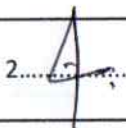
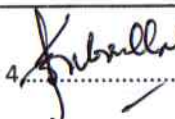

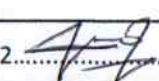
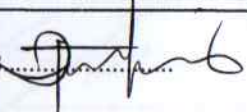
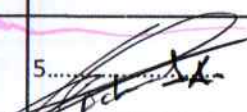

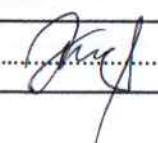
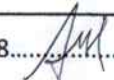


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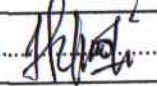
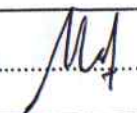
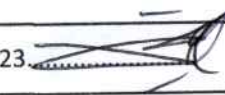
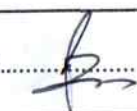
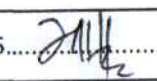
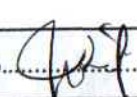
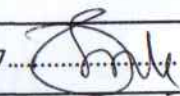
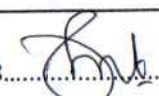
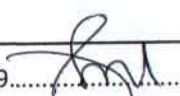
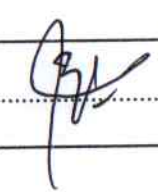
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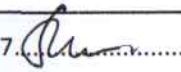
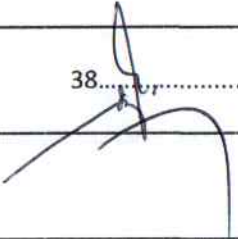
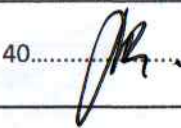
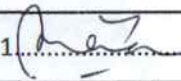

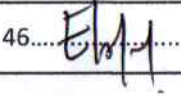
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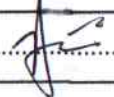

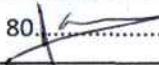


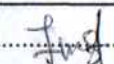

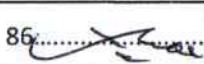
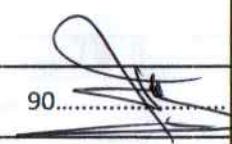
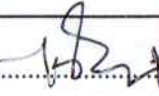
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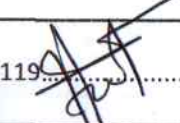
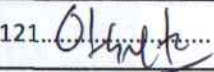
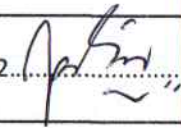


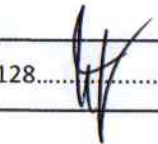
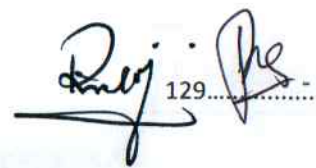
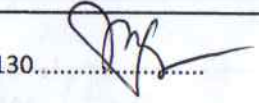
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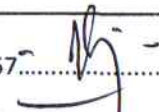
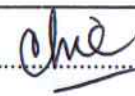
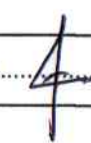

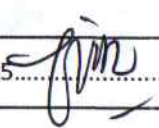
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Abstract. Katokkon chili (*Capsicum chinense* Jacq.) is one of the chili varieties in the districts of Tana Toraja and North Toraja which has a diversity of shapes in terms of morphology. This study aimed to identify morphological and cytological diversities and to determine kinship of several accessions of katokkon chili. The study used a survey method in which location determination and sampling were done by purposive sampling. The characters observed were plant height, leaf length, leaf width, petiole length, number of flowers per node, fruit length, fruit width, thickness of fruit flesh, fruit stalk length, and number of seeds per fruit. The survey results identified a total of 30 accessions of katokkon chilies consisted of 16 accessions from Tana Toraja Regency and 14 accessions from North Toraja Regency. Morphological analysis results using dendrogram show that the 30 accessions of chili katokkon obtained still had a high kinship with varying fruit shapes and leaf colors. At 96.70% similarity level, two groups were determined (group I consisted of 23 accessions and group II consisted of 7 accessions). Based on the observed characters, at 56.53% similarity, the accession can be categorized into two groups, namely group I (plant height, leaf length, petiole length, and leaf width) and group II (fruit length, fruit stalk length, fruit diameter, number of seeds per fruit and fruit thickness).

