Response of cocoa pod borer to chlorogenic acid

A P Firmansyah¹, S Sjam², G Alam³ and V S Dewi²

¹Agriculture Science Study Program, Graduate school, Universitas Hasanuddin, Makassar, 90245, Indonesia.
²Pest and Plant Disease Department, Faculty of Agriculture, Universitas Hasanuddin, Makassar, 90245, Indonesia.
³Pharmacy Department, Faculty of Pharmacy, Universitas Hasanuddin, Makassar, 90245, Indonesia.

E-mail: amandapatappari@pasca.unhas.ac.id

Abstract. Chlorogenic acid was first isolated from coffee beans, and this compound is found in many plants including cocoa fruit. Besides functioning as an antibacterial and antioxidant, this compound also acts as an insect repellent and attractant. According to literature, chlorogenic acid is a stimulant for laying eggs. Because this compound is also found in cocoa and has a function in attracting insects, an experiment was conducted to determine the response of the main cocoa pests, cocoa fruit borer (CPB). Pure dissolved chlorogenic acid was divided into several concentrations and then tested with CPB adults male and female. The results of this test show that at concentrations of 5% of chlorogenic acid compounds attract more CPB, and the average of the CPB adults whose choose is female. The most of CPB visit time was 3 hours after the experiment was carried out then stop visit after 18 hours.

1. Introduction
Chlorogenic acid is a secondary metabolite compound derived from the phenol group [1]. This compound was first discovered in coffee by Robiquet and Boutron [2], and also found in several other plants such as bluberry, grapes, pears, apples, sweet potatoes, cherries [3] and cocoa [4]. Cocoa is widely cultivated by farmers in Indonesia but is hampered by destructive pest cocoa pod borer (CPB; Conophomorpa cramerella Sn.) [5]. CPB is the main pest of cocoa which causes yield losses of up to 80% [5]. The ability of this pest to detect cocoa is influenced by plant chemical compounds, and chlorogenic acid is a component of cocoa pod. These compounds have several functions such as increasing the mechanism of plant resistance to pathogens and insects [7], as antioxidants and antibiotics [8], and stimulants for laying eggs [9]. Based on the description, the purpose of this study is to determine the effect of chlorogenic acid on CPB imago.

2. Material and methods
This research was carried out in the Pest and Disease Laboratory of the Faculty of Agriculture, Universitas Hasanuddin, Makassar, South Sulawesi from August to November 2018.
2.1. Experimental apparatus
Materials used in this study were CPB adults (male and female), chlorogenic acid (Sigma Aldrich), ethanol, sterile cotton, and gauze. The tools used in this experiment were plastic boxes dimension (9x16x13 cm), translucent plastic pipe, measurement pipe, vial bottle, homogenizer and labels.

2.2. Problem formulation
Pupae of CPB were taken from Anreapi village, West Sulawesi and then kept until they become adult. Chlorogenic acid was dissolved with ethanol to make concentrations (1%, 3%, 5% and 7%). Three plastic boxes connected by clear plastic pipes (20 cm long, 6 cm diameters) were arranged horizontally, the middle part to insert the CPB adult and the other two to place the treatment. 0.5 ml of chlorogenic acid solution were dropped on cotton wool and placed in a treatment box. Twenty 20 CPB imago (10 females and 10 males) were placed in the center box, then observed every 3 hours for 24 hours. The parameters included the number of CPB imago and the level of interest in each treatment.

