“CIRAGI” - The microbial fermentation starter for developing excellent coffee flavour

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Abstract. Most of the green bean coffees produced by smallholders are not properly fermented, while green bean coffees from large plantations undergo a spontaneous fermentation involving present microbial activity in the processing environment. The process of coffee fermentation itself involves not less than 144 endogenous microbial species originating from coffee fruits or from the surrounding environment. This condition is the source of inconsistency and low cup quality of coffee beans. The inoculation of selected microbial fermentation starter can transform microbial ecosystem. The transformation leads to beneficial microbes dominating and actively inducing flavour precursors into excellent aroma during roasting. The Indonesian Research Institute for Biotechnology and Bioindustry (IRIBB) has developed the CIRAGI (abbreviation of CitraRAsa tingGI meaning “a high flavour” in Indonesian), a fermentation starter for coffee beans using selected Lactobacillus sp. as the active ingredient. High cup quality coffee can consistently result from well-controlled fermentation process of the coffee bean using CIRAGI. The fermentation of both Robusta and Arabica coffee beans using CIRAGI has been demonstrated at laboratory and field trials. The cup tests of both Arabica and Robusta coffee have resulted in improved quality of the coffee flavour, increase of cup test scores based on the SCAA parameter, and elimination of off-flavour.

1. Introduction

Spontaneous fermentation of coffee beans using natural microbes is difficult to produce delicious taste precursors due to abundant natural microbes (about 144 strains) of different types depending on the processing environments [1, 2].

The efforts to improve the quality of coffee bean taste has been done, among others, through (1) application of yeast isolated from coffee fermentation [3], (2) the process of making artificial civet coffee, which mimics the process that occurs in the civet stomach [4] and civet coffee probiotics [5]. The Agustinisari, et al. used bioreactor to imitate the fermentation inside civet (Paradoxurus hermaphroditus) digestive system was being processed to obtain Indonesian Patent [4]. The fermentation starter used in this
research was bacterial isolates from civet digestive system liquid. This coffee making process was difficult to be applied in farmer's level due to the high price of the fermentor, also the limitation of fermentor capacity. The fermentation using microbial enzymes was considered expensive because of the microbial enzyme isolation cost. Moreover, the addition of crude enzyme could reduce the cup test score [6].

Most of the microorganisms that involved in the spontaneous fermentation of coffee were from coffee fruit or from the surrounding environment, i.e. fruit skin, mucus, and the shell of coffee bean. Besides that, the microbes may locate around the coffee processing environment site, i.e. in the fermentation box, the fermentation sacks, also the contamination from workers hand that involved in the fermentation process. Therefore, this spontaneous fermentation will produce various coffee flavours; depend on the type of indigenous microbes, the preparation of the fermented beans, the fermentation equipment, and the fermentation environment [7].

With adequate fermentation using important microbes from consistent inoculum, the fermentation process will run and the precursor’s flavour of coffee will be formed. This process will produce a tasty and consistent coffee flavour during coffee bean roasting. Indonesian Research Institute for Biotechnology and Bioindustry (IRIBB) has a coffee bean fermentation starter named “Ciragi” with an active ingredient of superior 

Lactobacillus sp. that proved significantly increase the flavour of Robusta and Arabica coffees. The coffee bean fermentation starter “Ciragi” has been registered to Indonesian patent (Registration Number P-00201407291) and has obtained the trademark registration number (No. D002014052980).

This study presents the performance of Ciragi fermentation starter in improving the taste of Robusta and Arabica coffees from several coffee-producing regions in Indonesia compared to spontaneous fermentation result. The performance of the fermentation starter was measured based on the increase of coffee cup score that fermented with Ciragi compared to control without the addition of Ciragi.

2. Materials and Methods

The materials used in this study were Arabica and Robusta coffee bean from several regions in Indonesia from Sigararutang, AS2K, S795, and mixed varieties, which have been ripening optimally, and Ciragi fermentation starter with active ingredients 

Lactobacillus sp. Each coffee cherry was peeled using a pulper machine. The study was conducted with a minimum 100 kg of peeled-off coffee (pulped coffee cherries) for Ciragi treatment and control with two replications.

