# GENETIC DIVERSITY AND RELATIONSHIP AMONG LOCAL RICE ACCESSIONS IN DISTRICT OF KAMPAR, RIAU, BASED ON MORPHOLOGICAL CHARACTERS

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## ABSTRACT

The diversity of rice germplasms in Kampar District, Riau has not been explored and studied. Genetic diversity is a base genetic material which is very important in rice breeding program to assemble new superior varieties with high productivity and good quality. Research with the aim to obtain basic information about the genetic diversity of local rice in Kampar District, Riau, as the basic data (database) on the protection of its genetic resources and to know the grouping of local rice in Kampar based on similarities & differences of morphological characters of rice landraces in Kampar District, Riau has been done in March 2017. This research was conducted using explorations, descriptive qualitative analysis and seed collection methods of 28 rice landraces in District of Kampar, Riau. Characters of culm height, leaves senescence and grain losses are highest diversity among 28 accessions of Kampar local rice. All of accessions has a very length of grains (>7.50 mm). Based on clustering analysis using the NTSYS-pc Program, all morphological data resulted in a dendrogram with similarity coefficients ranged from 0.44 to 0.80 in three main groups of local rice accessions. The first group (Group I) consisted of 17 accessions, the second group (Group II) consisted of six accessions and the last group (Group III) consisted with four accessions. Dendrogram also showed that Accession UR7 (Situjuah) and UR24 (Padi Coku) have a similarity level-up to 80%, the highest among other accessions. Meanwhile, accession UR23 (Puluik Putioh) is the only out-group accession.

Keywords: clustering analysis, genetic diversity, Kampar Riau, landraces, local rice

## INTRODUCTION

Kampar District is one of main of rice producer district in Riau Province. Based on the data, Kampar Regency consists of 576.5 hectares of paddy fields, 172.5 ha of upland rice land, 404 ha of irrigated land and 172.5 ha of rainfed rice area, distributed in nine villages (BPS Riau, 2014). The district has 25,363 inhabitants in population total (6772 households) with 4,360 of them work in the agricultural sector. Kampar farmers have been cultivating rice for years. They used several local varieties that have long developed in the community and well adapting to the local environment. Some genotypes play an important role in the livelihood of the people of this area.

The genetic improvement of yield and other economically important traits in crop species depends upon the genetic diversity available within the crop species. The cultivated varieties of rice arise as a result of human selection from the available genetic diversity in various environments and human cultures. Modern breeding in the last two decades has resulted in the development of varieties that are more uniform. With the introduction of high yielding varieties, the landraces are moving out of cultivation.

As such, there is very little information available on genetic diversity of traditional rice in Kampar. Some institutions such as BB-Biogen have been started to conduct Riau rice germplasms, and has been collected 18 aksesi of rice germplasms from Kampar (www.biogen.litbang.pertanian.go.id., 2017). Knowledge of genetic diversity and relationships among local rice genotypes commonly grown in Kampar may play a significant role in breeding programmes to improve production, productivity, quality traits, biotic and abiotic stresses, and also provide valuable information that can be used by plant breeders as a parental line selection tool. Thus, estimation and quantification of genetic diversity among the local rice germplasm are a perquisite for their genetic enhancement.

Morphological and biochemical markers were used for genetic diversity analysis and for establishing a relationship among cultivars. But these are limited in number, stage-specific and highly influenced by the environmental conditions, which thus renders them less popular among the researchers (Salgotra *et al*., 2015). Several workers reported the use of agro-morphological markers in the characterization of rice diversity (Chakravorty *et al*. (2013); Yawen *et al.* (2003); Patra and Dhua (2003). Assessment of genetic diversity is very important in rice breeding from the standpoint of selection, conservation of different landraces variety of rice and proper utilization (Mohammadi-Najad, 2008). Evaluation and characterization of existing landraces of rice are important due to increasing needs for varietal improvement.

This study aims to obtain basic information about the genetic diversity of local rice in Kampar District, Riau, as the basic data (database) on the protection of its genetic resources and to know the grouping of local rice in Kampar based on similarities & differences of morphological characters. For long-term this data is very important in rice breeding program to assemble new local superior varieties with high-yielding and specific adaptation in Kampar, Riau.