3. Result and discussion

3.1. Number of CPB adult in each treatments
Chlorogenic acid showed an effect to CPB adult and this proven by the number of CPB imago in each treatment compared to the control (ethanol). Analysis of variance showed that the treatment had a very significant influence on the percentage of CPB testing. Table 1 shows that the 5% concentration of chlorogenic acid treatment was the highest percentage of CPB visit with an average value of 46.25% and was significantly different from all the other treatments. CPB imago of interest in chlorogenic acid was suspected because this compound was identified (inherited by its parent) as a marker of its host plant. Cocoa fruit contains chlorogenic acid [4], this compound plays a key role of stimulating insects to lay eggs [9].

| Treatment | Chlorogenic acid |
|-----------|------------------|
| 7%        | 21.25 b          |
| 5%        | 46.25 a          |
| 3%        | 15.00 c          |
| 1%        | 8.75 d           |
| Control   | 3.75 d           |
| LSD_{0.05} | 5.15            |

Note: Numbers followed by the same letter (a,b,c,d) in the same column mean not significantly different in the 5% LSD test.

3.2. Percentage of interest of CPB adult in each treatments
Based on the number of CPB adult in each treatment (table 2), it can be seen the class of interest in chlorogenic acid. Concentration of 5% chlorogenic acid had the highest percentage of interest with 81.08% (very high category). This shows that this compound is very influential on CPB adults when compared to controls (ethanol). Chlorogenic acid is a phenol compound that can stimulate several insects, among insects originating from the Lepidoptera and Coleoptera orders. Effects caused by chlorogenic acid include stimulating insect pollinators, stimulants to lay eggs, or can also act as a food barrier.
Table 2. Percentage of interest of CPB adult in each treatments

| Concentration | Percentage of interest (%) | Category     |
|---------------|-----------------------------|--------------|
| 7%            | 58.82                       | Moderate     |
| 5%            | 81.08                       | Very high    |
| 3%            | 41.67                       | Moderate     |
| 1%            | 0                           | Negative     |
| Control       | 0                           | Negative     |

4. Conclusions
Chlorogenic acid 5% concentration greatly influenced on adult of CPB, this can be seen from the large number of adults in the treatment and the percentage of interest.

Acknowledgments
This research cannot be accomplished without funding from LPDP and cocoa farmers in Anreapi village West Sulawesi for their hands to collecting the pupas.

Reference
[1] Hendrawan V F, Wulansari D and Oktanella Y 2018 Effectiveness of chlorogenic acid supplementation on VEGF serum and placental MAP kinase expression in carbon Black-Exposed pregnant rattus norvegicus Res. J. Pharm. Technol. 11 1830–4
[1] Robiquet and Boutron 1837 Ueber den Kaffee von Robiquet und Boutron Ann. Pharmacie 23 93-95
[2] Sondheimer E 1958 On the distribution of caffeic acid and the chlorogenic acid isomers in plants Arch. Biochem and Biophys 74 131-138
[3] Harborne J B, Baxter H and Gerard P M 1970 Phytochemical Dictionary “A Hand book of Bioactive Coumpounds from Plants “ second Edition (Oxford: Taylor and Francis, Ltd)
[4] Gassa A, Fatahuddin, Abdullah T, Junaid M 2016 Black ant (Dolichoderus thoracicus): Artificial diet and nest prospects in controlling cocoa pod borer (Conopomorpha cramerella Sn.). Research Journal of Pharmaceutical, Biological and Chemical Sciences 7 3185-91.
[5] Wardojo 1980 Strategi Penelitian dan Pemberantasan Penggerek Coklat Proceeding Konfrensi Coklat Nasional Medan 16-18 November 1980
[6] Lattanzio V, Lattanzio V M T and Cardinali A 2006. role of phenolic in the resistance mechanisms of plants against fungal pathogens and insect Phytochemistry: Advances in Research ed Imperato F (Kerala: Research Signpost)
[7] Leitao S, Guerra-Guimaraes L, Bronze M R, Boas L V, Sa M, Almeida M G H, Silva M C. 2015. Chlorogenic Acid Content in coffee leaves: Possible role in coffee leaf rust resistance.
[8] Renwick J A A and Radke C D 1981 Host plant constituents as oviposition deterrents for the cabbage looper Tricophlusia ni Entomol. Exp. Appl. 30 201-4