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Inheritance Pattern of Qualitative Character Traits in F2 Population of the Bara x Ungara and Dewata x Unggara Crosses

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Abstract

The purpose of this study was to estimate the inheritance pattern of qualitative character traits from the F2 population of the Bara x Ungara and Dewata cross. The study was conducted in the experimental garden of Unhas, Tamalanrea sub-district, Makassar, South Sulawesi. The quantitative character traits observed consisted of four characters, namely, the color of the flower corolla, the coloring of the immature fruit, the branching habit, and the nodal color. The results showed that the population of F2 crosses showed a purplish-green color (34) as the dominant color in immature fruits. Crosses with the Ungara variety exhibited a significant contribution to the color in the immature fruit. The nodal color characters is closely related to the duplication interaction pattern between alleles at different loci

Keywords: *Capsicum frutescens*, F2 generation, pepper breeding, qualitative data

A. Introduction

The development of high anthocyanin chilies is an additional goal to realize food biofortification on health (Ilodibia, C.V., C.E. Ugwoke, T.P. Egboka, E.E. Akachukwu, U.M. Chukwuma, & B.O. Aziagba, 2015; Garg, M., N. Sharma, S. Sharma, P. Kapoor, A. Kumar, V. Chunduri, & P. Arora, 2018; Rehan, A. Sharma, & P. Singh, 2020). The Ungara variety is one of the varieties with high anthocyanin levels. It is characterized by purple leaves, stems, and fruit. According to Herison, C., E. Surmaini, Rustikawati, & Yulian (2018), Tang, B., L. Li, Z. Hu, Y. Chen, T. Tan, Y. Jia, Q. Xie, & G. Chen (2020), and Huang Y., X. Wang, W. Miao, H. Suo, C. Fu, M. Chen, X. Zhaoand, & L. Ou (2021), the purple color on the fruit indicates a high anthocyanin level, so the Ungara variety is good to be used as a biofortification plant. This can be corrected by crossing commercial varieties such as Bara and Dewata. This variety is considered very popular with its productivity and high level of spiciness (Kusmana K. Y. Kusandriani, & D. Djuariah, 2017; Umami K., D.R. Anugrahwati, & I.K.D. Jaya, 2022). Therefore, crosses between these varieties become one of the good assembly lines in forming biofortified varieties that are in demand by general consumers.

Bara x Ungara and Dewata x Ungara crosses have entered F2. The F2 generation population is the population with the highest level of diversity, including qualitative characters (Benowicz A., M. Stoehr, A. Hamann, & A.D. Yanchuk, 2020; Cazzola F., C. J. Bermejo, & E. Cointry, 2020). Qualitative characters are characters that are not or slightly influenced by environmental influences. This character can be an effective approach in estimating the potential diversity of a cross. In addition, this character can be an approach in knowing the pattern of interaction between alleles in controlling a trait (Syukur M., S. Sujiprihati, & R. Yunianti, 2015). Therefore, it is important to estimate the genetic diversity pattern of the population of the Bara x Ungara and Dewata x Ungara crosses. The purpose of this study was to estimate the inheritance pattern of qualitative character traits from the F2 population of the Bara x Ungara and Dewata x Ungara crosses.

B. Methology

The study was conducted in the experimental garden of Unhas, Tamalanrea sub-district, Makassar, South Sulawesi. This experiment was carried out with the concept of observation by planting 200 F2 lines in each cross (Bara x Ungara and Dewata x Ungara). However, the number of plants that germinated and grew well was 255 lines (101 F2 lines from Bara x Ungara cross and 154 F2 lines from Dewata x Ungara cross).

