	Yellow	5,60	5,59
GayoBT13	Central	Conical	Absent	Green	9,47	6,01
GayoBT14	Central	Round	Present	Green	6,80	6,09
GayoBT15	Asymmetrical	Conical	Present	Green	15,40	4,10
Average/Dominant	Asymmetrical	Conical	Present	green	9,57	5,49

Table 3. Fruit skin surface of avocados in Central Aceh, Indonesia

Accessions	Fruit skin surface	Skin Color of Unripe Fruits	Skin Colour of Mature Fruits	Lenticel Density	Fruit Thickness (mm)	Skin Weight (g)
GayoBT01	Intermediate	Dark green	Purple	Sparse	1,09	40,14
GayoBT02	Intermediate	Dark green	Purple	Intermediate	1,45	45,98
GayoBT03	Intermediate	Dark green	Purple	Sparse	1,09	40,14
GayoBT04	Smooth	Dark green	Dark green	Intermediate	1,10	50,97
GayoBT06	Smooth	Dark green	Dark green	Dense	1,19	39,89
GayoBT07	Intermediate	Dark green	Purple	Intermediate	1,18	38,05
GayoBT08	Rough	Dark green	Dark green	Intermediate	1,28	47,55
GayoBT09	Intermediate	Dark green	Purple	Dense	1,90	57,54
GayoBT10	Intermediate	Dark green	Dark green	Sparse	1,10	37,86
GayoBT11	Smooth	Dark green	Purple	Sparse	1,14	42,46
GayoBT12	Intermediate	Light green	Red	Intermediate	1,16	57,72

GayoBT13	Rough	Dark green	Red	Intermediate	1,22	41,15
GayoBT14	Intermediate	Dark green	Dark green	Intermediate	0,86	43,17
GayoBT15	Intermediate	Dark green	Dark green	Intermediate	0,63	30,79
Average/ Dominant	Intermediate	Dark green	Dark green	Intermediate	1,18	43,04

### Flesh Characters

The fruit flesh is yellow and white. The flesh thickness is between 1.40-2.90 cm with an average thickness of 1.78 cm. The flesh weight is between 239.77-446.73 grams with an average weight of 330.75 grams and an average *edible portion* of 71.12%. Fruit flesh had a total dissolved solid of 7.21°Brix, low levels of bitter taste and flesh fiber. Avocado flesh reached 65% of the total weight of fruit [8], and avocados are included in the superior category if the *edible portion* is greater than 65% [9]. The fruit flesh did not change in color after four hours of splitting. The color change of fruit flesh after being left for 4 hours was strongly influenced by the phenolic component in the avocado flesh which causes the avocado flesh to be quickly oxidized, phenol content in avocado reaches  $50,913 \pm 0,424 \mu\text{g/ml}$  [10].

### E. Seed Characters

The seeds of avocados in Central Aceh are various: oblate, heart-shaped and rounded base of rounded tops. The most common color seeds were cream, followed by pink and ivory. Seeds had an average weight of 59.06 grams, seed length and diameter average of 4.41 and 4.63 cm. If the fruit is split, the length and diameter of the seed chamber would be 4.89 and 4.74 cm, respectively (Table 5). Avocado seeds are round like a ball with a diameter of 2.5 to 5.0 cm and white seed reddish pieces [11]. The Central Aceh avocado seeds are predominantly flattened-shaped, rounded apex and cream in color.

### F. Analysis of Avocado Diversity

Cluster analysis is a technique for grouping individuals or objects into certain groups where each object in the same cluster has similarities with each other compared to other cluster members. In particular, the purpose of cluster analysis is to classify sample entities into a small number of specialized groups based on similarities between entities. Cluster analysis is a statistical technique that is useful for grouping objects or variables into certain groups where each object has properties and characteristics that are close together.

