Hygiene and Sanitation on Post-Harvest Coffee Processing in the South OKU Regency Comunity (Case Study)

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Abstract. One of the Robusta coffee producing areas in South Sumatera is South Ogan Komering Ulu Regency and it has an area of 70,799 hectares which is spread across 11 sub-districts. This study aims to assess the level of hygiene and sanitation in post-harvest coffee processing, and it was conducted through direct surveys at harvest time and by interviews and questionnaires. Sampling was carried out deliberately, on 30 coffee farmers spread across eleven villages in BPR Ranau Tengah Sub-District. The results showed that the farmers had not yet implemented hygiene and sanitation in post-harvest processing which involved every activity from the picking of the fruit to its storage. At the fruit picking stage, all colors were collected and then dried together without any sorting. The drying stage did not meet the post-harvest coffee processing standards, as it resulted in high water content of the beans, which was between 62,26 ±0,76 % and 13,97±0,55. Likewise, the storage process did not meet the hygiene and sanitation standards because not only were the coffee beans put in sacks, they were also stored in poorly ventilated warehouses or storage areas and mixed with other commodities. This predisposed them to fungi contamination. Two ochratoxin producing fungi, namely, Aspergillus niger and Aspergillus ochraceus were found in processed and stored coffee beans that did not meet hygiene and sanitation standards.

1. Introduction

Coffee is a type of plantation crop that has long been cultivated, and plays an important role, both as a source of foreign exchange and support for the people's economy. Indonesia is the second largest coffee producing country in Asia after Vietnam[1]. One of the Robusta coffee producing areas in South Sumatra is South OKU Regency. In this community, the quality of coffee produced is of grades 4, 5 and 6. This is partly due to the low quality of plant materials, and poor post-harvest handling [2][3].

One aspect of quality standards that is currently being required by markets world-wide, especially by the European Union, is the absence of ochratoxin contamination in coffee beans that will be traded through exports. Aspergillus species which produces this contaminant include A.ochraceus, A. carbonarius and A. niger, while Penicillium species, are P. verrucosum, P. citrinum and P. viridicatum [4][5]. Ochratoxin is known to be capable of causing liver cancer and degeneration, fever, brain swelling, and kidneys, and neurological disorders [6][7]. Therefore, its existence in various
commodities is prohibited. The processes required to eliminate or reduce ocratoxin are very expensive, therefore, many farmers choose to leave the contaminant in the coffee. Moreover, according to a research by [8], there is still a way to solve this problem, and it involves preventing the emergence of the causative microorganisms which are A. niger and A. ochraceus fungi. The potential of the people's coffee commodity in Buay Pematang Ribu (BPR) Ranau Tengah gives implications for the importance of implementing Standard Operating Procedures in post-harvest coffee processing, to reduce this contaminant, as well as increase the quality and uniformity of coffee produced. The research aims to determine the level of hygiene and sanitation in post-harvest coffee processing, and the handling procedures currently carried out in BPR Ranau Tengah Sub-District in Indonesia.

2. Material and method
This research was conducted in the Microbiology Laboratory of the Mathematics and Natural Sciences Faculty, Sriwijaya University, and in coffee plantations in BPR Ranau Tengah Sub-District, Indonesia from May-July 2020. Sampling was carried out on 30 coffee farmers spread across eleven villages, using the purposive sampling method. This research was conducted by observing, direct interviews with farmers, and through the distributing questionnaires. Furthermore, coffee bean samples were also obtained from each farmer and then observed and examined in the laboratory to check for the possibility of ocratoxin A-producing fungi causing liver cancer and degeneration, fever, brain swelling, kidneys and neurological disorders in consumers. Observations and interviews were carried out directly on farmers regarding the post-harvest process, starting from picking the fruit to storage processes, related to hygiene and sanitation. Sampling is conducted to check the water content and the presence of fungal contaminants producing toxins. It aims to study the impact of post-harvest coffee processing activities on hygiene and sanitation standards for food processing.

