

## CHEMICAL CHARACTERISTICS COMPARISON OF PALM CIVET COFFEE (KOPI LUWAK) AND ARABICA COFFEE BEANS

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**Abstract.** Chemical characteristics of coffee are depended on types of coffee. Those characteristics are the result of volatile and nonvolatile components during roasting then affecting taste. Luwak Coffee has distinct chemical and taste from regular coffee. On previous research, Marcone (2004) and Mahendratta et al. (2011) explained that quality improvement on Luwak coffee is result of lower protein content and higher fat content compared to regular coffee. Lower protein content reduces bitter taste while higher fat content can increase body or feeling heavy. The aim of this research was to obtain information about chemical compound of Luwak Coffee and regular Arabica coffee. This research was done in Laboratory Chemical FMIPA Padjadjaran University, Bandung, in February 2014. The method used this research is experiment method. From this study, it can be analyzed that protein content of regular green coffee beans was 9.48%, and regular roasted bean was 11.3% while protein content of Luwak Coffee green bean was 8.8%, and its roasted bean was 10.12%. Further, caffeine content had been analyzed where regular coffee beans contained 0.70% and its roasted bean contained 0.61% while caffeine content of green bean from Luwak Coffee was 0.51%, and its roasted bean was 0.47%. pH valued was also observed where regular green bean was 6.7 and regular roasted bean was 6.9 while green bean of Luwak Coffee was 5.3 and its roasted bean 5.7. Moreover, sugar content of regular coffee beans was 1.9% and its roasted bean was 0.015% while sugar content of Luwak Coffee green bean was 1.6% while its roasted bean was 0.013%. Fat content of regular green coffee beans was 8.5% and its roasted bean was 11.7% while fat content of Luwak Coffee green bean was 9.3% and its roasted bean was 12.2%.

**Keywords:** arabica coffee, chemical characteristics of coffee, luwak coffee

### 1. Introduction

Coffee beans are one of the leading commodities from Indonesia's plantation since it has significant market both in local and international market. Most of coffee beans from Indonesia are sold to global market particularly to the United States, Germany, and Japan (Dirjen PPHP, 2010).

Arabica coffee is one of the main commodities and is very much in demand because of its good aroma and taste. Arabica coffee also has better quality than other types of coffee, this can be seen from the relatively higher selling price.

Currently, there is one kind of coffee beans with high price selling named kopi luwak. Kurniawan (2011) explained that selling price of Kopi Luwak in Japan and South

Korea was about Rp. 2 million/kg which was higher than selling price in Indonesia (Rp. 1 million/kg).

Kopi Luwak is derived from Arabica or Robusta coffee beans consumed by civet and processed in its digestive system then excretes in feces. Before consumption as Kopi Luwak, beans were cleaned, sun-dried and ground. The history of Kopi Luwak itself was engaged in the history of coffee plantation in Indonesia since Dutch colonization ordered coffee plantation in almost Indonesia's area. For those plantations, coffee beans were imported from Yemen. Ironically, coffee farmers can not drink their coffee. Thus around the 19th century, farmers in Central Java started to consume coffee from civet excretion around their plantation. Coffee beans in civet's feces were dried and still in its thin layer skin then collected by farmers to be processed and brewed. Farmers secretly shared this Kopi Luwak information and continued to collect and consume Kopi Luwak (Panggabean, 2011).

Chemical characteristic of coffee was defined by its type. Different type of coffee has different chemical components. Chemical compounds in coffee beans affect taste and aroma of brewed coffee. Further, they also affect volatile and nonvolatile compounds during roasting that is important for coffee taste. In Kopi Luwak cases, it has particular characteristics compared to regular coffee. (Marcone, 2004) and Mahendradatta *et al.*, (2012) explained that improving coffee taste is a result of lower protein content but higher fat content compared to regular coffee beans. Lower protein content can reduce bitter taste while higher fat content increases body or heavy during cup test.

From this condition, it needs further study to identify chemical characteristic of Kopi Luwak. This study aimed to observe chemical components of Kopi Luwak and regular Arabica coffee.