Based on scoring data, 15 avocado accessions were obtained by dendrogram as in Figure 1 which formed two main groups at 45% similarity coefficient level. The value of the diversity formed ranges from 45-81%. The grouping done was not based on cultivars and the environment of the growing place but it based on the similarities in the

Retrieval Number: F12480476S519/19©BEIESP

characters used for analysis. The first group consisted of 11 levels of accession which separated at 45% similarity level. The second group consisted of 4 accessions which separated at 51.4% similarity level. Genetically, the type of variety and the place where it is grown are the main factors that influenced the existence of differences and similarities in the characteristics of the dendrogram grouping. A high degree of similarity in plants can occur because they come from the same parent plant. The similarity is said to be insignificant if it is less than 60% and vice versa, the similarity is said to be near if the number approaching 100%.

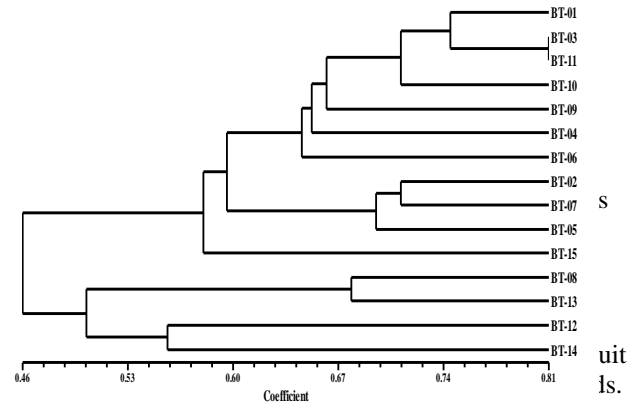
Table 4. Fruit flesh of Avocados in Central Aceh, Indonesia.

Accessions	Flesh Thickness (cm)	Flesh weight (g)	Edible Portion (%)	PTT (°Brix)	Bitterness	Flesh Fiber	Color of fruit after 4 hours
GayoBT01	1,68	346,29	75,39	7,59	Low	Low	Color unchanged
GayoBT02	1,61	317,01	71,71	10,46	Low	Low	Color unchanged
GayoBT03	1,63	397,02	75,83	7,80	Low	Low	Color unchanged
GayoBT04	2,36	446,73	76,26	8,24	Low	Low	Color unchanged
GayoBT05	1,67	262,04	66,50	7,32	Low	Low	Color unchanged
GayoBT06	1,85	360,84	72,94	7,65	Low	Low	Color unchanged
GayoBT07	1,53	289,05	71,38	7,87	Low	Low	Color unchanged
GayoBT08	1,40	239,77	66,35	5,88	Low	Low	Color unchanged
GayoBT09	1,46	299,25	66,26	7,93	Low	Low	Color unchanged
GayoBT10	2,90	289,48	65,86	6,83	Low	Low	Color unchanged
GayoBT11	1,67	327,20	72,60	7,68	Low	Low	Color unchanged
GayoBT12	1,86	401,63	70,22	5,10	Low	Low	Color unchanged
GayoBT13	1,51	266,54	64,58	4,71	Low	Intermediate	Color unchanged
GayoBT14	1,65	381,44	70,35	6,67	Low	Low	Color unchanged
GayoBT15	1,92	336,97	80,59	6,38	Low	Low	Color unchanged
Average/ Dominant	1,78	330,75	71,12	7,21	Low	Low	Color unchanged