2.1. Water content analysis
Analysis of the water content of the beans was carried out according to SNI:01-2907-2008. The clean porcelain dish was dried in an oven at 105°C for 1 hour without the lid. Then it was removed using tweezers and cooled in a desiccator, still without the lid, for 1 hour. After cooling, the dish was weighed and covered. Next, 2 grams of coffee were collected using a porcelain dish, and dried in an oven at 80°C for 8 hours, with the lid removed. After that, using pliers the porcelain dish was closed, and then cooled in a desiccator for 30 minutes without the lid. Next, it was closed shut and weighed. Determination of the water content carried out by calculating the difference between the weight of the coffee sample before and after drying in the oven.

2.2. Analysis of ocratoxin producing fungi in coffee beans
Analysis was performed using direct plating (BAM 2001 method). Coffee beans from each sample were disinfected twice with 1% Na-hypochlorite for one minute each, and then rinsed with sterile distilled water twice for 1 minute each. Next, they were dried in a Petri dish which was covered with 2 sheets of sterile filter paper. After that, 10 seeds were placed in Petri dishes (in diameter 9 cm) containing the PDA medium, into which 0.01% chloramphenicol had been added. The seeds were then inoculated when the medium was frozen, and incubated for 4 to 5 days at room temperature until there was fungal growth on the PDA medium. Activities were carried out in Laminar Air Flow (LAF), and then observed macroscopically by paying attention to the characteristics of A. niger and A. ochraceus fungi. After that the fungal isolates were grown on MEA (Malt Extract Agar) media and observed microscopically. Identification was carried out by using key fungal identification tables, or by matching the descriptions contained in the Introduction of Food and Airborne [9], and Phylogeny, identification and nomenclature of the genus Aspergillus[10].

3. Result and discussion
The survey results and interviews show that coffee is still harvested using the traditional method, where farmers only go through 3 stages; namely, harvesting, drying, and storing. The observation
results of hygiene and sanitation are presented in Table 1 below.

**Table 1. Observations on the hygiene and sanitation of coffee farmers in BPR Ranau Tengah sub-district**

| Criteria                        | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---------------------------------|---|---|---|---|---|---|---|---|---|----|----|
| **Hygiene**                     |   |   |   |   |   |   |   |   |   |    |    |
| Drying:                         |   |   |   |   |   |   |   |   |   |    |    |
| - Clothes                       | + | + | + | + | + | - | - | + | + | + |   |
| - Wearing face shield           | + | + | + | + | + | - | - | + | + | + | - |
| - Gloves                        | - | - | - | - | - | - | - | - | - | - | - |
| - Footwear                      | - | - | + | + | + | + | + | - | - | - | - |
| **Sanitation**                  |   |   |   |   |   |   |   |   |   |    |    |
| How to Pick (concoction) **(R)**|   |   |   |   |   |   |   |   |   |    |    |
| Sortir                          | - | - | - | - | - | - | - | - | - | - | - |
| Drying:                         |   |   |   |   |   |   |   |   |   |    |    |
| - Tarp                          | BP | BP | BP | BP | BP | BP | BP | BP | BP | BP | BP |
| - Location                      | H  | H  | K  | K  | H  | K  | H  | K  | H  | H  | H  |
| Storage in warehouse            |   |   |   |   |   |   |   |   |   |    |    |
| - Ventilation                   | + | - | - | + | + | - | - | + | - | - | - |
| - PP sacks                      | New | New | BP | New | BP | New | New | New | BP | New | New |

Desc: Village sequencesly: (1,2,3 dst)=Tj. Setia, Suka Marga, S.Sender Tengah, Tj. Kemala, Subik, Jepara, S.Sender Timur, Serumpun Jaya, Hangkusa, Simpang Sender, Sukarame. BP=Used, H=Yard, K=Garden