## 2. Materials and Methods

The research was conducted in Chemical laboratory, Singaperbangsa, Faculty of Mathematics and Natural Science, Padjajaran University on February 2014. Descriptive analytical method was conducted in this study with different color of coffee fruit as treatment which were red coffee fruit and red blackish from both regular Arabica coffee and Kopi Luwak while parameters are: (1) protein contents of regular Arabica coffee and Kopi Luwak (roasted bean); (2) caffeine content of regular Arabica coffee and Kopi Luwak (roasted bean); (3) fat content of regular Arabica coffee and Kopi Luwak (roasted bean); (4) glucose content of regular Arabica coffee and Kopi Luwak (roasted bean); (5)

pH value of regular Arabica coffee and Kopi Luwak (roasted bean); and (6) defining fatty acid compound in Kopi Luwak coffee beans using Gas Chromatography Mass Spectrometry (GC-MS) method. Figure 1 showed the research process.

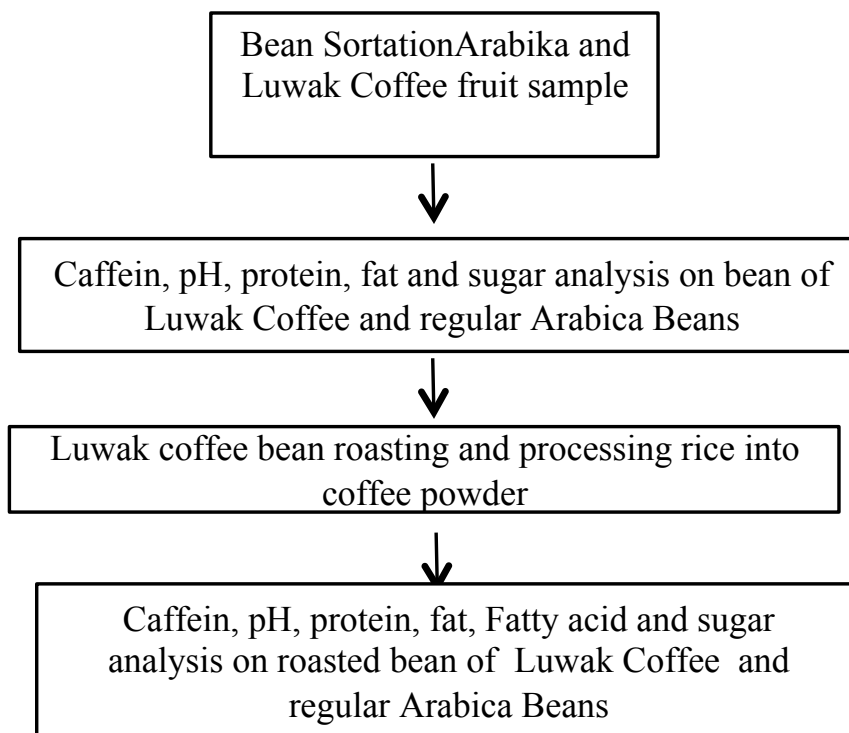


Figure 1. Research flow

### 3. Result and Discussion

Chemical content that detected in Arabica and Luwak Coffee are shown in Table 1.

Table 1. Chemical content that detected in Arabica and Luwak Coffee

Type of Coffee Beans	Chemical Content (%)				
	Protein	Caffeine	Sugar	Fat	Acidity
Arabica coffee	9.48	0.7	1.9	8.5	6.9
Luwak coffee	8.8	0.52	1.6	9.3	5.7

#### Protein Content

It was analyzed that protein content of roasted coffee beans of palm civet coffee (Kopi Luwak) was lower than those from regular Arabica coffee beans as shown in Figure 2. It can be observed that protein content of green bean from regular coffee was about 9.48%, roasted bean from regular coffee was about 11.3%, green bean of Kopi Luwak was about 8.8% and roasted bean Kopi Luwak was about 10.12%.