## MATERIALS AND METHODS

The research was conducted from January to March 2017. This research used local rice accession obtained in Kampar Regency, Riau. A descriptive qualitative analysis method was used consisted of exploration, collection, and analysis of the genetic relationship. Local rice accessions collection activity has been done in in 5 sub-districts in Kampar District, Riau i.e: Tambang District, East Kampar Sub-District, Rumbio Jaya Sub-District, Kampar Sub-District and North Kampar Sub-District. Exploration was conducted to sample determination using snowball sampling, collection, and interview with a local farmer (farmer group). List of local names of local rice accessions were obtained in exploration activities are shown in Table 1.

The data used in this study are primary data derived from observation of morphological character of local accession of Kampar rice based on Rice

Characterization and Evaluation Descriptors (Departemen Pertanian, 2003). The data observed in this activity are morphological data depending on the growth phase found in the field. Observations were made directly to the selected plants as accession samples and supplemented by interview data from farmers. In addition, seeds from each accession had been collected in sufficient quantities (approximately 500 grams) for each genotype for further identification and testing.

Data from exploration have been analyzed using dendrogram analysis method to assess the similarity between local rice accessions Kampar. The data has been transformed into binary data in matrix form, then it has been calculated the matrix of similarity between the collection numbers of the observed plants. The NTSYS program has been used to generate a dendrogram to analyze the genetic relationship and to assess patterns of diversity of rice accessions.

Table 1. List of local rice accessions in Kampar

| No | Accession number | Local name* | Location | Owner |
|---|---|---|---|---|
| 1 | UR1 | BB8 | District of Tambang | Haryah |
| 2 | UR2 | Cupak Putiuh | District of Tambang | Darnis |
| 3 | UR3 | Sakampau | District of Tambang | Darnis |
| 4 | UR4 | Sikuniang | District of Tambang | Darnis |
| 5 | UR5 | Sicantik Manis | District of Tambang | Darnis |
| 6 | UR7 | Situjuah | District of Tambang | Darnis |
| 7 | UR8 | Bungo Macang | District of Tambang | Darnis |
| 8 | UR9 | Puluik | District of Kampar Timur | SiE |
| 9 | UR10 | Padi Gondang | District of Kampar Timur | SiE |
| 10 | UR11 | BB48 | District of Rumbio Jaya | Darmi |
| 11 | UR12 | Puluik Itam | District of Rumbio Jaya | - |
| 12 | UR13 | - | District of Rumbio Jaya | - |
| 13 | UR14 | - | District of Rumbio Jaya | - |
| 14 | UR15 | Siputioh | District of Rumbio Jaya | - |
| 15 | UR16 | Suntiang | District of Rumbio Jaya | Fatmawati |
| 16 | UR17 | Korya | District of Rumbio Jaya | - |
| 17 | UR18 | Proyat | District of Rumbio Jaya | - |
| 18 | UR19 | Onda Cupak | District of Kampar | Nurman |
| 19 | UR20 | - | District of Kampar | Saiya |
| 20 | UR21 | - | District of Kampar | Kelupak Pandan |
| 21 | UR22 | - | District of Kampar | - |
| 22 | UR23 | Puluik Putioh | District of Kampar | Nazar |
| 23 | UR24 | Padi Coku | District of Kampar | Sarima |
| 24 | UR25 | Padi Cupak Daek | District of Kampar Utara | Marhama |
| 25 | UR26 | Puluik Sia (Pulut Merah) | District of Kampar Utara | Marhama |
| 26 | UR27 | Padih Putioh | District of Kampar Utara | Samsudin |
| 27 | UR28 | Padi Alui | District of Kampar Utara | Mak Ijam |
| 28 | UR29 | Padi Lidah Kobou | District of Kampar Utara | Mak Ijam |

*based on the interview with farmers

Characteristics observed included tillering ability, culm vigour, culm length, leaf senescence, panicle exsertion, grain losses, spikelet fertility, leaf blade length, leaf surface, leaf attitude, flag leaf attitude, basal leaf sheath color, leaf color, ligule shape, culm habit, culm color, type of penicle, secondary branching of penicle and attitude of main axis of penicle.

## RESULTS AND DISCUSSION

### Analysis of Genetic Diversity

Observation and identification of rice germplasms are important to rice breeding program. From the exploration in five sub-districts in Kampar, the result shows 28 accessions with variations to its character from all observed characters. Variance value of 20 morphological characters can be shown in Table 2.