1. Introduction

Katokkon chili is a plant belonging to the family of Solanaceae. This chili is one of the site-specific genetic resources where the growth is in Tana Toraja and North Toraja Regencies, South Sulawesi Province. Katokkon chili is also one of the local assets that have the potential to be developed. Unique



characteristics of chili such as fruit shape are quite different from chili in general. In addition, aromatic distinctive taste of this kind of chili is so much in demand, especially in the local community where this plant is grown [1].

Katokkon chili is also one of the leading commodities of Toraja that needs serious attention because this plant is quite difficult to cultivate and has a narrow environmental adaptation. In addition to its distinctive aroma, Katokkon chili powder also has a high level of spiciness compared to other types of chili indicated by the Scoville Heat Units of 30,000 - 50,000 SHU [2]. The shape of the Katokkon chili looks more like a red bell pepper but with a smaller size so that there are some Toraja communities who make it a yard plant because it has an aesthetic value when viewed from a unique fruit shape and bright red color.

Katokkon chilli grows well in highland areas and has been registered at the Indonesian Center for Plant Variety Protection and Agricultural Licensing under the name "Katokkon" (Publication No.: 055 / BR / PVL / 02/2014) and "Katokkon Sayang" (Publication No.: 096 / BR / PVL / 08/2017). Based on the description of the registered Katokkon, differences has been noted on the shape of the fruit of the varieties. The Katokkon variety has an oval round fruit shape with the tip of the fruit and the base of the fruit is tapered, the size of the fruit is 8.5–11 cm while the Katokkon Sayang variety has a box shape with a curved shoulder base and a curved fruit tip, cross-section of the corrugated fruit with a fruit length of 4 - 6.5 cm in width, 3-5 cm wide [3, 4].

Characterization of chili aimed to see the morphological genetic diversity that can be used to determine the kinship relationship. Kinship can provide information on the proximity of cultivar relations biologically. Characterization can be seen from the character of the fruit [5]. Research on the exploration and characterization of katokkon chili has not been widely publicized and not many varieties of katokkon chili have been identified. Therefore, this study aims to identify the level of kinship from the katokkon chili obtained in Tana Toraja and North Toraja Regencies.

2. Methodology

The study was conducted using survey method in two contiguous regencies of Tana Toraja and North Toraja which are the endemic region of katokkon chili in South Sulawesi, followed by characterization of the sample collected from the field at the Laboratory of Reproductive Plant Bioscience and Biotechnology, Faculty of Agriculture, Universitas Hasanuddin Makassar. The research was conducted from May to June 2019.

Determination of location and sampling were based on purposive sampling method by selecting region of katokkon center sub districts. Eight sub-districts were selected each for Tana Toraja and North Toraja Regencies, respectively. Sub districts were determined based on information from the Department of Agriculture of Tana Toraja Regency and North Toraja Regency, Traders in the Market and Farmers. Eight sub districts selected in Tana Toraja Regency were Kurra, Rantetayo, Sangalla Utara, Malimbong Balepe, Rembon, Makale Selatan, Gandang Batu Sillanan and Mengkendek while eight sub districts in North Toraja Regency were Rinding Allo, Kapalapitu, Sesean, Nanggala, Sopai, Rantebua, Buntao and Kesu'. Fruit sampling was carried out directly to the farmer's land and by taking 10 pieces of katokkon chili as a sample. The last step of documentation and characterization of the fruits sample were conducted quantitatively and qualitatively based on the standards by IPGRI (1995) [6].

3. Results and discussion

From the survey conducted, 29 accessions of katokkon chili and 1 accession of non-katokkon chili were obtained in Tana Toraja Regency included sub districts of Kurra, Rantetayo, Sangalla Utara, Malimbong Balepe, Rembon, Makale Selatan, Gandang Batu Sillanan, and Mengkendek (Figure 1) and in North Toraja Regency namely sub districts of Rinding Allo, Kapalapitu, Sesean, Nanggala, Sopai, Rantebua, Buntao and Kesu' (Figure 2).