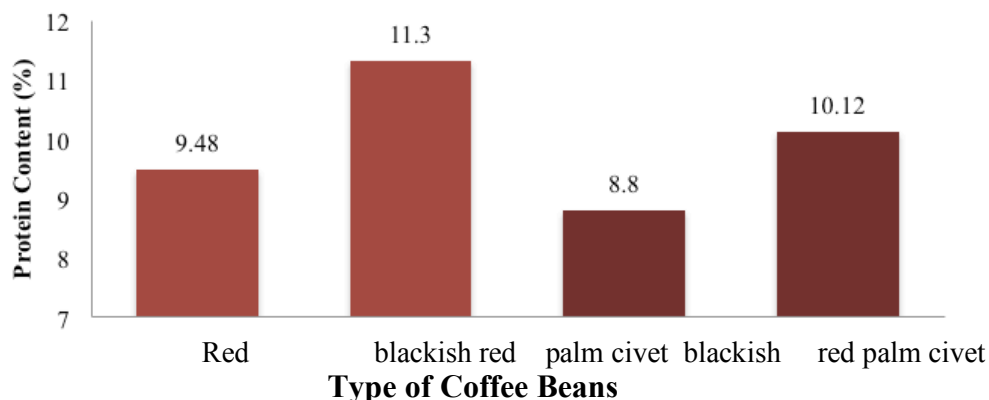


Figure 2. Protein content of green bean and roasted bean of kopi luwak and regular coffee beans

Different protein content is the result of the process of coffee beans in civet digest system. Based on a study in a university in Canada, ripe fruit of coffee was consumed by civet (*Paradoxurus hermaphrodites*) and entered its digest system. Proteolytic enzymes in its digestive system break protein chains from digested food including coffee fruit. Moreover, digestive enzymes consumed fruit or mesocarp but left coffee beans with its undamaged silverskin which would be released with feces. Results of digestive fermentation of civet were peptide and free amino acid. Protein has a significant effect on coffee taste and aroma thus it might be related to improving and giving special taste and aroma of Kopi Luwak (Hanifah & Kurniawati, 2013).

It was also explained by Massimo Marcone, a coffee researcher from Guelph University, Canada, in Panggabean (2011) that digestive fermentation of civet can improve coffee quality because it is related to optimum temperature for fermentation, enzyme and bacteria in civet digest system. Endogenous secretion from digestive system of civet was absorbed into coffee beans. Further, secretion of proteolytic enzyme broke down protein compound in coffee beans thus reducing the number of peptides and free amino acid. Reducing protein and free amino acid develop the unique taste of Kopi Luwak.

Fermentation in civet digestive produced coffee beans special aroma, this is the same as the opinion Panggabean, 2011, Luwak coffee was enzymatically processed in civet digestive system by bacteria named *Leuconostoc sp.* This bacteria ferment coffee beans then produced acid and alcohol that pushed aromatic volatile compound out from coffee beans. When coffee beans out with civet feces, coffee beans have special aroma different than regular coffee.

### Caffeine Content

Based on caffeine content analysis from green bean and roasted bean, palm covets

coffee (Kopi Luwak) has lower caffeine content than those in regular Arabica coffee bean as shown in Figure 3. It can be observed also that caffeine content from regular green bean was 0.70%, roasted regular bean 0.61% while caffeine content from green bean of Kopi Luwak was 0.51% and its roasted bean was 0.47%.

Low caffeine content of Kopi Luwak beans is a result of fermentation in civet digestive system. Fermentation aimed to separate mucilage from beans. During fermentation process, pectin hydrolysis by pectinase from coffee fruit and its reaction can accelerate using microorganism. Further, mucilage was also fermented and broke by microorganism. These conditions led to caffeine decomposition through bacterial and enzyme fermentation to break protein chain (Hanifah & Kurniawati, 2013).