### 3.1. Coffee Harvesting

Harvesting is conducted by picking all the fruit contained in a branch, regardless of their color. Based on the questionnaires and direct interviews with farmers, the method of harvesting green seeds is by biting them. If they feel hard, they can be harvested because it means they are old, but they are left alone if they are soft. This method is not following the standard for harvesting coffee. According to this standard, coffee is only to be harvested when red. Harvesting at the proper time will provide technical advantages, such as ease in peeling the skin without damaging the skin and economic benefits in the form of an increase in yields. Furthermore, sugar compounds in the fruit pulp positively correlate with the types and amounts of flavor-forming compounds in the beans. A red fruit will have a more complete and maximum chemical composition of flavor-forming compounds \([11][12]\). According to \([12]\) and \([11]\), the harvested coffee beans that are still green or yellow are very susceptible to the microorganism’s growth. They still contain many cellulose fibers preferred by fungi, where the red ones contain high sucrose. The greenfruit will contaminate and affect the quality of the red coffee that is dried within simultaneously.

### 3.2. Drying

Drying coffee in BPR Ranau Tengah uses a dry process, and this method is carried out because its results are better. It is conducted on the tarp at the house yard on the day; therefore, it is simply folded at the middle with the coffee beans still inside in the afternoon. However, coffee beans left in a closed state will sweat, making them vulnerable to microbial growth, such as fungi \([12]\).

From the observations, the tarp used is almost never cleaned, unless when exposed to sudden rain or after being used for drying pepper. Therefore, coffee beans are prone to microbial contamination from these untreated tarp. Fungal contamination in the natural or dry process is greatly influenced by...
the processing method, namely, the drying period and the cleanliness of the equipment used, as well as environmental conditions during processing. The techniques closely related to fungal contamination, namely, fungi and mycotoxin production [13] [14]. At this stage, a reduction in water content from 62.26 ±0.76% to 13.97±0.55 was observed in the average initial (fresh fruit). However, it increased again after storage (Figure 1).

![Figure 1. Water content of coffee beans during drying and storage](image)

3.3 Storage process

Storage is carried out using a polyethylene (PE) sack that is usually replaced when torn or no longer suitable for use. Warehouse buildings are often used to store a variety of commodities, namely coffee and pepper. However, these buildings are not usually adequately ventilated (Table 1). Storage is an activity that is influenced by packaging and is carried out to manage coffee beans' supply and keep them safe [14]. Product packaging is one-factor affecting shelf life because it plays an essential role in protecting products against adverse environmental conditions [15]. Polyethylene (PE) sacks have a reasonably good density level, ensuring that the packaged materials do not come out of them and are waterproof and durable. In addition, these sacks are not airtight, and when used repeatedly, are susceptible to microbial contamination. According to the SNI standard, water content above the recommended 12.5% predisposes coffee beans to microbial action. In this study, water content ranged from 13.97±0.55% after drying but increased to 16.63±1.17% on storage 20 days and 15.99±1.33 on storage 30 days (Figure 1). Two contaminant fungi produce ochratoxin, which is dangerous for consumer health, namely *Aspergillus ochraceus* and *Aspergillus niger* (Figure 2).

![Figure 2. Coffee beans sample containing A. ochraceus (a) and A. niger (b) fungi producing ochratoxin A](image)

It includes a group of 7 isocoumarin derivatives that are related to the amino group of L-β phenylalanine through amide bonds. Currently, there are at least three types of ochratoxin, namely type A (OA), B (OB), and C (OC). The A-type is the most toxic and commonly found in nature. Aflatoxin is another type of mycotoxins that is commonly found in coffee. Furthermore, it is a toxin produced by *Aspergillus flavus* and *A. parasticus*[16] [17].
3.4 Hygiene of coffee farmers
During the field observation, it was discovered that farmers only wore ordinary clothes, and most of the time, face shields (in the form of kerpus/cap). Therefore, they were protected from dust and sunlight when drying the fruits. Furthermore, they do not wear gloves, and only two were putting on footwear when drying the fruits (Table 1). For the warehousing process, workers tasked with carrying sacks of coffee wear only ordinary clothes and shoes, or sandals. Besides, some also wear gloves, but most of them do not. The hygiene of coffee farmers is crucial because it affects product contamination and their health status [18].

4. Conclusion
Hygiene and sanitation in post-harvest coffee processing in BPR Ranau Tengah sub-district have not been appropriately implemented. The relevant agencies need to be considered to suppress the presence of ochratoxin A-producing fungi, consequently increasing the quality of coffee beans.

