BIODIVERSITAS
Volume 13, Number 3, July 2012
Pages: 124-129

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d130304

The exploration and diversity of red fruit (*Pandanus conoideus* L.) from Papua based on its physical characteristics and chemical composition

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Manuscript received: 20 December 2010. Revision accepted: 20 June 2011.

ABSTRACT

Murtiningrum, Sarungallo ZL, Mawikere NL. 2012. *The exploration and diversity of red fruit (*Pandanus conoideus *L.) from Papua based on its physical characteristics and chemical composition. Biodiversitas 13: 124-129.* The aim of this study was to determine the diversity of red fruit based on its physical characteristics and chemical composition. Exploratory survey method and laboratory research (pure experiment) were used to assess the physical character and chemical composition of crude red fruit. Physical character of each accession showed a variation on fruit color (dark red and red); the fruit and single fruit (*drupa*) length ranged from 21-71 cm and 1.2-1.8 cm, respectively. The dried red fruit contains 2.03- 3.50% ash, 3.12-6.48% protein, 11.21-30.72% fat, 43.86-79.66% carbohydrate, 3.78-21.88 mg/100g vitamin C, 2.00-3.14 mg/100g vitamin B1, 0.53-1.11% Ca, 8.32-123.03 ppm Fe, and 0.01-0,33% P, with total carotenoids and total tocopherol ranging from 332.65-3309.42 ppm and 964.52-11917.81 ppm. The clustering analysis result of red fruit based on its physical characteristic and chemical composition showed that the related accessions was U Saem and Tawi Magari, having a 25% similarity. The accession U Saem and Tawi Magari had the highest level of similarity in total carotenoids and total tocopherol. Furthermore, they also perform similar physical characteristics by having triangular cylinder shape, red flesh color, and fruit length category.

Key words: red fruit, *Pandanus conoideus*, accession, physical, chemical, cluster

INTRODUCTION

The genus *Pandanus* is a complex plant with highest species diversity. It is believed that there are approximately 600-700 species of this genus around the world. These plants are prevalent in tropical areas, especially in the Pacific islands, Malaysian islands and Australia (Wagner et al. 1990; Jong and Chau 1998). In Indonesia, a total of 100 species, 60 species and 20 species are found in Papua, Borneo and Maluku, respectively (Purwanto 2007). Some species of the genus *Pandanus* are very important for people whom live in the highlands of the Papua and West Papua Provinces, one of which is *Pandanus conoideus* L. *P. conoideus* is known with different local names in Indonesia, such as pandan seran (Maluku), saun (Seram), sihu (Halmahera), while Papuan call this plan as buah merah which literally means red fruit. This plant is also used by people of Papua New Guinea and it is commonly known as marita (Pidgin) (Stone 1997).

Red fruit grows at wider altitudes ranging from the coast up to 1700 m above sea level (Wiriadinata 1995). These plants spread almost all over of Papua and West Papua territory. However, the tree is predominantly in Jayawijaya Mountains, Jayapura, Manokwari, Nabire, Timika, and Sorong (sub-district of Ayamaru) (Budi and Paimin 2004). Besides the difference of the deployment, red fruit also composed of different accessions, which is used by local people for various purposes. Papua and West Papua society, especially who lives in the surrounding mountains of Arfak and Wamena, utilize red fruit as food. They may consume it directly, or used it as a sauce for sago and sweet potato, or consumed directly (Sadsoeitoeboen 1999).

The diversity of red fruit accession which spread in Papua and West Papua is not yet known. It is probably because the public have not intensively cultivated these plants, and only a few people who has tried to cultivate this crops. The diversity of red fruit accessions can be identified based on their physical characteristics and chemical composition. *Chepalium* of red fruit consists of a tubular (cylindrical) triangle-shaped, bright yellow to dark red with a length of 42-70 cm (100-110 cm), and 9.6-11 cm in diameter (circumference 30-34.5 cm), which is the center of the pedicel *chepalium* white; and composed by many single fruit (*drupa*). Drupa or single fruit has triangular-shape with *pericarp* (layer of single fruit) and contains fat (pulp) yellow or red that is surrounding seed (Walujo et al. 2007). Physical character of a fairly prominent red fruit varies in form of fruit (pericarp), *drupa* size, and color, while its chemical composition varies mainly on the content of carotene, vitamins, and minerals.