Table 2. Variance value of 28 local rice accessions in Kampar

| No | Characters | Variance |
|---|---|---|
| 1 | Tillering ability | 2.556 |
| 2 | Culm vigour | 1.794 |
| 3 | Culm length | 7.683 |
| 4 | Leaf senescence | 5.249 |
| 5 | Penicle exsertion | 2.138 |
| 6 | Grain losses | 4.127 |
| 7 | Grain fertility | 2.878 |
| 8 | Leaf length | 0.397 |
| 9 | Leaf surface | 0.470 |
| 10 | Leaf attitude | 0.693 |
| 11 | Flag leaf attitude | 3.534 |
| 12 | Basal leaf sheath color | 0.417 |
| 13 | Leaf color | 0.349 |
| 14 | Ligule shape | 0.194 |
| 15 | Culm habit | 2.386 |
| 16 | Stem nodus color | 0.522 |
| 17 | Type of penicle | 3.090 |
| 18 | Secondary branching of penicle | 0.497 |
| 19 | Attitude of the main axis of penicle | 0.247 |
| 20 | Seed length | 0.000 |

Observation of morphological characters from 28 accessions collected through exploration, obtained different diversity data between accessions. The highest value of diversity is plant height (7,683). There are 3 accessions in the short category (<110 cm), 7 accessions in medium category (110 - 130 cm) and 18 accessions of high rice category (> 130 cm). For leaves yellowing trait and grain losses trait has variance value of 5,249 and 4,127 respectively. Observation on all leaves below the flag leaf has obtained all accessions observed in Kampar District, 13 accessions were slowly and gradually on leaves yellowing, 14 accessions were moderate leaves yellowing, while only one accession was yellowing rapidly. For the last category is marked with all leaves yellow or dead.

Panicle threshability determined by grasping the panicle with the hand, applying a slight rolling pressure with the palm and fingers, and assessing the percentage of grains that are removed by the action. A total of 13 accessions (46.43 %) had the level of loss of seeds from panicle that was difficult, 6 accessions (21.43%) had a rather difficult level of loss and 7 accessions (25%) had a moderate degree of loss. Last, about 7% (two accessions) that had an easy level of threshability. While the observation of 10 representative grains said that all rice accessions (100%) collected from Kampar District has average of

grain length more than 7.50 mm. based on Deptan (2003), it is included in a very long seed category.

Wahibah and Herman (2013) reported that 12 local rice germplasms in Indragiri Hilir and Bengkalis, Riau has genetic variation in vegetative and generative traits. Roheini and Hastini (2015) also reported that they founded and inventarization 12 accessions of rice local germplasms in Ciater, West Java, 5 of them are sticky rice. Lesmana, *et al.* (2004), said that morphological traits commonly used as markers in rice cultivar ie: culm length, tillering, culm color, leaf surface, grain per penicle, grain color and grain surface.

Observation on rice characters should be based on guidelines that have been issued by some research institutes. For example, IRRI has publication Rice Descriptor is most widely used by rice researchers around the world (Bioversity International *et al.*, 2007). In Indonesia, Ministry of Agriculture has released 'Panduan Sistem Karakterisasi dan Evaluasi Padi" as guidelines for researchers in observing the characters of rice. Analysis of diversity among varieties commonly using phenotypic approaches, morphological, anatomy, sitology or molecular markers (Rugayah *et al.*, 2014). Morphological and anatomy observation are the most commonly used because they are relatively easy and cheap.

Yawen *et al.* (2003) studied the genetic diversity of 5,285 accessions of landraces of rice in China and found considerable morphological variation among accessions. Hartanto *et al.* (2015), was conducted an inventory of local rice germplasms in North Halmahera, and they were found that there were four local rice varieties (Padi Merah, Molulu, Taraudu and Manyanyi) in North Halmahera that had a high potential to be used as parentals in breeding program to assembly of new improved varieties. Similarly, Saleh *et al.* (2009), was conducted exploration in upland rice accession in Banggai, Central Sulawesi and successfully collected 63 accessions. There was diversity in morphological characters between all accessions.

**Analysis of Genetic Relationship**

The genetic relationship analysis among Kampar's local rice accessions was used to determine a relationship that had collected from the exploration. Observations of qualitative and quantitative characters from field were collected based on rice descriptor (Departemen Pertanian, 2003) and were transformed into binary data to be processed to form a dendrogram as shown in Figure 1.