## Morphological Diversity of Avocados (*Persea americana* Mill.) in Central Aceh, Indonesia

Accession	Seed Shape	Seed colour	Seed weight (g)	Seed length (mm)	Seed diameters (mm)	Length of Seed cavity (mm)	Diameter of seed cavity (mm)
Gayo BT01	spheroid	Cream	73,33	4,70	5,34	5,09	5,35
Gayo BT02	Base flattened, apex rounded	Pink	89,90	4,85	5,38	5,88	5,44
Gayo BT03	Cordiform	Cream	89,04	5,03	5,41	5,66	5,77
Gayo BT04	Base flattened, apex conical	Cream	66,73	4,80	4,82	6,24	5,79
Gayo BT05	Base flattened, apex rounded	Cream	78,36	4,39	5,10	4,88	5,28
Gayo BT06	Base flattened, apex rounded	Ivory	79,47	4,75	5,21	5,55	5,53
Gayo BT07	spheroid	Cream	56,23	4,18	4,83	4,73	5,05
Gayo BT08	Cordiform	Pink	59,06	4,41	4,63	4,89	4,74
Gayo BT09	Base flattened, apex rounded	Cream	88,52	4,85	5,31	5,66	5,81
Gayo BT10	Flattened	Cream	93,12	4,79	5,62	5,20	5,54
Gayo BT11	Cordiform	Cream	75,28	4,60	5,12	5,21	5,33
Gayo BT12	spheroid	Cream	111,99	5,02	5,58	5,45	5,97
Gayo BT13	Base flattened, apex conical	Cream	85,60	4,73	5,25	5,28	5,48
Gayo BT14	Base flattened, apex conical	Cream	90,90	4,80	5,38	5,36	5,63
Gayo BT15	Base flattened, apex rounded	Cream	74,01	4,90	4,96	5,50	5,13
Average/dominant	Base flattened, apex rounded	Cream	80,77	4,72	5,19	5,37	5,46

Table 5. Character of Avocado Seeds in Central Aceh,



b. Avocado plants in Central Aceh have a low level of diversity where the similarity coefficient ranges from 0.46 to 0.81.

### ACKNOWLEDGEMENTS

We would like to thank the Ministry of Research, Technology and Higher Education of the Republic of Indonesia for funding this research through the PDUPT grant in 2018.

### REFERENCE

1. Accessed on 11 September 2018). SISNI.bsn.go.id/index.php/sni\_main/sni/index\_simple SNI 01-3168-1992 (Accessed on 18 May 2017)
2. 7. Febrianti, Novi dan Muhammad Zulfikar. 2016. *Aktivitas antioksidan buah alpukat (persea americana) dan buah stroberi (Fragaria vesca L)*. Universitas Ahmad Dahlan. Yogyakarta.
3. Balitbu, litbang. Pertanian. 2015.
4. Hasil Penelitian Informasi Teknologi Pengkajian Jenis-Jenis Alpukat (online). <http://www.balitbu.litbang.pertanian.go.id/ind/index.php>, (Accessed on 06 March 2018)
5. 9. Ismadi, Rd. Selvy Handayani, Hafifah, Iqbal Fahrezi, 2018, Exploration and Morphological Characterization of Vegetative Part of Avocado at Bebesan Subdistrict Central Aceh District, Indonesia (<http://www.worldagroforestry.org/sites/treedbs/treedatabases.es.asp>)
6. M.M. Martinez Pacheco, R. Lopez Gomez, R. Salgado Garciglia, M. Raya Calderon, R.E. Martinez Munoz. 2011

1. Griesbach, J. 2005. *Avocado Growing in Kenya*. World Agroforestry Centre, Nairobi, Kenya.
2. Rd SelvyHandayani, Ismadi, 2018. Inventory and Morphological Characterization of Durian (*Duriozibethinus*) in Langkahan and Sawang Sub-District of North Aceh Indonesia, Emerald Publishing Limited.
3. Rd SelvyHandayani, Ismadi, 2017, Analisis Keragaman Kualitas Buah Durian Unggulan (*Duriozibethinus*) Aceh Utara, Jurnal Hortikultura Indonesia.
4. [IPGRI] International Plant Genetic Resource Institute, 1995. Descriptors for Avocado (*Persea* spp). Rome, Italy, International Plant Genetic Resource Institute.
5. Orwa C, A Mutua, Kindt R, Jamnadass R, S Anthony. 2009. *Agroforestry Database: a tree reference and selection guide version 4.0*