The aim of this study was to determine the diversity of red fruit in some areas of Papua and West Papua Provinces based on their physical traits and chemical composition. It can be assumed that by identifying the chemical components in red fruit flesh, there is an opportunity of red

fruit to be utilized as a good source of natural antioxidants for food and non food products.

MATERIALS AND METHODS

The selected areas for exploration were the central areas of red fruit (*P. conoideus*) distribution. Those areas were (i) in the Province of West Papua, Indonesia consisted of Manokwari, Teluk Bintuni, and South Sorong Districts, and (ii) in the Province of Papua, there were Nabire and Jayawijaya Districts (Figure 1). In Manokwari District, sampling was conducted in the Sub-district of Masni representing lowland and Sub-district of Minyambou representing highland. In Teluk Bintuni District, sampling was carried out in the Sub-district of Merdey representing the lowland area. In South Sorong District, sampling was taken in Kampung Susai, Sub-district of Aifat, belonging to middle latitudes. In Nabire District, sampling was performed in Kampung Rawawudo and Kalisemen, Sub-districts of Nabire representing the lowlands; while in the Jayawijaya District sampling conducted in the Sub-district of Kelila which classified as highland.

This study used exploratory survey which was included: (i) inventory of red fruit accessions that are known by the name of their local community, and (ii) observation in the community to examine the use of red fruit based on the society knowledge. After red fruit accessions exploration in every area of research, as much as 1-3 accessions of red fruit which is related to the criteria of most widely grown and consumed by local people was taken as a sample. Moreover, further observations of physical character and chemical composition were performed on selected accessions.

Laboratory analysis was conducted to study the physical characteristics and chemical composition of *drupa*. Observation of the physical characteristics which are consists of the cross-sectional shape of fruit, fruit color, fruit length, and *drupa* length. Analysis of chemical composition on the *drupa* include water content (oven method), ash (furnace method), fat (Soxhlet extraction), protein (micro Kjeldahl), levels of calcium (Ca), iron (Fe), phosphorus (P), vitamin B1 and vitamin C (oxidometry method), and total carotene (spectrophotometry) and total tocopherol (spectrophotometry) (AOAC 1999).