1. Research procedures

The seedling was done using a planting medium consisting of soil, compost, and husk charcoal (1:1:1). Chili seeds were sowed in a seeding tray previously moistened with water until evenly distributed. Each planting holed consisted of one seed. The seeds will be transferred to small polybags 14 days after planting (DAP). Then, the seedling maintained until they were 40 DAP to transfer to the field. Planting was done with a spacing of 60 x 50 cm with a zigzag concept on mulch beds measuring 1 m x 10 m. Each planting hole is planted with one chili seed and given a buffer stake so that the plant does not collapse or break. Maintenance of chili plants includes watering, replanting, fertilizing, weeding, controlling pests and diseases, and harvesting. Watering is carried out twice a day, namely in the morning and evening. Embroidery is carried out on cayenne pepper plants that experience abnormal growth, wilt, and are attacked by pests or diseases. Embroidery time is carried out one week after planting (WAP) and carried out in the afternoon. The Fertilization is focused on chemical fertilizers NPK 15:15:15 which is done regularly once per week. The NPK fertilizer was diluted with a concentration of 5g/liter and 200 ml of the solution was given per plant. Weeding is done to remove weeds that interfere with growth around the plant which is carried out periodically once every three weeks. Control of pests and diseases using a mixture of insecticide Curacron 500 EC with a concentration of 2 cc/liter of water and fungicide Antracol 70 WP with a concentration of 2 g/liter of water. Pesticides and fungicides are applied by spraying on the soil surface and or under the leaves according to the level of attack of these pests and pathogens. The harvesting was carried out according to the common harvest criteria.

2. Data Analysis

The Observations were made on qualitative characters. The qualitative characters observed consisted of four characters, namely the color of the flower corolla, the color of the immature fruit, the branching habit, and the nodal color. All characters were displayed with individual frequency concepts in an Excel table.

C. Result and Discussion

The flower corolla color was shown in Table 1. In common, white was more dominant than other colors in the two populations (B/U = 91 and D/U = 144). Purple as the base color of Ungara was not seen in both populations. Meanwhile, the combination of the two populations occurs at the ends of the purple flower's corolla or purplish white flowers corolla (Nascimento N.F.F., M.F. Nascimento, R.M.C. Santos, C.H. Bruckner, & F.L. Finger, 2013). White as a general color in chili flower corolla that has a strong dominance. It was also reported by Gurung T., B.K. Sitaula, T. Penjor, & D. Tshomo (2020). When looking at the comparison between white and purplish white, there are two assumptions, namely, there is a duplication interaction between alleles, or crossover occurs in some parts of the purple trait. Possible duplication interactions are based on the proportion between white and purplish white. This proportion is close to a 15:1 ratio in the D/U population, so the interaction is thought to follow the pattern of allele duplication interactions between different loci (Sobir and Syukur, 2011). However, in the B/U population, the proportion between the two is 9:1 or does not follow the 15:1 duplication interaction proportion. In addition, the total purple trait did not appear in both populations in sufficient numbers. It indicates that the full purple corolla flower has too little probability. So, the color diversity pattern of the flower corolla is thought to not follow the concept of gene interaction. However, the pattern is thought to be more inclined to crossover blending. The possibility of crossing over is also corroborated by the purple color occurring only at the ends of the corolla flowers. When completely segregated, the color of the corolla flower will be purple in total.

Table 1. Inheritance pattern of flower corolla color in the population of chilies crossing Bara x Ungara and Dewata x Ungara

Population	Fruit corolla color		
	White	Purplish white	Purple
Bara x Ungara (B/U)	91	10	0
Dewata x Ungara (D/U)	144	10	0

The inheritance pattern of immature fruit colors was shown in Table 2. Based on the table, the population of the Bara x Ungara cross showed a purplish-green color (34) as the dominant color in immature fruits. It is followed by light green (22) and purplish white (15). On the other hand, the Dewata x Ungara cross shows that dark green is more dominant than other colors. It is followed by light green (37) and purplish green (31). Based on the results above, the inheritance pattern of immature fruit color shows a high complexity. It is also in line with the report of Herison C., E. Surmaini, Rustikawati, & Yulian, (2018). As a qualitative character, this character has quite a lot of groups. The more groups indicate that the more genes are involved in influencing the character. It was also reported by Jeong H-B., S-J. Jang, M-Y. Kang, S. Kim, J-K Kwon, & B-C Kang (2020), where there are three alleles PSY1, CCS, and PRR2 that affect the color of immature fruit. In addition, according to Andrade N.J.P., A. Monteros-Altamirano, C.G.T. Bastidas, & M . Sørensen (2020) immature fruit color is influenced by the interaction of two genes. These two reasons cause the mapping pattern of the inheritance of immature fruit color traits to be relatively complex. In general, the color of the immature fruit in the Bara variety is dark green, the Dewata variety is white, and the Ungara variety is purple. Crosses with the Ungara variety showed a significant contribution to the color of the immature fruit. The proportion of purple was reflected in both crosses, although the percentage of purple in the fruit was not too dominant. The high complexity of the fruit properties makes the purple color presentation more visible in the cross-population. It is different from the color of the corolla flower which has relatively few classes, so the effect of purple is minor on the character. The relatively dominant purple pattern will correlate with the increase in anthocyanins in chili fruit (Tang *et al*. 2020; Huang Y., X. Wang, W. Miao, H. Suo, C. Fu, M. Chen, X. Zhaoand, & L. Ou, 2021) so that crosses with the Ungara variety are considered effective.

