Correlation Between Fruit Characters with Capsaicin Content in F2 Population of Chili

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Abstract. Chili is one of the most important vegetable spice crop valued for its aroma, flavor, and pungency for Indonesian food. An experiment on chili (Capsicum annuum L) was undertaken to study the genetic correlation and relationship of morphological and fruit characters on capsaicin content using path analysis. The F2 population was developed from the cross between the high capsaicin content of cayenne pepper CF02 inbred line and curly chili K15 inbred line. Capsaicin content was negatively associated with fruit surface, fruit length, fruit diameter, fruit weight, and fruit weight per plant. Based on path analysis, these characters had direct effect and indirect effect on capsaicin content. Direct selection may be executed considering these traits as the primary selection criteria to reduce the indirect effect of other characters during the development of high yielding chili variety.

1. Introduction
Chili or pepper (Capsicum annuum L.) belongs to family Solanaceae. The center origin of chili is Mexico, with secondary centers in Guatemala and Bulgaria [1]. Chili is one of the most important vegetable spice crop valued for its aroma, flavor, and pungency [2]. The pungency of chili is due to a crystalline acid volatile alkaloid capsaicin (C18H27NO3) present in the placenta of fruit.

The plant breeder tries to partition the correlation coefficients into components of direct and indirect effects by employing the path coefficient analysis, which involves measurement of the influence of one trait upon the set of other traits through standardized partial regression coefficient to increase the efficiency of selection. Correlation and path analysis was proposed by Wright [3] to organize the intercourse between predictor variables and the response variable. Correlation measures association between capsaicin and fruit characters. This method is very useful in plant breeding programs to determine whether there is a relationship between fruit characters and the character of capsaicin content so that it is helpful to improve correlated responses [4]. Therefore the present investigation was carried out to determine the nature and degree of association among the fruit characters with their capsaicin content and their direct and indirect effects to chili.

2. Methods And Materials
The experiment was carried out in 2016-2017 at the farmer field Ciparanje, Jatinangor district. Totally 300 F2 chili plants obtained from the cross CF02 X K15 type and it was evaluated for high yield and quality characters during the year 2016. Observations were recorded on single plant wise for each of F2 populations. Cultivation techniques used in the research location are standard cultivation techniques in chili. The seeds are sown first in a sterile seedling tray until the age of three weeks after planting (WAP). The data was observed from nine quantitative characters, which includes fruit surface, fruity brightness, resilience, fruit length, fruit diameter, number of fruits, fruit weight per plant, weight per fruit, and capsaicin content. The data were statistically analyzed for estimation of the correlation coefficient among different characters. The path coefficient of various fruits characters
towards capsaicin content was calculated according to [5].

3. Results and Discussion

High correlation only shows the closeness of the relationship between traits but cannot prove a causal relationship. Path analysis can be used to determine the causal association and can sort it into direct and indirect influences [6]. Fruit characteristics included in the path analysis were fruit surface, fruit length, fruit diameter, fruit weight per plant, and weight per fruit, because these characters correlate with capsaicin levels (P > 0.05) based on the Pearson correlation test. The results of this study indicate that the type of cayenne pepper has the spiciest taste which is characterized by high capsaicin contents. The level of capsaicin strains tested ranged from 0.09 - 1.06. The highest yield was achieved by lines 212 and 249 respectively 1.05 and 1.06. The results of the correlation coefficients was presented in Table 1.

| Traits                  | Z1  | Z2  | Z3  | Z4  | Z5  | Z6  | Z7  | Z8  | Y   |
|-------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Fruit surface           | 1   | 0.355*** | 0.070 | 0.677*** | 0.055 | -0.057 | 0.397** | 0.647** | -0.238***|
| Fruit Bright            | 0.355*** | 1   | -0.050 | 0.312** | 0.051 | -0.028 | 0.208** | 0.350** | -0.094   |
| Resilience              | 0.070 | -0.050 | 1   | 0.046 | 0.044 | 0.016 | 0.111 | 0.040 | 0.006   |
| Fruit Length            | 0.677** | 0.312** | 0.046 | 1   | 0.044 | -0.085 | 0.548** | 0.871** | -0.290***|
| Fruit Diameter          | 0.055 | 0.051 | 0.044 | 0.044 | 1   | 0.237** | 0.227** | 0.096 | -0.176   |
| Number of fruit         | -0.057 | -0.028 | 0.016 | -0.085 | 0.237** | 1   | 0.678** | -0.151* | -0.074   |
| Fruit weight per plant  | 0.397** | 0.208** | 0.111 | 0.548** | 0.227** | 0.678** | 1   | 0.525** | -0.215***|
| Weight per fruit        | 0.647** | 0.350** | 0.040 | 0.871** | 0.096 | -0.151* | 0.525** | 1   | -0.299***|
| Capsaicin content       | -0.238** | -0.094 | 0.006 | -0.290*** | -0.176* | -0.074 | -0.215** | -0.299** | 1   |