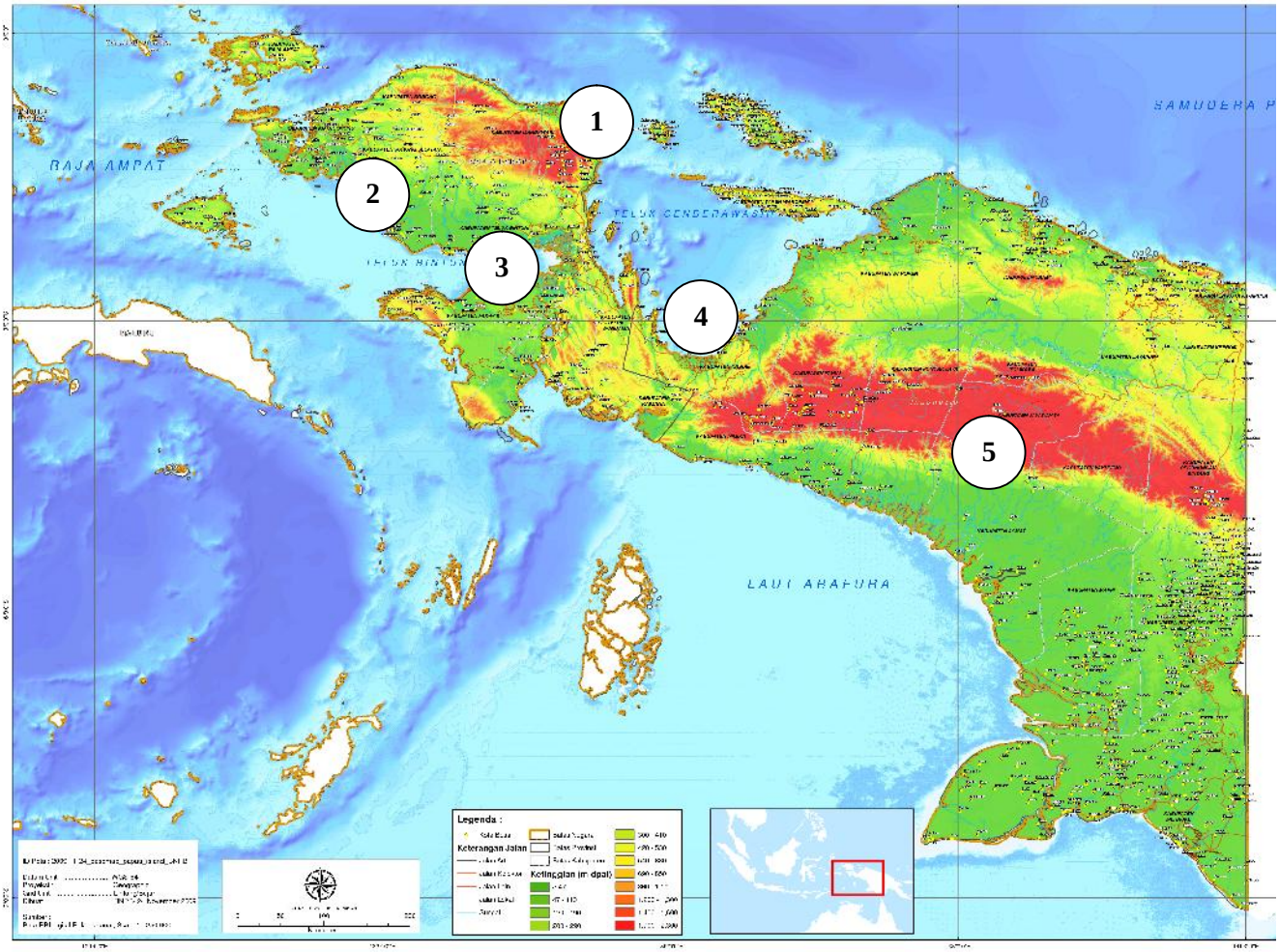

Figure 1. Study area to explore the diversity of red fruit *(Pandanus conoideus)* in Indonesian Papua. Note: 1. Manokwari, 2. South Sorong, 3. Teluk Bintuni, (West Papua Province), 4. Nabire, 5. Jayawijaya (Papua Province).

Data of physical character and chemical composition was analyzed using a Cluster Analysis. Dendogram character diversity among accessions was constructed by Unweighted Pair-Group Method with Arithmetic (UPGMA) using NTSYS-pc computer program version 2.0 (Rohlf 1993).

RESULTS AND DISCUSSION

Exploration of the red fruit accessions

The exploration result of some target area showed that there was a variety on physical and chemical characteristics of each accession of red fruit. In Manokwari, there were 18 accessions of red fruit. It is included two accessions in the Sub-district of Masni and 16 accessions in the Sub-district of Minyambouw. In Teluk Bintuni (Sub-district of Merdey) they were 32 accessions and in South Sorong (Sub-district of Aifat) and Jayawijaya (Sub-district of Kelila) there were 12 accessions, moreover in Nabire, there were only 11 accessions. Total red fruit accessions which found in Papua and West Papua were 85 accessions.

The naming for these red fruit accessions based on the traditional classification which was called 'emic' by the local peopled. The local people differentiated each accession based on the characteristics of its growth, fruit size, fruit color, *drupa* size, and utilization. The naming for the red fruit accessions in every region started by the name of a specific area. For example in Jayawijaya it was named as Tawi, the letter U in South Sorong District. In Sub-district of Minyambou, it was called Hib/Him/Hit in and while in District Teluk Bintuni, it was called Mongk.