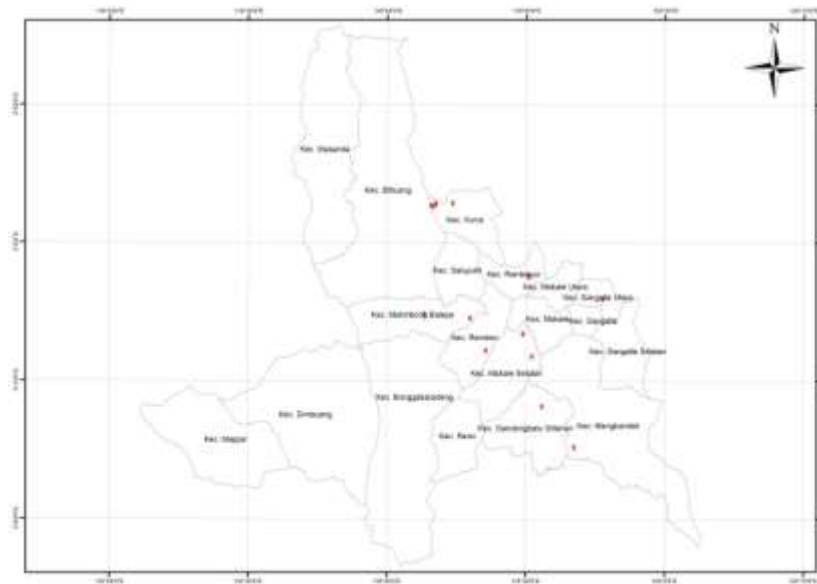


Figure 1. Location of cultivation katokkon chili in Tana Toraja Regency

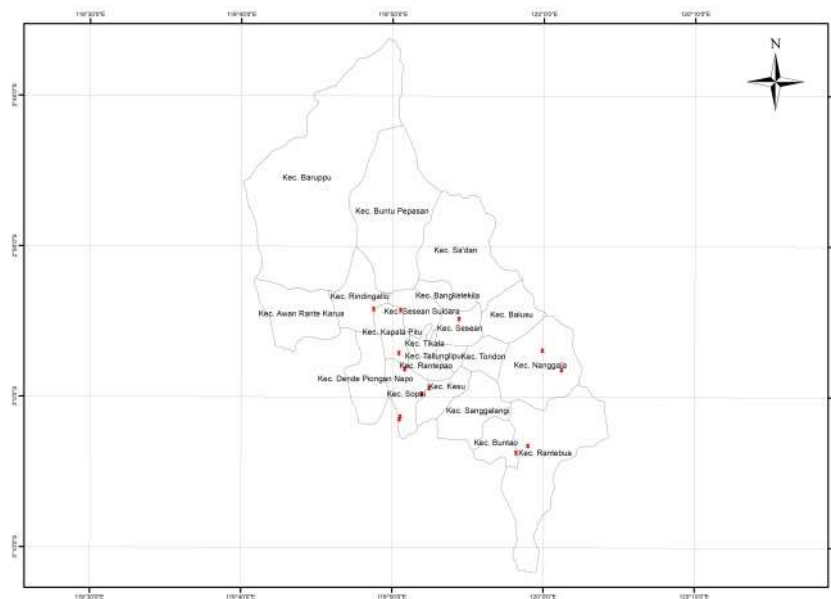


Figure 2. Location of cultivation katokkon chili in North Toraja Regency

The location of katokkon chili which locally cultivated by the people of Tana Toraja and North Toraja Regencies tends to be in a location with adequate road access for transportation and not far from the market location with an altitude range of 680 - 1,464 m above sea level (asl). This condition possibly is caused by some accessions of katokkon chili which are found to be easy to rot due to high water content. Based on the variety registered at the Center for Plant Variety and Agricultural Licensing Protection Publication Number 055 / BR / PVL / 02/2014, the katokkon chili has a moisture content of 85.40% [3].