Figure 1 shows the dendrogram of Kampar local rice accessions obtained from exploration activities. Based on 20 observed characters, 28 local Kampar paddy accessions have similarity coefficients ranging from 0.44 to 0.80. The highest coefficient values are owned by the accession UR7 (Padi Situjuah) from Tambang and accession UR 24 (Padi Coku) from Kampar. Both accessions have similarities in all characters except tillering ability, length of culm, a habit of culm and type of penicle. Based on Figure 1, all the accessions could be grouped into three groups. The genotypes within each group had higher similarity to each other than the accessions in different groups. A maximum number of accessions (17) were included in group I followed by six accessions in group II and four accessions (group III). These three groups have an equation of up to 46.5%. While there is one accession that is outside the groups are accession UR23 Kampar origin.

Based on dendrogram, 18 of accessions of Kampar local rice were clustered in Group I and five sub-groups The genetic similarity coefficients found in the

genotype comparison matrix were relatively moderate (0.49). The accessions collected from Tambang (BB48) and from Rumbio Jaya (Siputioh and BB48) were grouped in Sub-group I-a. The genotypes from Tambang (Si Cantik Manis), Kampar (Onda Cupak) and North Kampar (Cupak Daek and Padi Alui) were groups in Sub-group I-b and six accessions collected from Tambang (Cupak Putioh and Situjuah), Rumbio Jaya (UR15 and UR13), Kampar (Padi Coku) and North Kampar (Puluik Sia) were grouped in Sub-group I-c. Genotype number 18 (Proyat) and No.27 (Padih Putioh) from Rumbio Jaya and North Kampar, also UR 21 and Padi Lidah Kobou from Kampar and North Kampar were grouped in Sub-group I-d and Sub-group I-e respectively.

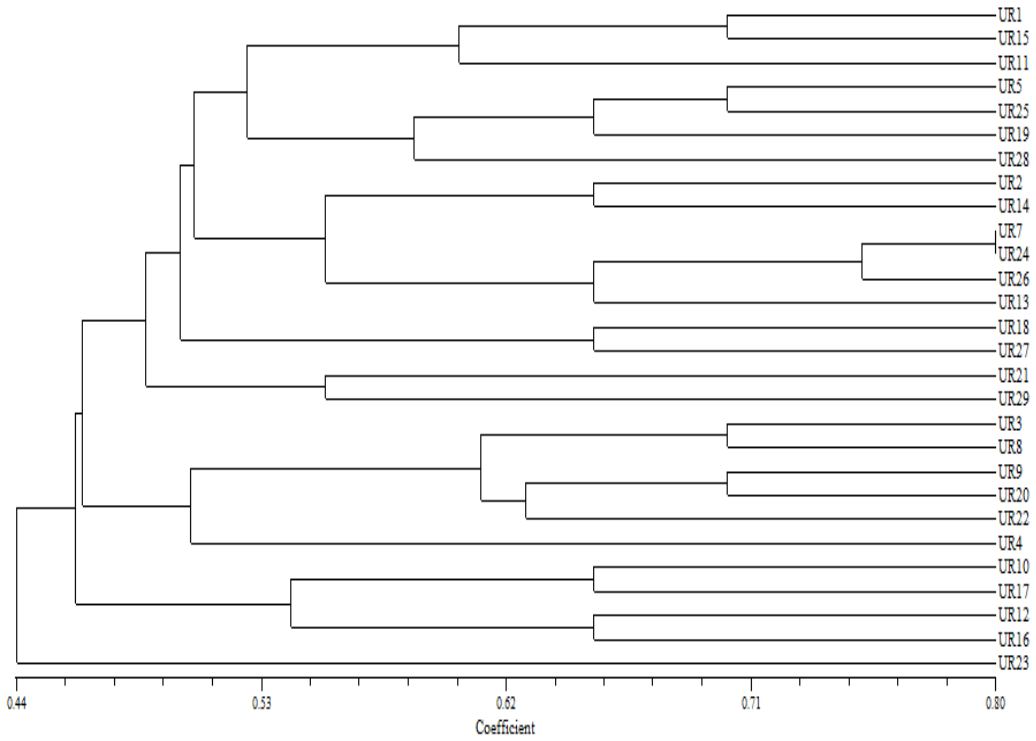


Figure 1. UPGMA dendrogram showing three groups (I, II and III) of all 28 local rice in Kampar

Three accessions from Tambang (Sikampau, Bungo Macang and Sikuniang), two accessions from Kampar (UR20 and UR22) and one accession from East Kampar (Puluik) cluster in group II with a relatively moderate of similarity coefficients 0.497 (50.3% of similarity). Genotype Padi Gondang from East Kampar and three genotypes from Rumbio Jaya (Korya, Puluik Itam and Suntiang) were clustered in group III.