The interview results showed that not all accessions of red fruit had a potential to be utilized by the local community. Trees that had been cultivated, rich in oil, highly productive, and resistance to disease are accessions that had the potential to be developed. Based on this evaluation, it was found that the accessions which have a potential to be developed were 7 accessions of Manokwari (1 accession in Masni, 3 accessions in Minyambouw and 3 accessions of Teluk Bintuni (Sub-district of Merdey), there were also 3 accessions each from Nabire, Jayawijaya and South Sorong, so overall there were 16 accessions in total (Table 1).

It is believed that this study might reveal the potential natural resources of Papua based on community local knowledge. Red fruit accessions have not highly-cultivated, therefore commonly planted accession was a primitive native race, and even some of them are taken directly from the nature.

Physical characteristics of red fruit

The identification of accessions of red fruit in some areas of Papua and West Papua shows a diversity of physical characteristics (Table 1). Generally, the cross-sectional units (cores) of red fruit had triangular shaped and yellow white color. Outer shape of red fruit is not always influenced by the shape of cross-section. For example, there are accessions of red a fruit that form a triangular cross-section, but has round fruit shape extending from the base to the tip of fruit. The color of the set pieces of red fruit is red to dark red, which is influenced by the content of carotenoid and environmental conditions. In addition, there are some set of pieces of red fruit color such as orange and yellow color, but this accessions are rarely found in society.

The size and length of red fruit can be classified into long pieces (size > 50 cm), medium (size 49-53 cm), and short (size < 35 cm). The highland generally have medium fruit size (42 cm) to long size (80.2 cm), while the lowland areas tend to have a length ranging from 59 to 66 cm. In lowland areas, the size of the fruits is more varied, that is in short (25-29 cm) to long (70 cm).

The variation of length of the red fruit *drupa* ranging from 1.2 to 1.8 cm. Accession of MMS-M has a shortest grain size length (1.2 cm), while accessions MHY-M, and MHB-M and MTM-N have the longest *drupa* length (1.8 cm). Long fruit size does not corresponded to the length of *drupa*. For instance, the accessions MID-M has long pieces (62 cm) but has a shorter length of *drupa* (1.3 cm). MMW-M accessions have short pieces (21 cm), and a longer length of *drupa* (1.7 cm) (Table 1). Regarding to the height of growth, red fruit in the highland have relatively long size (1.5-2.0 cm), in the lowland varies from short (1.2 cm) to long (1.7 cm), whereas in the middle land have moderate to long grain length (1.4-1.6 cm).

Diversity of red fruit accessions physical character populations in one area may differ in other populations. It is assumed that the growth of red fruit is dependent on the type of its ecogeography. This phenomenon was similar to *Jatropha curcas* L. which was growing scattered in some areas of Mexico in differences altitude, average temperature, and type of climate. It has a different protein content (19-33%) and fat (46-64%), and also has different physical characteristics, especially shape and size of seeds (Makkar et al. 1998; Herrera et al. 2010). Diversity of physical characteristics, especially those controlled genetically are very useful as a source for red fruit breeding program. In agricultural technology, physical characteristics are required to accomplish the equipment design for handling, processing, and storage (Asoegwu et al. 2006).

Chemical composition of red fruit

The chemicals compositions of selected red fruit accessions were varied among others (Table 2 and Table 3). The average value was ash 2.03-3.50%, protein 3.12-6.48%, fat 11.21-30.72%, carbohydrate 43.86-79.66%, vitamin C 3.78- 21.88 mg/100g, vitamin B1 0.97-3.14 mg/100g, calcium (Ca) 0.53-1.11%, iron (Fe) 8.32-123.03%, phosphorus (P) 0.01-0.33%, total carotenoids 333-3309 ppm and total tocopherol 964-11918 ppm. Table 2 shows that the *drupa* containing the highest fat compared to other proximate components. It can be said that the red fruit is a good source of oil. *Drupa* of accessions from lowlands are higher in fat than accessions from medium and highland. Red fruit accession with the highest fat content was MMS-M (30.72%).