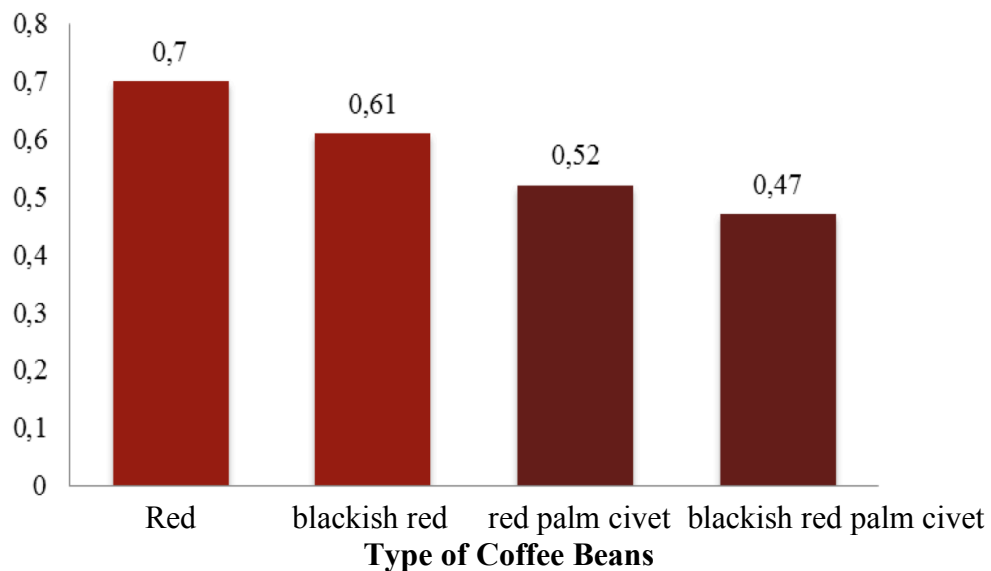


Figure 3. Caffeine content of green bean and roasted bean of kopi luwak and regular coffee bean

In addition to the different types of coffee, the amount of caffeine in coffee plants can be influenced by several factors, including growth area, plant varient, plant age, leaf age, length of planting season, field conditions, soil nutrition, rainfall and pests. The solubility process of caffeine begins with the breakdown of complex caffeine bonding compounds due to heat treatment, with the higher the temperature of the solvent the breakdown process will take place faster. Caffeine compounds become free with a smaller size, are easy to move, easily diffuse through the cell wall and participate through solvents. In addition, caffeine damage can be caused by several factors, including high temperatures, chemical compounds, and bacteria (Zarwinda & Sartika, 2018).

#### Acidity (pH)

It was observed on pH analysis on green bean and roasted bean of Kopi Luwak

were higher than those of regular Arabica coffee as shown in Figure 4. It is also can be analyzed that the coffee bean was 6.7 and its roasted bean was 6.9 while green bean of Kopi Luwak was 5.3 and its roasted bean was 5.7.

Kopi Luwak beans had a lower pH or more acid compared to those of regular coffee bean as the result of lactic acid fermentation. Other acid compounds from fermentation process were ethanol, butyric acid and propionate. A longer fermentation process caused a lower pH or more acid condition since more aliphatic acid was produced. Moreover, the chemical composition of coffee beans was changed during longer fermentation from aliphatic acid chains into carboxylic acid esters. However, these components can cause defect and bad taste on coffee bean (Sulistyowati & Sumartona, 2002).

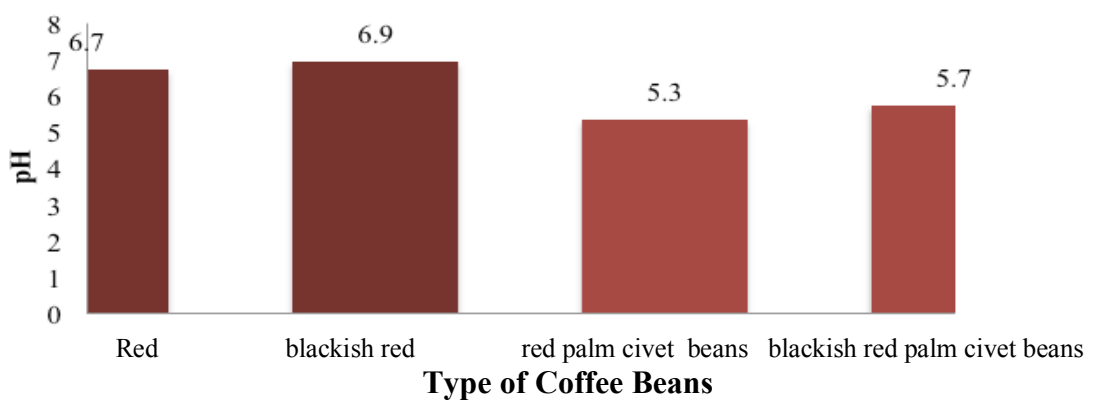


Figure 4. Acidity (pH) of green bean and roasted bean from Kopi Luwak and Regular Arabica beans