Sinha and Mishra (2013) have explained genotypes that found in the same cluster were characterized by almost identical traits per characters. This suggests that these genotypes are probably formed from the same population. They may have a closer relationship. This information will be useful when the breeder will conduct crossing. Genotypes with high similarity can be interpreted as having genetic closeness. So if the cross is done then it will have higher inbreeding possibility. Therefore, crosses within the same group should be avoided.

The genetic relationship of rice has been reported by many researchers. Irawan and Purbayanti (2008) were analyzed of similarity coefficient between 21 local rice in Rancakalong, Sumedang ranged from 0.32 to 0.78 and divided into

two main groups. Similarly, Saleh, *et al.* (2005) also was grouped 63 rice varieties in Banggai based on isozyme analysis into 45 clusters, with scale 0.5 of all accessions, 22 clusters with scale 1.0 of all accessions and 8 clusters with scale 1.5. From 29 varieties that founded in Tana Toraja Highland, South Sulawesi, Suhardi *et al.* (2015) was clustered all accessions in 3 groups of dendrogram.

The similarity coefficients found in this analysis were relatively moderate. Zero indicated different genotypes, and 1 indicated similar genotypes. However, most of the values found between 0.44 and 0.80, with an average of 0.50 among all the 28 accessions used indicating a dissimilarity level among the genotypes. From the variance distribution, phenotypic analysis, and dendrogram, it is evident that the studied of Kampar local rice germplasm has a moderate diverse genetic base and high population structure. Hence the most divergent genotypes obtained in this study can be utilized for the future Kampar local rice breeding programme with specific adaptation in Kampar as our long-term objective.

## CONCLUSION

1. The three highest variance values among 28 accession of Kampar local rice are culm height (7.683), leaves senescence (5.249) & grain losses (4.127). All of the accession has a very length of grains (>7.50 mm).
2. Based on clustering analysis, 28 accessions have similarity coefficients ranged from 0.44 to 0.80 in the 3 groups of local rice accessions. Accession UR-7 (Padi Situjuah) & UR-24 (Padi Coku) have the highest similarity (80%), while accession UR-23 (Padi Puluik Putioh) is only outgroup accession
3. Group I consists of five sub-groups: Sub-group I-a consist of 3 accessions: UR1 (BB8), UR11 (BB48) & UR15 (Siputioh), Sub-group I-b consist of 4 accessions: UR5 (Padi Sicantik Manis), UR19 (Onda Cupak), UR25 (Padi Cupak Daek) & UR28 (Padi Alui) Sub-group I-c consist of 6 accessions: UR2 (Padi Cupak Putioh), UR7 (padi Situjuah), UR13, UR14, UR24 (Padi Coku) & UR26 (Padi Puluik Siah), Subgroup I-d consist of 2 accessions: UR18 (Padi Proyat) & UR 27 (Padi Putioh) and Subgroup I-e consist of 2 accessions: UR 21 & UR 29 (Padi Lidah Kobou).
4. Group II consists of 2 sub-groups: Subgroups II-a consist of 5 accessions: UR3 (Padi Sikampau), UR8 (Padi Bungo Macang), UR9 (Puluik), UR20 & UR 22 and Subgroups II-b consist of UR4 (Padi Sikuniang). Group III consists of 4 accessions UR10 (Padi Gondang), UR12 (Padi Puluit Itam), UR16 (Padi Suntiang) and UR17 (Padi Korya)

## ACKNOWLEDGEMENT

The authors are thankful to LPPM Universitas Riau for helping in the foundation of this research. This article a part of *Dosen Muda UR*'s Research Scheme 2017 entitled "Identification based on morphological and agronomy markers of Kampar's local rice germplasms to assembly high yielding varieties with specific adaptation in Kampar, Riau".