A variety of fat content can be affected by a variety of plants, genetic, climate conditions, level of maturity, harvest time, and method of extraction (Idouraine et al. 1996; Egbekun and Ehieze 1997). Younis et al. (2000)

states that the yield of *Cucurbita pepo* L. African plant oils that grows in the highlands to the low temperatures have a higher fat content than those grown in the lowlands to high temperatures. Although accessions of MMS-M were found in the lowland, the growth has average air temperature which is sufficient for their growth. As a result, it contains the highest fat content (30.72%). Merdey sub-district where MMS-M accession found has an average air temperature of 27.4^{o}C and humidity of 82.83%. Required air temperature to grow crops of red fruit is 23-33^{o}C and in moderate humidity (Budi and Paimin 2004).

Drupa of the accessions which were found in the lowlands also contain higher vitamin C, iron (Fe), phosphorus (P), total carotenoids, and total tocopherol than accessions originating from medium and highland. The highest content of vitamin C is produced by MMW-M accession (21.88 mg/100g), the highest of vitamin B1 is produced by MUSW-S accessions (3.14 mg/100g), the highest calcium levels produced by MUSW-S and MTM-W accessions (0.90%), the highest iron levels resulting in MID-M accessions (123.03 ppm), the highest phosphorus levels resulting in MUA-S accessions (0.33%), the highest total carotenoids is produced by MTM-N accessions (3309.42 ppm), and the highest total tocopherol is produced by MID-M accessions (11917.81 ppm) (Table 3).

Cluster analysis

Of the 16 accessions of red fruit used in this study, each accession showed different characteristics. The differences are due to the red fruit habitat. The habitat of plants is influenced by sunlight, weather or climatic conditions, temperature, humidity, and the availability of nutrients which can be absorbed by plant. It is also known that habitat of plants be affected the physical characteristics and chemical composition of the plant.

Even though there were different characteristics on each accession, there were also similar characteristics of the 16 red fruit-accessions as shown in Table 1, 2 and 3. The similarities in some of red fruit plant were evaluated to determine the genetic relationship by Cluster Analysis. Pattern of each red fruit accession similarity depicted in the dendogram of physical and chemical characters (Figure 2).

Table 1. Physical character red fruit (*Pandanus conoideus*) from Papua, Indonesia

No	Origin of accession (district/sub-district)	Locally name	Red fruit accession	Core	Fruit flesh color	Fruit length (cm)	Length of *Drupa* (cm)
1	Manokwari/Masni	Idebebcs	MID-M	Triangular cylinder	Dark red	62/long	1.3
2	Manokwari/ Minyambow	Hityom	MHY-M	Triangular cylinder	Red	76/ long	1.8
3	Manokwari/ Minyambow	Himbiak	MHB-M	Triangular cylinder	Dark red	71/ long	1.8
4	Manokwari/ Minyambow	Hibnggok	MHG-M	Triangular cylinder	Red	42/ long	1.7
5	Teluk Bintuni /Merdey	Monsmir	MMS-M	Triangular cylinder	Red	68/ long	1.2
6	Teluk Bintuni /Merdey	Memyer	MMY-M	Triangular cylinder	Red	70/ long	1.3
7	Teluk Bintuni /Merdey	Memiwuk	MMW-M	Triangular cylinder	Red	21/short	1.7
8	South Sorong /Aifat	U Saem	MUSM-S	Triangular cylinder	Red	66/ long	1.6
9	South Sorong /Aifat	U Sauw	MUSW-S	Triangular cylinder	Red	61/ long	1.4
10	South Sorong /Aifat	U Aupat	MUA-S	Triangular cylinder	Red	59/ long	1.6
11	Nabire/Nabire	Tawi Bilim	MTB-N	Triangular cylinder	Red	52/ long	1.5
12	Nabire/Nabire	Tawi Muni	MTM-N	Triangular cylinder	Red	53/ long	1.8
13	Nabire/Nabire	Tawi Kubu	MTK-N	Triangular cylinder	Dark Red	54/ long	1.6
14	Jayawijaya/Kelila	Tawi Ugi	MTU-W	Triangular cylinder	Red	75/ long	1.6
15	Jayawijaya/Kelila	Tawi Magari	MTM-W	Triangular cylinder	Red	60/ long	1.6
16	Jayawijaya/Kelila	Tawi Kenen	MTK-W	Triangular cylinder	Red	60,1/long	1.5