### Sugar Content

From this study, it was found that sugar content of Kopi Luwak both green bean and roasted bean were lower than those of regular Arabica coffee as shown in Figure 5. It can be observed that sugar content of green bean from regular Arabica coffee was 1.9% while its roasted bean was 0.015%, green bean of Kopi Luwak 1.6% while its roasted bean was 0.013%.

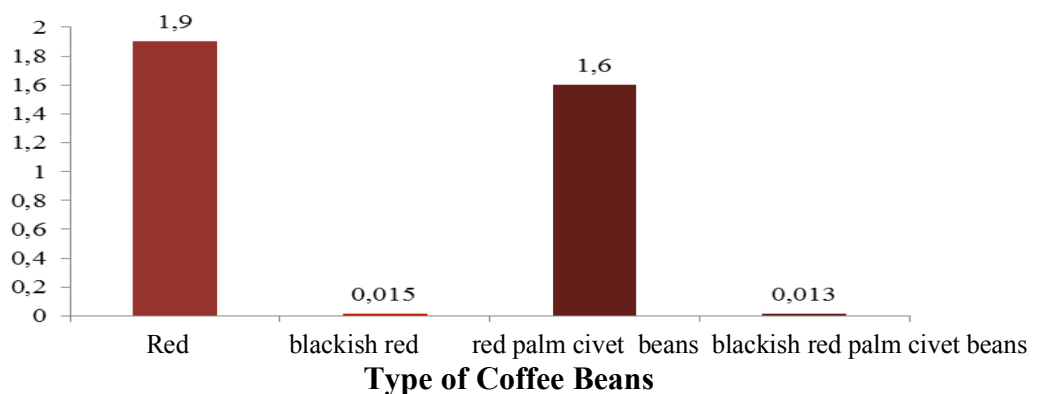


Figure 5. Sugar content of green bean and roasted bean from kopi luwak and regular coffee

Decreasing sugar content is related to fermentation in civets digestive system. Moreover, fermentation is aerobic energy production process in cell thus there was mucus decomposition including protopectin and sugar by enzyme in civet digestive system. Some acid compounds, alcohol and reducing sugar content are the results of this fermentation (Ivan, 2014).

In addition to the type of coffee, the fat content and caffeine content of ground coffee are influenced by interactions between the level of fruit maturity, length of fermentation, and length of roasting. Coffee fruit which is harvested reddish yellow, then fermented for 36 hours and roasted for 13 minutes produces relatively higher levels of fat and caffeine. Water and protein levels are influenced by the interaction between the maturity level of the fruit and the length of fermentation, and the interaction between the level of fruit maturity and the length of roasting. The longer the fermentation process and / or roasting process causes the ash content and pH to be higher ( Tarigan & Towaha, 2017).

### Fat Content

It can be found from this research that fat content of Kopi luwak both green bean and roasted bean was higher than those of regular Arabica coffee as shown in Figure 6. It can be observed also that each fat content of regular Arabica coffee was 8.5% for green bean and 11.7% for its roasted bean while Kopi Luwak were 9.3% for its green bean and 12.2% for its roasted bean.