Thirty accessions of the katokkon chili obtained from the survey in the two districts can be classified into two clusters at 96.70% similarity. The first cluster consisted of 23 accessions namely K1, K9, K16, K3, K4, K6, K5, K2, K17, K8, K13, K18, K30, K12, K14, K22, K11, K20, K15, K19,

K21, K29 and K27. While the second cluster consisted of 7 accessions namely K7, K10, K23, K25, K24, K28 and K26. Dendrogram showing the kinship of the katokkon chili based on quantitative characters is shown in Figure 3.

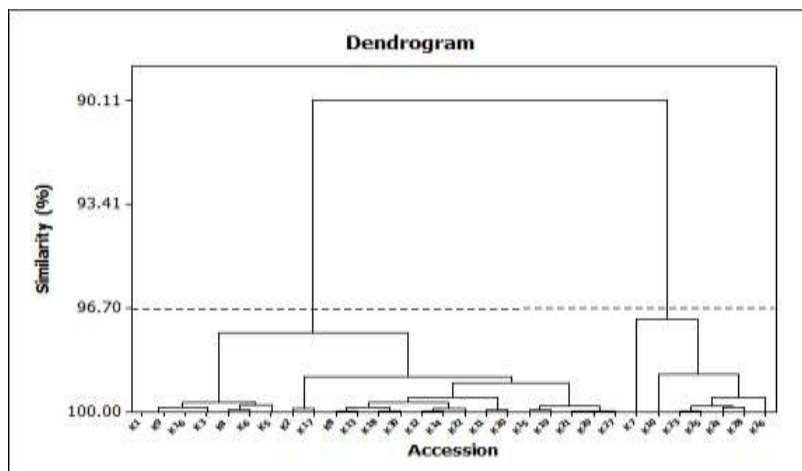


Figure 3. Dendrogram of kinship level of katokkon chili accessions based on quantitative characters

The first cluster has a diverse morphological characters. Observation on the shape of the fruit tip and the shape of the fruit base show that it is dominated by the presence of grooves. The second cluster has qualitatively morphological characteristics of the same leaf color that is dark green and jagged edges on the petals. According to Situmorang et al. [7], the similarity of characters in the chili genotypes tested can indicate the closeness in the kinship between the genotypes. In line with the opinion of Senior et al. [8], analysis of diversity and kinship relationships can provide information on biological genetic relationships between genotypes. This information is important in cross-planning. Plant breeders can determine and select local genotypes as parent breeding based on grouping kinship [9].

Figure 4 shows that observational characters based on quantitative characters can be classified into two clusters at 56.53% similarity level. The first cluster consisted of plant height, leaf length, petiole length, leaf width, and number of flowers per node. The second cluster consisted of fruit length, thickness of fruit flesh, fruit width, number of seeds per fruit, and fruit stalk length.

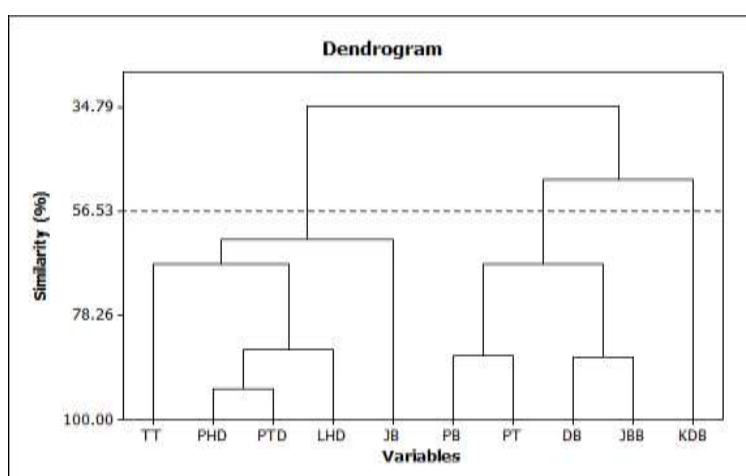


Figure 4. Dendrogram kinship level of the observed parameters based on quantitative characters. TT: plant height, PHD: leaf length, PTD: petiole length, LHD: leaf width, JB: number of flowers per node (JB), PB: fruit length, PT: thickness of fruit flesh, DB: fruit width, JBB: number of seeds per fruit, KDB: fruit stalk length.