Table 2. Proximate composition of 16 accessions red fruit (*Pandanus conoideus*)

Red fruit accessions	Water (%,bb)	Ash (%,bk)	Protein (%,bk)	Carbohydrate (%, bk)	Fat (%,bk)
MID-M	40.82±0.08	2.62±0.04	4.01±0.04	71.15±0.19	22.23±0.20
MHY-M	52.70±1.04	2.77±0.09	5.53±0.31	71.19±0.78	20.50±0.56
MHB-M	51.18±0.06	2.99±0.00	5.78±0.02	74.67±0.36	16.55±0.34
MHG-M	46.95±0.72	3.50±0.28	6.48±0.09	78.81±0.59	11.21±0.22
MMS-M	40.26±0.40	2.10±0.08	5.54±0.26	61.64±0.14	30.72±0.19
MMY-M	43.96±0.01	2.09±0.07	5.30±0.15	71.43±0.44	21.18±0.36
MMW-M	51.93±0.91	2.64±0.11	4.33±0.15	68.33±0.65	24.70±0.39
MUSM-S	51.53±0.29	2.45±0.31	4.77±0.35	77.77±0.17	15.00±0.13
MUSW-S	47.10±0.13	2.78±0.07	5.37±0.65	64.96±0.41	26.88±0.18
MUA-S	45.18±0.39	2.03±0.01	5.20±0.18	71.66±1.11	21.10±0.92
MTB-N	41.57±1.29	2.31±0.07	6.22±0.07	79.66±0.45	11.81±0.32
MTM-N	44.07±2.61	3.15±0.28	5.69±0.25	68.01±1.82	23.15±1.86
MTK-N	41.42±1.01	2.95±0.00	5.45±0.37	79.33±0.52	12.27±0.15
MTU-W	51.26±0.38	2.76±0.16	5.50±0.18	75.66±0.36	16.07±0.37
MTM-W	42.99±0.03	3.03±0.02	3.12±0.10	66.46±0.21	27.39±0.09
MTK-W	49.02±0.64	2.65±0.87	5.15±0.02	74.24±0.26	17.96±0.36

Table 3. Vitamins, minerals, total of carotene and tocopherol composition of 16 accessions red fruit (*Pandanus conoideus*)

Red fruit accessions	Vit. C (mg/100 g)	Vit. B1 (mg/100 g)	Ca (%, bk)	Fe (ppm)	P (%, bk)	Total carotenoids (ppm)	Total tocopherol (ppm)
MID-M	20.61±0.93	1.88±0.02	0.60±0.00	123.03±2.09	0.11±0.00	2584.82±224.78	11917.81±72.32
MHY-M	16.18±0.59	2.60±0.12	0.77±0.02	20.86±0.12	0.01±0.00	748.86±18.39	5927.11±512.26
MHB-M	8.02±0.16	2.30±0.04	0.83±0.01	14.65±1.73	0.01±0.00	332.58±92.36	2988.76±26.57
MHG-M	9.97±1.20	2.39±0.15	0.74±0.00	16.27±0.86	0.02±0.00	704.04±37.72	6778.49±293.79
MMS-M	12.53±0.11	0.97±0.03	0.68±0.00	22.52±0.91	0.32±0.00	1264.28±38.96	2294.12±211.48
MMY-M	18.90±0.00	1.09±0.01	0.54±0.00	11.83±1.58	0.25±0.00	1137.98±37.24	1180.54±46.37
MMW-M	21.88±1.27	2.47±0.00	0.58±0.00	17.18±1.20	0.31±0.00	593.89±27.94	2424.49±101.38
MUSM-S	9.42±0.61	2.11±0.00	0.90±0.05	39.37±0.36	0.29±0.00	547.96±51.29	2853.23±7.15
MUSW-S	8.45±0.28	3.13±0.02	1.11±0.05	21.88±1.01	0.31±0.00	857.90±15.62	1043.04±49.21
MUA-S	10.30±0.13	2.22±0.00	0.59±0.01	22.29±0.51	0.33±0.02	603.16±4.63	964.52±39.39
MTB-N	3.78±0.08	2.00±0.10	0.55±0.00	29.07±0.90	0.08±0.00	759.12±16.72	4529.84±1178.36
MTM-N	5.64±0.82	2.97±0.13	0.79±0.04	26.69±3.72	0.07±0.00	3330.51±902.91	6736.36±1625.27
MTK-N	7.33±1.25	3.09±0.16	0.71±0.01	26.6±4.76	0.07±0.00	1185.80±198.52	6419.41±723.01
MTU-W	4.39±2.30	2.54±0.11	0.57±0.04	8.32±0.99	0.02±0.00	388.75±11.95	1848.96±150.63
MTM-W	7.40±1.07	2.21±0.11	0.90±0.04	24.54±0.02	0.01±0.00	545.80±63.46	2599.00±297.95
MTK-W	15.41±1.57	2.04±0.06	0.53±0.02	12.34±0.79	0.01±0.00	730.63±106.65	3665.85±521.64