Fermentation using “Ciragi” was done by adding 0.5-1% (w/w) “Ciragi” starter to the peeled-off coffee (0.5-1 kg Ciragi per 100 kg peeled-off coffee) and then mixed evenly. Fermentations were done in plastic bags for 12-36 hours. Fermentation without “Ciragi” as control was done according to Standard Operational Procedure (SOP) applied in government own estate with 36 hours of fermentation time. After fermentation, each wet HS coffees were washed and dried under the sun until the moisture content reached 15%. Each HS coffee was peeled into green bean and re-dried under the sun until the water content reaches 12%.

As much as 250 g of green bean coffee samples, both for the treatment (fermented with Ciragi) and control (fermented without Ciragi), were sent to Indonesian Coffee and Cocoa Research Institute (ICCRI) for a flavour test based on SCAA cupping-protocols (http://www.scaa.org.). Several separated samples of green beans that fermented using “Ciragi” and control without Ciragi were sent to Laboratory in Netherland for cup test score based on Qmax and flavour notes.

3. Results and Discussion

The experiments of Ciragi fermentation have been done in several coffee estates in several provinces in Indonesia, namely West Java (Pangalengan and Ciwidey), Central Aceh (Bener Meriah and Takengon Regency), East Java (Jember and Banyuwangi), West Sumatera (Solok), East Nusa Tenggara
(Manggarai), South Sulawesi (Tana Toraja) and Central Java (Banaran). The type of coffee that used for this experiment depended on geographic condition. Some provinces only produce Arabica or Robusta coffee, but the other regions may produce both types of coffee.

3.1. Effect of fermentation starter against fermentation time
The preliminary study showed that fermentation using Lactobacillus formula could shorten the fermentation time from 36h to 12h (data not shown). The shorten fermentation time has several advantages, i.e. reduce the need of fermentation facilities, especially fermentation site and labour during the peak season of the coffee harvest period. For this reason, fermentation using Ciragi can be carried out for 12 hours. While the fermentation without Ciragi, the optimum fermentation time was achieved after 36 hours using a standard operational procedure that implemented in the government own estate.

3.2. Cup test data from ICCRI
Table 1 showed that the application of "Ciragi" starter on coffee fermentation proved to significantly increase the cup score as well as the specialty level of coffee, both Arabica and Robusta coffees. These results are in line with the data in Table 2 that show the cup test results from Netherland laboratory.

| No. | Sample origin | Type of coffee | Cup test score and flavour note without “Ciragi” | Cup test score and flavour note with “Ciragi” |
|-----|---------------|----------------|-----------------------------------------------|---------------------------------------------|
| 1.  | Ciwidey, West Java | Arabica | 82.75; spicy, herbal, astringent | 86.25; sweetcorn, fragrance, lemony |
| 2.  | Bener Meriah 1, Aceh | Arabica | 81.0; herbal, astringent, greenish, bitter after taste | 85.0; flowery, sweet, sweet corn, caramelly, bright acidity |
| 3.  | Bener Meriah 2, Aceh | Arabica | 80.75; fruity aroma, chocolaty | 84.08, chocolaty, caramelly, clean |
| 4.  | Manggarai, East Nusa Tenggara | Robusta | 79.38; dark chocolaty, rather rubbery, rather chemical, very astringent | 84.50; chocolaty, acidity, excellent, buttery, fresh. On second experimental trial get cup score 89.30; Champion no 1 Banyuwangi Nusantara Coffee Festival |
| 5.  | Manggarai, East Nusa Tenggara | Arabic | 82.75; spicy, herbal, astringent | 86.25; sweet corn, fragrance, lemony. On second experimental trial get cup score 87.52; Champion no 1 Banyuwangi Nusantara Coffee Festival |
| 6.  | Tana Toraja, South Sulawesi | Arabic | 83.50; spicy, herbal | 85.38; spicy, nutty |
| 7.  | West Java | Arabic | 83.50; vanilla, astringent, heavy body | 84.50; caramelly, balance |
| 8.  | Bogor, West Java | Arabic | 80.00; spicy | 85.50; chocolaty |
| 9.  | Banaran, Central Java | Robusta | 79.50 woody, caramelly | 84.50 caramelly, spicy, vanilla |
The latest data collected from applications of "Ciragi" fermentation starter were shown in the cup test results of Arabica Toraja coffee, Robusta Banaran coffee from government own estate, and farmer’s coffee from Bogor region. In three samples observed, application of fermentation starter proved to increase the cup test score. The use of fermentation starter was also able to reduce astringency, herbal, and spicy-off flavours which are classified as coffee flavour defects.