Table 2. Inheritance pattern of immature fruit color in the population of chilies crossing Bara x Ungara and Dewata x Ungara

Population	Immature fruit color					
	DK	LH	PG	W	PW	P
Bara x Ungara	10	22	34	9	15	10
Dewata x Ungara	52	37	31	8	16	10

Notes: DK = dark green, LH = light green, PG = purplish green, W = white, PW = purplish white, P = purple.

The inheritance pattern of branching habits was shown in Table 3. Based on the table, both populations have dense branching habits (B/U = 51 and D/U = 66). It is different from Gurung *et al.* (2020) showed more sparse habits than other branching habits. However, the study worked on the concept of exploration rather than on the results of the cross. Sparse habit and intermediate habit in the population of Bara X Ungara have relatively the same number of individuals, namely 21 and 29, respectively. Meanwhile, the population of Dewata X Ungara has 36 and 52 individuals with sparse and intermediate branching habits, respectively. Based on the inheritance pattern, the dominance of dense characters is very prominent in the population of the Bara x Ungara cross. The Bara variety has a sparse branching habit, while the Ungara variety has a dense branching habit. On the other hand, in the Dewata x Ungara population, relatively dense canopy treatments had almost the same number as intermediate branching habits. It is because the Dewata variety is also dense, so the pattern that occurs is relatively dominated by dense and intermediate characteristics.

Table 3. Inheritance pattern Branching habit in the population of chilies crossing Bara x Ungara and Dewata x Ungara

Population	Branching habit		
	Sparse	Intermediate	Dense
Bara x Ungara	21	29	51
Dewata x Ungara	36	52	66

The color inheritance pattern of the book has very few classes, namely green and purple (Table 4). In common, the book green color predominates in both populations (B/U = 92 and D/U = 141). This pattern is similar to the color of the corolla flower, where the ratio is around 9:1 for the Bara x Ungara cross and 10:1 for the Dewata x Ungara cross. However, the color of the book is relatively small, so the inheritance pattern is relatively easy to predict. Possible interaction patterns on book characters are dominant interactions between alleles at one locus or duplication interactions between alleles at different loci. When viewed from the proportions of the two populations, the green and purple color patterns of the book are relatively close to the duplication interaction between alleles at different loci (Sobir and Syukur 2011). It is because the interaction between alleles in one locus has a ratio of around 3:1, so this pattern is very far from the results in book color (Syukur *et al.* 2015). Therefore, the inheritance pattern of book color is closer to the duplication interaction pattern between alleles at different loci.

Table 4. Inheritance pattern of book color in the population of chilies crossing Bara x Ungara and Dewata x Ungara

Population	Nodal color	
	Green	Purple
Bara x Ungara	92	9
Dewata x Ungara	141	13

D. Conclusion

The results of inheritance on qualitative characters have various patterns depending on the phenotype class possessed by these characters. Nodal color characters and corolla flower colors have relatively few gropus and have relatively the same comparison pattern. However, the color of the book is thought to have an inheritance pattern of duplication interaction, while the color pattern of the flower corolla has a role of crossing over the inheritance. Immature fruit color characters have many classes with complex interactions. Crosses with immature purple fruit relatively affect the inheritance pattern of fruit color and are correlated with an increase in fruit anthocyanins. Meanwhile, the inheritance pattern of the Branching habit shows a role of dominance, especially for the dense Branching habit. This cross pattern of qualitative characters is the basis for not continuing the analysis of the inheritance of quantitative characters, so these two populations are recommended to be analyzed more deeply for quantitative characters.