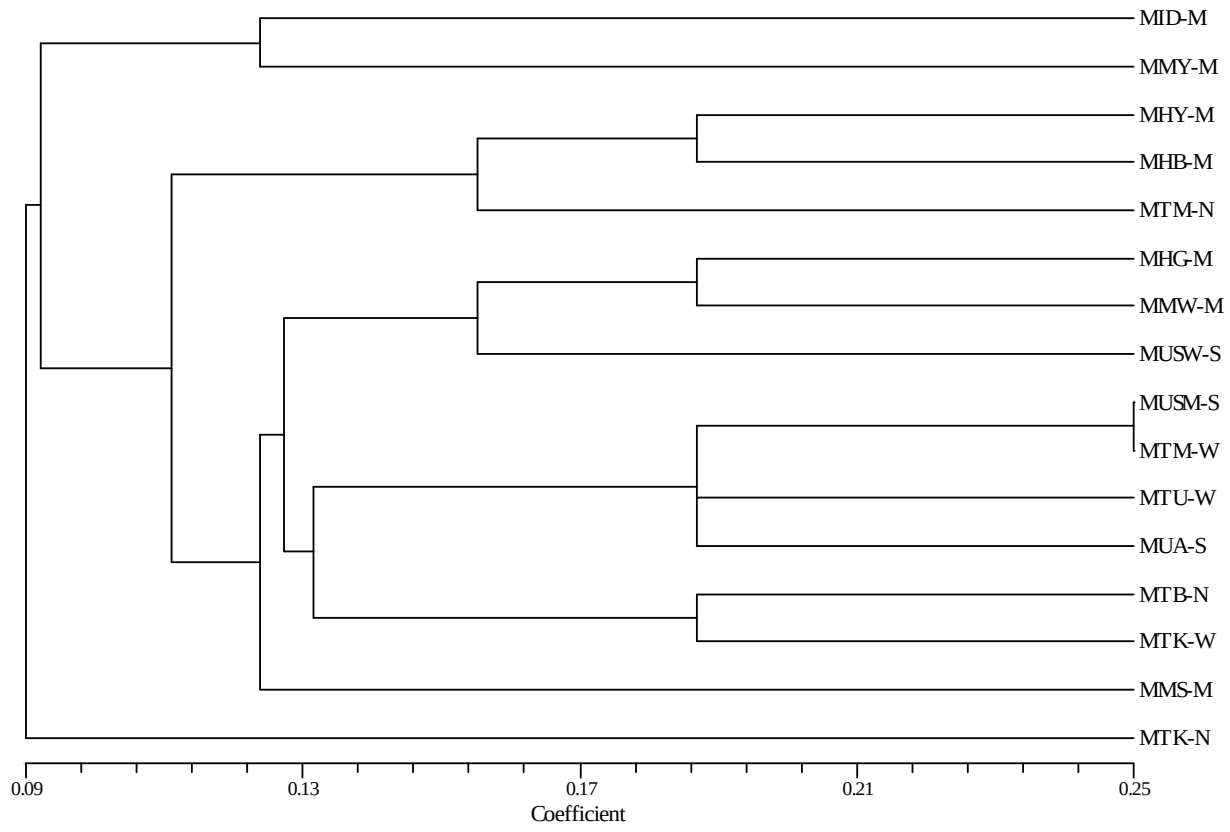

Figure 2. Dendogram of similarity of physic characters and chemical composition in 16 accessions red fruit (*Pandanus conoideus*) from Papua and West Papua Provinces. Note: Abbreviation of the red fruit accession follows Table 1.

The results of clustering analysis by UPGMA method (Unweighted Pair Group Method with Arithmetic) shows that the patterns of accessions was not based on region of origin, but grouped randomly according to character similarity. These results provide evidence that the accessions of red fruit in Papua and West Papua were very heterogeneous. Several factors that can cause a high diversity of plant characters were (i) the occurrence of hybridization between accessions, (ii) gene mutation, (iii) migration, (iv) introduction, and (v) the difference of

ecogeographic. Natural hybridization can lead to high diversity in populations derived when the different characters are passed down from elders (Grant 1971). Migration or movement of an individual or population of plants from one place to another followed by the occurrence of geographical isolation and hybridization can lead to gene flow, which ultimately leads to increase the diversity of plant characters (Nagy 1997; Mawikere 2007).

MTK-N accession was grouping in a single group and differ from 15 other accessions, with the similarity just as much as 9%. It is indicated that the MTK-N accessions from Nabire have a fairly distant genetic relationship with other accessions, both accessions from the same region or from other areas. Characters that distinguish the MTK-N with other accessions were their chemical characters. Accessions that have the closest genetic relationship were accession MUSM and MTM-W, with 25% similarity of character. Although comes from different regions of origin, accessions MUSM-S (South Sorong) and MTM-W (Jayawijaya) have the same chemical and physical components i.e. the highest content of total carotenoids, total tocopherol, the fruit-sectional shape (triangle), color of flesh (red), and fruit length (length). This phenomenon indicates that the red fruit that comes from a region not necessarily have a closer genetic relationship compared to other regions.

