Characteristics of Gayo Coffee's Chemical Compound Based on Different Roasting Condition – An Explorative Study

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Abstract

Roasting is an industrial coffee processing which has heavy contribution towards formation of coffee flavor. This heat treatment modifies the aroma precursor in coffee bean through Maillard reaction and Stecker Degradation. Conventionally, roasting is done by contacting the green bean with hot air in short time. However several producing countries have different techniques of roasting, such as torrefacto whisch defined as roasting with additional ingredients. This work aims to investigate the effect of two roasting conditions (conventional and torrefacto) towards Gayo coffee (Arabica and Robusta varieties) which being sold commercially and laboratory experimented. The measured chemical compounds are moisture (%), ash (%), lipid (%), protein (%) and carbohydrate with two repetitions. The results showed that both commercial and experimental roasted coffee powders are meeting the SNI requirements for moisture and ash contents, where commercial product has higher amount of these compounds. To be conclude with, Arabica and Robusta coffee from Gayo Highland have differences and chemical compounds and it also varies based on the roasting process.

Keywords: torrefacto; roasting; Arabica; Robusta; Maillard, Gayo Highland.Introduction

1. Introduction

Gayo Highland has been acknowledged as single origin coffee since successfully claimed its Geographical Indication in 2010 [1]. The highland is ultimate production area for Arabica coffee in Indonesia which has largest plantation area and superior quality. As global demands for this single origin coffee increases [2] many attempts has been made towards Gayo coffee quality improvements especially towards cupping quality in green bean [3, 4].The attempts are done based on thoughts that coffee cupping quality is a manifestation of complex process of harvesting, semi-wash process and roasting. During this long chain the chemical compounds of coffee cherries modified as it changed in to green bean and roasted bean [5].

Roasting ultimately has large contribution in the formation of coffee flavor which produces coffee as pleasurable brewed drinks [6]. Roasting enables coffee bean to release the volatile compounds, which produces the complex cupping quality as the roasting degree varied based on certain condition [7]. During roasting which the maximum temperatures are 210-230^{o}C [8], the bean cells are ruptured since beans are directly exposed with the heat, dried up most of moisture contents and released the aromatic compounds [9] which counted more than 900 volatile compounds mainly formed during this process [6]. As results, the physical appearance of coffee bean is changed dramatically, and consists of carbohydrates, protein fragments, lipids, less moisture contents, caffeine, trigonelline and melanoidins as results of Maillard reactions [8,9].

In Gayo Highland farmers also planted Robusta varieties in lower elevation area which mainly consume by local citizen in Aceh regions, whilst Arabica mainly considers as export commodity [5]. As local consumption, coffee is roasted in special way named as torrefacto, where the 10-15% of sugar is added during roasting [6]. Torrefacto claimed as roasting techniques which enable to cover the defects of coffee and produce heavy, creamy and sweeter brewed drink. This project aims to explore the changes of Gayo coffee based on its varieties (Robusta and Arabica) in different roasting techniques (conventional and torrefacto). As torrefacto method is commonly used by commercial roaster in Banda Aceh, this research also has objective to compare roasted coffee which are commercially sold and laboratory experimented.

2. Methods

2.1. Materials

This research used commercial and experimental samples. The commercial sample, both for Robusta and Arabica varieties are bought from several coffee shops in Banda Aceh districts. On the other hand,for experimental samples, materials used in this research are Gayo Arabica green bean variety Gayo 1, planted at 1200-1440 m.a.s.l in Aceh Tengah district and Gayo Robusta variety S 88, planted at800 m.a.s.l. For commercial samples, it is roasted and bought one day prior to analyses. The commercial samples are then mixed in order to have homogenous samples In order to have reliable data, the moisture contents of green bean is counted based on AOAC [10].

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Table 1. Moisture contents of raw material (green bean)

Moisture Contents (%)	
Arabica Gayo 1 (from farmers)	13.05
Arabica GayoMultivarieties	12.82
Robusta S 88	10.05
Robusta Multivarieties	9.80

2.2. Procedures

Conventional commercial roasting used hot air drum roaster where the coffee bean is roasted at 160-180^{o}C for 7-8 minutes then chilling out in the conveyor for another 10-15 minutes. For *torrefactocommercial roasting*, coffee bean is mixed with 15% of sugar then is roasted at 160-180^{o}C for 7-8 minutes then chilling out in the conveyor for another 10-15 minutes. *Laboratory experimented conventional roasting* used drum air Didacta Italia roaster, while coffee bean is roasted at 175-180^{o}C for 7-8 minutes, chilling out in cylinder bath for another 10 minutes. For *torrefacto,* sugar is added after the bean roasted at drum air roaster, by adding 15% of sugar, then mix manually above gas stove.