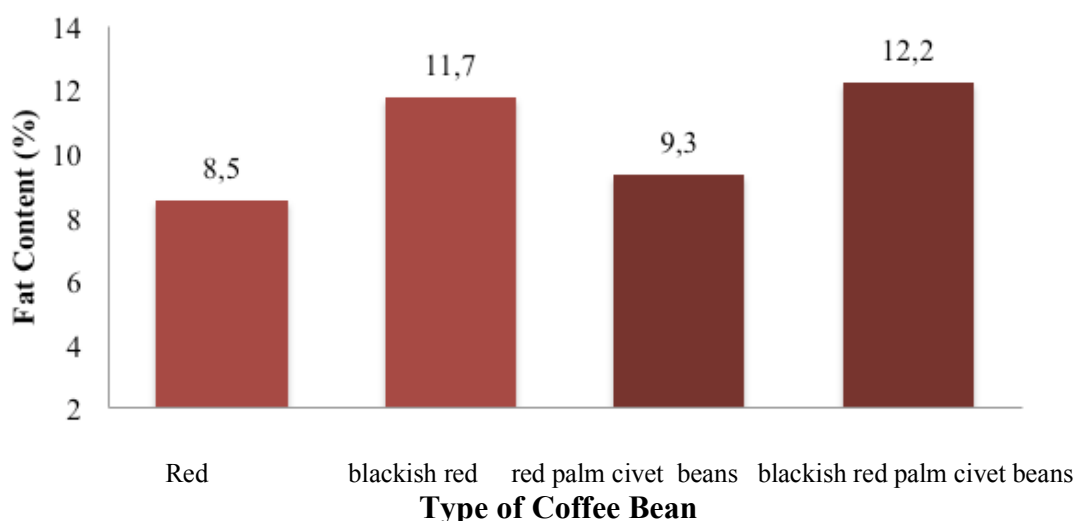


Figure 6. Fat content of kopi luwak and regular Arabica coffee

It can be predicted that fermentation in civet digestive system affected higher fat content in Kopi Luwak beans. During fermentation, a complex molecule will be

processed into a simple molecule by degrading enzyme and also released energy. This kind of activity mostly was conducted by bacteria. Further, glucose will be processed anaerobically during fermentation including glycolysis. However, smaller energy was produced from glucose fermentation. In civet digestive system, mixed fermentation was happened by enzyme thus it is affected to increase fat content in coffee beans (Hanifah & Kurniawati, 2013). In agree with Rubiyo & Juniaty (2013), they found that improving taste quality of Kopi Luwak is a result of higher fat content compared to regular coffee beans. High-fat content can improve coffee taste which is related to quality of coffee beans.

### **Fatty Acid Components In Kopi Luwak And Regular Arabica Coffee Beans**

Laboratory test results component of fatty acid from regular Arabica coffee and Kopi Luwak beans are shown in Table 2. It can be observed that fatty acid compounds in Kopi Luwak beans have a higher area than those of regular Arabica coffee beans. Regularly, fatty acid components consisted of hexadecanoic acid with 40.3% area in regular coffee beans and 44.3% in Kopi Luwak beans. Further, another component, octadecenoic acid, has 2.46% of area in regular coffee beans and 7.12% in Kopi Luwak beans.

Table 2. Several components detected in fatty acids of regular arabica and kopi luwak beans

Type of Coffee	Component	Molecule Formula	Area (%)
Regular Coffee	Hexadecanoic acid	$C_{16}H_{34}O_2$	40.3
	Octadecenoic acid	$C_{18}H_{36}O_2$	2.46
Kopi Luwak	Hexadecanoic acid	$C_{16}H_{34}O_2$	44.3
	Octadecenoic acid	$C_{18}H_{36}O_2$	7.12

Fatty acid components in Kopi Luwak beans are hexadecanoic acid and octadecenoic acid which classified as palmitic acid. It is related to fatty acid in coffee beans that consist of fatty acid from palmitic acid, and behenate. It can be found linoleic acid (40-50%) and palmitic acid as much as 30-50% in coffee oil. As explained by Hayati *et al.* (2012), fatty acid in coffee is one of component in defining coffee taste. the content of fatty acid in Kopi Luwak as a result of coffee bean fermentation by various enzyme in civet digestive system. Since fatty acid affects coffee aroma, Kopi Luwak has distinct aroma compared to regular coffee (Ikhwan, 2013).



#### 4. Conclusion

Conclusion for this article are: there were significant differences in chemical characteristics between Kopi Luwak and regular coffee. Caffeine content, sugar and protein content of Kopi Luwak were lower compared to those of regular coffee while pH and fat content of Kopi Luwak was higher than those of regular coffee.

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