Information: Z1: Fruit surface; Z2: Fruit Brightness; Z3: Resilience; Z4: Fruit Length; Z5: Fruit diameter; Z6: Number of fruit; Z7: Fruit weight per plant; Z8: Weight per fruit; Y: Capsaicin content.

The results of correlation analysis on the F2 generation of the cross between the high capsaicin content of cayenne pepper CF02 inbred line and curly chili K15 inbred line showed that the significant highly correlation with capsaicin content. This indicates that chili genotypes that have high capsaicin levels tend to have a character. The results of correlation analysis showed that the characters of fruit surface, fruit length, fruit diameter, fruit weight per plant, weight per fruit were highly significantly correlated with capsaicin levels, with a correlation coefficient (r) of -0.238, -0.290, -0.176, -0.215, and -0.299. This result indicated that chili genotypes which have low capsaicin levels tend to have small fruit length, small fruit diameter and fruit weight per plant and low weight per fruit. The correlation between capsaicin levels and other characters is not significant or negative.
This shows that the character most influence the capsaicin content levels. According to [7], the independent variable that has the most significant impact on the dependent variable is determined as a direct influence. Direct influence can be interpreted if each increase in one standard deviation in an independent value will increase the standard deviation of a dependent variable. There is a correlation between morphological characters with the character of capsaicin contents, giving opportunities are used as morphological characters selection criteria to get characters fruit components required.

The path-coefficient analysis can explain the relative contribution of fruit characters to capsaicin levels, both directly and indirectly (Table 2). Five morphological characters contributed 34.4 % to the variation of capsaicin content. However, there characters significantly contributed to the capsaicin content of chilli (F $\leq$ 0.05).

**Table 2.** Direct and indirect effects for five quantitative traits in chilli (*Capsicum annuum* L.).

| Variable | Direct influence | Indirect influence | Total |
|----------|------------------|--------------------|-------|
|          | Direct influence |                    |       |
| Fruit surface | -0.053 | 0 | -0.07582 | -0.00825 | -0.01032 | -0.09058 | -0.238 |
| Fruit length | -0.112 | 0 | 0 | -0.00656 | -0.01425 | -0.12194 | -0.290 |
| Fruit diameter | -0.149 | 0 | -0.00493 | 0 | -0.0059 | -0.01344 | -0.176 |
| Fruit weight per plat | -0.026 | 0 | -0.06138 | -0.03382 | 0 | -0.0735 | -0.216 |
| Weight per fruit | -0.140 | 0 | -0.09755 | -0.0143 | -0.01365 | 0 | -0.299 |

Path diagrams are used to clarify further the description of path analysis put forward (Figure 1). By combining diagrams geometric and algebraic equations, then in-depth statistical analysis study the causal-effect correlation between variables to be more weighted in the sense that the results are easier to understand. Path diagrams are arranged based on the underlying knowledge about causal relationships based on the hypotheses made [8].

Efforts to determine the characters that can be used as criteria of effective selection can be seen from the magnitude of direct influence, the correlation between characters and the difference between associations between independent variables and influences directly the variable [9]. Thus the character which matches the selection criteria is characters had influence values directly positive marked equal to the correlation value and had a difference small. The fruit diameter has a value of -0.176 is the character that gives the most direct influence on the capsaicin content.
Figure 1. Path diagram quantitative character on the F₂ generation chili.

4. Conclusion
Based on the results of the experiment can be concluded that the characters that have a direct influence on capsaicin content is fruit surface, fruit length, fruit diameter, fruit weight per plant, and weight per fruit. Morphological characters that have direct influence can be used as selection criteria for improving spiciness character.

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