The correlation analysis between the observation parameters in Table 1 shows that there is a very significant positive correlation, namely plant height and leaf width, leaf length and leaf width, leaf length and fruit stalk length, leaf width and fruit stalk length, fruit length and fruit width, fruit length and fruit stalk length, fruit length and number of seeds per fruit, fruit width and thickness of fruit flesh, fruit width and number of seeds per fruit, fruit stalk length and number of seeds per fruit with a sequential correlation coefficients of 0.53 **, 0.85*, 0.87**, 0.71**, 0.49**, 0.52**, 0.73**, 0.70**, 0.56**, 0.74** and 0.58**, respectively. Significant positive correlation is plant height and leaf length, leaf length and number of flowers per node, leaf length and fruit length with a sequential correlation coefficient 0.38*, 0.39* and 0.34*, respectively. Rana et al. [10] obtained similar results, namely there was significant to highly significant positive correlation between plant height and fruit length and fruit width. These parameters of fruit length, fruit width and plant height contribute directly to yield during the plant selection process [11].

Table 1. Correlation values between observed morphological Katokkon chili parameters.

Characters	PH	LL	LB	PL	NFPN	FL	FB	TFF	FSL
LL	0.38*								
LB	0.53**	0.85**							
PL	0.35 ^{ns}	0.87**	0.71**						
NFPN	0.33 ^{ns}	0.39*	0.34 ^{ns}	0.25 ^{ns}					
FL	0.07 ^{ns}	0.34*	0.49**	0.27 ^{ns}	-0.15 ^{ns}				
FB	0.09 ^{ns}	0.05 ^{ns}	0.21 ^{ns}	-0.06 ^{ns}	0.05 ^{ns}	0.52**			
TFF	0.05 ^{ns}	0.01 ^{ns}	0.18 ^{ns}	-0.02 ^{ns}	0.12 ^{ns}	0.27 ^{ns}	0.56**		
FSL	-0.18 ^{ns}	0.13 ^{ns}	0.05 ^{ns}	0.04 ^{ns}	-0.30 ^{ns}	0.73**	0.35 ^{ns}	0.00 ^{ns}	
NSPF	0.00 ^{ns}	0.08 ^{ns}	0.22 ^{ns}	0.06 ^{ns}	-0.04 ^{ns}	0.70**	0.74**	0.30 ^{ns}	0.58**

(**) = significant at 1%, (*) = significant at 5%, ns = not significant.

PH (plant height), LL (leaf length), LB (leaf Width), PL (petiole length), NFPN (number of flowers per node), FL (fruit length), FB (fruit Width), TFF (thickness of fruit flesh), FSL (fruit stalk length), NSPF (number of seeds per fruit).

Close relationship between parameters can be indicated by the value of a positive correlation or negative correlation. Significant positive correlation shows that an increase in one of the parameter values will increase the correlated parameters while a real negative correlation shows that an increase in one of the parameter values will decrease the correlated parameters.

4. Conclusions

1. There were 30 accessions of katokkon chili found in the study location consisted of 16 accessions from Tana Toraja Regency and 14 accessions from North Toraja Regency. At 96.70% similarity level, two groups were obtained (group I consisted of 23 accessions and group II consisted of 7 accessions).
2. The observed characters can be grouped into two clusters, at 56.53% similarity level, namely cluster I, consisted of plant height, leaf length, petiole length and leaf width, and cluster II, consisted of fruit length, fruit stalk length, fruit width, number of seeds per fruit and thick fruit flesh.
3. The correlation coefficient shows a very significant positive correlation between plant height and leaf width with a value of 0.53**, leaf length with leaf width and fruit stalk length with a value of 0.85** and 0.87**, leaf width with fruit stalk length and fruit length with a value of 0.71** and 0.49**, fruit with fruit width, fruit stalk length and number of seeds per fruit with a value of 0.52**, 0.73** and 0.70**, fruit width with thickness of fruit flesh and number of

seeds per fruit with a value nilai 0.56** and 0.74**, fruit stalk length with number of seeds per fruit with a value of 0.58**.

Acknowledgment

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