E. References

Andrade, N.J.P., A. Monteros-Altamirano, C.G.T. Bastidas, & M . Sørensen. (2020). Morphological, sensorial and chemical characterization of chilli peppers (*Capsicum spp*.) from the CATIE genebank. *Agronomy* 10(11):*1732*. https://doi.org/10.3390/agronomy10111732.

Benowicz, A., M. Stoehr, A. Hamann, & A.D. Yanchuk. (2020). Estimation of the F2 generation segregation variance and relationships among growth, frost damage, and bud break in coastal Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) wide-crosses. *Ann. For. Sci*. 77 (2): 1-13.

Cazzola, F., C. J. Bermejo, & E. Cointry. (2020). Transgressive segregations in two pea F2 populations and their respective F2:3 families. *Pesquisa Agropecuaria Brasileria* 55: 1-8.

Garg, M., N. Sharma, S. Sharma, P. Kapoor, A. Kumar, V. Chunduri, & P. Arora. (2018). Biofortified crops genenrated by breeding, agronomy, and transgenic approaches are improving lives of millions of people around the world. *Front. Nutr*. 5:12. Doi. 10.3389/fnut.2018.00012.

Gurung, T., B.K. Sitaula, T. Penjor, & D. Tshomo. (2020). Genetic diversity of chili pepper (*Capsicum spp*.) genotypes grown in Bhutan based on morphological characters. *SABRAO J Breed Genet*. 52 (4) 446-464.

Herison, C., E. Surmaini, Rustikawati, & Yulian. (2018). Morphological characterization of 10 chili pepper genotipes in low altitude land. *Akta Agrosia* 21(2):47-54.

Huang, Y., X. Wang, W. Miao, H. Suo, C. Fu, M. Chen, X. Zhaoand, & L. Ou. (2021). The photosynthetic characteristics of different purple peppers. *Holticulturae*. 7: 1-8. Doi.org/10.3390/ horticulturae 7090304.

Ilodibia, C.V., C.E. Ugwoke, T.P. Egboka, E.E. Akachukwu, U.M. Chukwuma, & B.O. Aziagba. (2015). Breeding pepper for enhanced food nutrients. *Asian J. Crop. Sci*. 7 (3): 214-218.

Jeong, H-B., S-J. Jang, M-Y. Kang, S. Kim, J-K Kwon, & B-C Kang. (2020). Candidate gene analysis reveals that the fruit color locus C1 corresponds to PRR2 in pepper (*Capsicum frutescens*). *Front. Plant Sci*. 11:399. doi: 10.3389/fpls.2020.00399.

Kusmana, K. Y. Kusandriani, & D. Djuariah. (2017). Yield trial of seven genotypes of chili in higland ecosistem in Pangalengan, West Java. *J. Hort*. 27(2): 147-154.

Rehan, A. Sharma, & P. Singh. (2020). Biofortification: Enriching vegetable crops with nutrients to reduce global hunger. *InInt. j. curr. microbiol. Sci*. 11: 2499-2511.

Nascimento, N.F.F., M.F. Nascimento, R.M.C. Santos, C.H. Bruckner, & F.L. Finger. (2013). Flower color in double and three-way hybrids of ornamental peppers. *Acta Hort*. 1000: 457-464.

Sobir, & M. Syukur. (2011). *Genetika Tanaman*. IPB press. Bogor (ID).

Syukur, M., S. Sujiprihati, & R. Yunianti. (2015). *Teknik Pemuliaan Tanaman*: Edisi Revisi. Penebar Swadaya. Depok (ID).

Tang, B., L. Li, Z. Hu, Y. Chen, T. Tan, Y. Jia, Q. Xie, & G. Chen. (2020). Anthocyanin accumulation and transcriptional regulation of anthocyanin biosynthesis in purple pepper. *J. Agric. Food Chem.* 68(43): 12152–12163 Doi.org/10.1021/acs.jafc.0c02460.

Umami, K., D.R. Anugrahwati, & I.K.D. Jaya. (2022). Pengaruh pupuk daun terhadap pertumbuhan dan hasil tanaman cabai rawit varietas Dewata 43 yang ditanam di luar musim. *Jurnal Ilmiah Mahasiswa Agrokomplek* 1(2): 148-154.