## REFERENCES

Bioversity International, IRRI and WARDA. 2007. Descriptors for wild and cultivated rice (*Oryza* sp.). Bioversity International, Rome, Italy; International Rice Research Institute, Los Banos, Philippines; WARDA, Africa Rice Center, Cotonou, Benin

BPS Riau. 2014. Riau dalam angka. Pekanbaru

Chakravorty, A., P.D. Ghosh, P.K. Sahu, P.K. 2013. Multivariate analysis of phenotypic diversity of landraces of rice of West Bengal. American Journal of Experimental Agriculture, 3(1):110-123.

Departemen Pertanian, 2003. Panduan Sistem Karakterisasi dan Evaluasi Tanaman Padi. BB-Biogen, Bogor

Hartanto, S., Y. Hidayat, I.H. Hendaru. 2015. Eksplorasi Plasma Nutfah Padi Lokal di Kabupaten Halmahera Utara, Maluku Utara. page 144-150. Prosiding Seminar Nasional Sumber Daya Genetik Pertanian

Irawan, B., K. Purbayanti. 2008. Karakterisasi dan Kekerabatan Kultivar Padi Lokal di Desa Rancakalong, Kecamatan Rancakalong, Kabupaten Sumedang. Proceeding Seminar Nasional PTTI, 21 -23 Oktober 2008

Lesmana, O.S., H.M. Toha, I. Las, dan B. Suprihatno. 2004. Deskripsi Varietas Unggul Baru Padi. Sukamandi, Subang: Badan Penelitian dan Pengembangan Pertanian- Balai Penelitian Tanaman Padi.

Mohammadi-Najad, G., A. Arzani, A.M. Rezai, R. K. Singh, and G. B. Gregerio, G.B. 2008. Assessment of rice genotypes for salt tolerance using microsatellite markers associated with the saltol QTL. African Journal of Biotechnology. 7(6): 730-736.

Patra, B.C., S.R. Dhua. 2003. Agro-morphological diversity scenario in upland rice germplasm of Jeypore tract. Genetic Resources and Crop Evolution. 50:825-828.

Rohaeni, W.R., T. Hastini. 2015. Inventarisasi Padi Lokal di Kawasan Ciater, Subang, Provinsi Jawa Barat. Page 189-193. Pros Sem Nas Masy Biodiv Indon. Volume 1 (2), April 2015 ISSN: 2407-8050.

Rugayah, A., Retnowati, F.I. Windadri, A. Hidayat. 2004. Pengumpulan Data Taksonomi. *In* Rugayah, E.A. Widjaja, Praptiwi (*Eds*). Pedoman Pengumpulan Data Keanekaragaman Flora. Bogor, Indonesia: Puslit Biologi-LIPI. pp: 5-40.

Saleh, M., S.F. Pasaru, M. Yunus. 2009. Eksplorasi Padi Gogo Lokal di Kabupaten Banggai. Media Litbang Sulteng 2(1):15–20.

Salgotra, R.K., B.B Gupta, J.A. Bhat, S. Sharma. 2015. Genetic Diversity and population structure of basmati rice (*oryza sativa* l.) germplasm collected from north western himalayas using trait linked ssr markers. PLoS ONE 10(7):e0131858.

Sinha, A.K., P.K. Mishra. 2013. Agro-morphological characterization and morphology-based genetic diversity analysis of landraces of rice variety *(Oryza sativa* L.) of Bankura District of West Bengal. International Journal of Current Research. 5(10):2764-2769.

Suhardi, Herniwati, F. Djufry. 2015. Keragaman Karakter Morfologi Plasma Nurfah Padi Lokal Dataran Tinggi Tana Toraja, Sulawesi Selatan. Page 134-143. Prosiding Seminar Nasional Sumber Daya Genetik Pertanian.

Wahibah, N. N., Herman. 2013. Studi Fenotipik Plasmanutfah Padi Lokal di Provinsi Riau. Prosiding Semirata FMIPA Universitas Lampung, 2013. FMIPA UNILA.

www.biogen.litbang.pertanian.go.id. 2017. Katalog Data Paspor SDG Tanaman Pangan 2017. Diakses pada 5 Sept 2017.

Yawen, Z., S. Shiquani, L. Zicho, Y. Zhongyi, W. Xiangkun, Z. Hongliang, and W. Guosong. 2003. Ecogeographic and genetic diversity based on morphological characters of indigenous rice (*Oryza sativa* L.) in Yunnan, China. Genetic Resources and Crop Evolution. 50: 567-577