References
[1] Martauli E D 2018 Analysis of Coffee Production In Indonesia 1, 2 112–20
[2] Company P and Limited N-P 2010 Chemical , Physical and Biological Approaches to Prevent Ochratoxin Induced Toxicooses in Humans and Animals pp 1718–50
[3] Haile M 2019 The Role of Microbes in Coffee Fermentation and Their Impact on Coffee The Role of Microbes in Coffee Fermentation and Their Impact on Coffee Quality
[4] Taniwaki Mh, Pitt Ji, Copetti M V, Teixeira Aa, Iamanaka Bt 2019 Understanding Mycotoxin Contamination Across The Food Chain in Brazil : Challenges and Opportunities pp 1–17
[5] Al-Abdalall 2016 A. Aflatoxin and Ochratoxin Production in Ground Coffee During Aflatoxin and Ochratoxin Production.
[6] Djossou O, Roussos S, Isabelle P, Macarie H, Germain K, Yoan L 2015 Fungal Population , Including Ochratoxin A Producing Aspergillus Section Nigri Strains From Ivory Coast Coffee Bean 10, 26 pp 2576 – 89
[7] Kok D, Pizzutti Ir, Scholten J, Cardoso Cd, Spanjer M 2017 Analytica Chimica Acta Simultaneous Determination of 117 Pesticides and 30 Mycotoxins in Raw Coffee , Without Clean-Up , By Le-Esi-Ms / Ms Analysis pp 1–11
[8] Choiron M Penerapan Gmp pada Penanganan Pasca Panen Kopi Rakyat untuk Menurunkan Okratoksin Produk Kopi (Studi Kasus di Jember) pp 114–20
[9] Samson R, Houbraken Jamp, Kuijpers Afa, Frank Jm, Jens C, Lyngby D-K 2004 New Ochratoxin A or Sclerotium Producing Species in Aspergillus Section Nigri pp 45–61
[10] Houbraken J, Vries Rp De, Samson Ra 2014 Modern Taxonomy of Biotechnologically Important Aspergillus and Penicillium Species 1st Ed. Advances in Applied Microbiology Elsevier Inc. 86 pp 199-249
[11] Bradford Kj, Dahal P, Asbrouck J Van, Kunusoth K, Bello P, Thompson J, et al. 2018 Trends In Food Science & Technology The Dry Chain : Reducing Postharvest Losses And Improving Food Safety In Humid Climates. Trends Food Sci Technol 71 84–93
[12] Martinez V M, Ivan D A El 2017 Evaluation of The Composition Effect of Harvested Coffee in The Organoleptic Properties Of Coffee Drink
[13] Noonim P, Mahakarnchanakul W, Nielsen Kf, Frisvad Jc, Samson Ra 2008 Identification and Toxigenic Potential of Ochratoxin A-Producing Aspergillus Species From Coffee Beans Grown In Two Regions of Thailand. Int J Food Microbiol 128 (2) 197 – 202
[14] Manandhar A, Milindi P, Shah A 2018 An Overview of The Post-Harvest Grain Storage Practices of Smallholder Farmers In Developing Countries pp 13 – 20
[15] Carmanini F, Meira F, Silva G, Ribeiro R, Lima D, Ribeiro M, et al. 2011 Storage of Green Coffee in Hermetic Packaging Injected with Co 2. J Stored Prod Res 47 (4) 341 – 8
[16] Vieira T, Cunha S, Casal S 2015 Mycotoxins in Coffee Coffee in Health and Disease Prevention Chapter 25 Elsevier Inc. pp 225-233
[17] Nganou Nd, Durand N, Tatsadjieu Nl, Métayer I, Montet D 2014 Mbofung Cnf. Fungal Flora and Ochratoxin a Associated with Coffee in Cameroon 4 (1) 1 – 17
[18] Bui-Klimke Tr, Wu F, Bui-Klimke Tr, Wu F 2015 Ochratoxin A and Human Health Risk: A Review of The Evidence Ochratoxin A And Human Health Risk: A Review of The Evidence 8398.