CONCLUSION

It can be concluded that in order to have more accurate data of genetic relationships among red fruit accessions, the identification cannot be measured only by the physical characteristics and chemical composition, but also on other characters such as molecular traits. It might be due to the facts that physical characteristics and chemical composition were still more influenced by ecogeographic conditions of plants.

The dried red fruit contains 2.03-3.50% ash, 3.12-6.48% protein, 11.21-30.72% fat, 43.86-79.66% carbohydrate, 3.78-21.88 mg/100g vitamin C, 2.00-3.14 mg/100g vitamin B1, 0.53-1.11% Ca, 8.32-123.03 ppm Fe, and 0.01-0,33% P, with total carotenoids and total tocopherol ranging from 332.65-3309.42 ppm and 964.52-11917.81 ppm. The results of clustering analysis based on physical characteristics and chemical composition of 16 accessions of red fruit showed that the accessions MTK-N into a single cluster was different from 15 other accessions, with only 9% similarity of character. Accessions that have the closest genetic relationship were accession MUSM-S and MTM-W with of 25% similarity of character. Accession MUSM-S and MTM-W were similar on their chemical components of the highest content of total carotenoids and especially total tocopherol and also common features of the physical character of which is fruit sectional shape (triangle), fruit flesh color (red) and fruit length.

ACKNOWLEDGEMENTS

The authors would like to thank to the Directorate for Research and Community Service, Directorate General for Higher Education for funding through Competition Research Grant XIV No. 037/SP3/PP/DP2M/II/2006. Thanks to Sergius Wamafma and Sefnad Asmorom for their assist in the study.

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