3.3. Cup test score data from Netherland Laboratory
Similar data were obtained from Netherland laboratory (Table 2). Qmax from coffee bean fermented using Ciragi was higher compared to control without Ciragi. Some good flavour notes also appear from coffee fermented using Ciragi.

Table 2. Overall results of cup test score and flavour note from the Netherland laboratory for several

| No. | Variety (field)                  | Control                      | Using fermentation Starter (Ciragi)                                                                 |
|-----|---------------------------------|------------------------------|---------------------------------------------------------------------------------------------------|
| 1.  | ANDUNSARI Variety, Sindangkerta field | (No data)                     | Good smell, Good taste, Good body, Good acidity, Well balanced Fraction sweet/ fruity Good aftertaste.  
|     |                                 |                              | Q mark: 8.0                                                                                     |
| 2.  | ANDUNSARI Variety, Pangalengan field | Fraction common flat smell, Good body, fraction common/flat a little less sweet/fruity. Fairly neutral.  
|     |                                 |                              | Good smell, Sweet ferment, Good body, good acidity, green fruity aromatic but fraction ferment        
|     |                                 |                              | Q mark: 8.25                                                                                   |
| 3.  | SIGARARUTANG Variety, Pangalengan Field | Good smell, Good body, Good aroma, good fruity acidity, fraction flat  
|     |                                 |                              | Good smell, Good body/aromatic Fraction green, Good acidity, Rather sweet Q mark: 8.2              |
| 4.  | SIGARARUTANG Variety, Sindangkerta field | Good aromatic smell, Good body, good acidity, Some sweet fruity acidity, Good balance Nice aftertaste.  
|     |                                 |                              | Good smell, Good body, good acidity, good sweet/ fruity aromatic with a very good aftertaste        
|     |                                 |                              | Q mark: 8.5                                                                                   |
| 5.  | Mix Variety, Ruunggunung field | Good smell, Good body, Somewhat sweet/fruity, Good acidity, Well balanced with a nice aromatic aftertaste  
|     |                                 |                              | Good smell, Very good, Green sweet/fruity, Good balance aromatic, Good aftertaste. Q mark: 8.5     |

Data in Table 1 and 2 showed that *Lactobacillus* sp. as a fermenter was proven capable of increasing cup score of coffee bean. The improvement of coffee flavour using “Ciragi” fermentation starter was better than using physical treatment as described by Yusianto & Widyotomo (2013) [8]. Improving fermentation was the important way in increasing the quality of coffee bean [9]. Furthermore, the use of *Lactobacillus* sp. in coffee fermentation can reduce contamination by another microorganism, especially in suppressing the contamination of *Aspergillus ochraceus* that produce ochratoxin [10].

4. Conclusions
Coffee bean fermentation starter “Ciragi” with the active ingredient of selected *Lactobacillus* sp. was proven consistently capable in improvement cup score of Robusta as well as Arabica coffee in laboratory and field trials. The improvement of cup score and the elimination of off-flavour may result from well-controlled fermentation process of the coffee bean using these selected bacteria. Fermentation using
selected bacteria has several advantages, not only in improving the formation of flavour precursor but also shorten the fermentation time from 36 to 12 hours.

5. Acknowledgements

Authors would like to thank Indonesian Coffee and Cocoa Research Institute (ICCRI) for flavour test of coffee samples and to Government own estate PTPN 9 for giving coffee cherries sample.

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