Fig. 1. Drum air roaster for commercial purpose (left); Didacta Italia drum roaster (right)

2.3. Samples preparation

The roasted bean is grounded at 20 mesh and stored in vacuum container. The process should be done one day prior to analysis. Then the measured chemical compounds are moisture contents, lipids, protein fraction, ash followed AOAC, whilst carbohydrate contents measured by difference.

3. Results and Discussion

Arabica varieties in Gayo Highland are commonly processed by semi-wash methods. This method consists of ripe-red cherries picking, washing and screening in floatation tank, pulping and drying up to 40% moisture contents, wet hulling and drying up to 12-13 % moisture contents. Based on the moisture contents of raw material as can be seen in Table 1, the commercial samples used multi-varieties which has 12.82% moisture contents, whereas variety Gayo 1 as laboratory experiment sample as 13.05%. On the other hand, Robusta which treated by dry process, commonly reported to have lower moisture contents since the cherries are directly dried start from the beginning as can be seen in Table 1.

However,these slightly lower differences of moisture contents could not be seen in commercial coffee roasted for both varieties. But the moisture contents are considerably differs based on commercial and experimental. Table 2 shows that based on commercial and experimental roasting, commercial has higher value of moisture then experimental roasted coffee even for the raw material commercial coffee has lower moisture contents. This is might be an effect of different amounts of coffee being roasted in one batch roasting process. The commercial roasting has 10 kg of green bean for one batch roasting whilst the experimental only has 3 kg for one batch roasting. Since the experimental has fewer amounts,makes the surface area is larger,that might be possible for hot air to make larger contact with coffee bean. However, all of coffee samples fulfilled the SNI 01-3542-2004 [11] for grounded coffee, which stated moisture contents should be blow 7.00%.

Table 2. Arabica Gayo chemical compounds based on method of roasting

Chemical Compounds (%)	Robusta				Arabica			
	Commercial Roasting		Experimental Roasting		Commercial Roasting		Experimental Roasting	
	Conventional	Torrefacto	Conventional	Torrefacto	Conventional	Torrefacto	Conventional	Torrefacto
Moisture	6.95	6.59	1.60	1.60	6.17	6.80	4.00	3.20
Ash	4.95	4.96	5.00	5.0	3.62	3.88	4.00	4.50
Lipids	5.05	5.37	5.15	5.54	6.25	6.25	7.36	7.36
Protein	12.97	13.92	16.79	18.67	14.17	14.12	8.04	8.04
Carbohydrate	69.17	12.97	71.96	69.19	68.99	68.95	76.60	76.60

Roasting is heat treatment process where the bean has direct contact to the hot air [12]. Drum roaster as the most common tools used in industries is preferable since it grants homogenous color and quicker in process. This equipment also allows the roaster master to modify the time and temperature variation for each roasting degree. Then roasting temperatures can vary between 180-240^{o}C for 8 to 15 minutes which classifies roasting at three degree levels, which are light, medium dark. Light roasting produces sweet, cocoa, and nutty aromas whereas medium roast converts coffee with more complex aroma and dark roast is contributed to ashy, burnt and roasted characteristics. Later it also reported that medium roasting, as used in this research enables to point out the regional characteristics of single origin coffee [13, 14]. The evaporation of free and bound water started at the first phase of roasting, while the chemical changes mainly occurred at the end phase of roasting [8].

As evaporation of free and bound water started at the first phase of roasting, the chemical changes mainly occurred at the end phase of roasting. As the bean temperature reached 130^{o}C, caramelization of sucrose and browning occurs, and beans are swelling. Later, when temperature reached above 180^{o}C all non-volatile compounds such as carbohydrate, lipids, protein and minerals participate simultaneously, the compounds degraded into low and high molecular weight such as melanoidins and protein [8, 15]. Protein content of Arabica is slightly lower than Robusta [16] for both green and roasted coffee bean [8]. As can be seen as well in Table 2 Arabica has protein range between 8.04-14.17% and in Robusta, protein is in the range 12.97-18.67%. The protein and other nitrogen containing compounds are reacted with carboxyl group reducing sugars in which so called Maillard reactions and caramelization, forming out melanoidins and small fraction of nitrogen which stated to be responsible for coffee flavor [13, 17]. For coffee with torrefacto roasting, most of sample has higher protein contains than conventional roasting.

From Table 2, it can be seen that mineral or ash contents are varied between 3.62 to 5.00%. Arabica green bean reported to have 3.2-4.2% of ash contents where Robusta ash contents are between 4.4-4.5%. Moreover the roasted bean for both Arabica and Robusta reported to have ash contains between 4.5-4.7% [8]. Mineral in coffee mainly consists of potassium, and manganese, iron and cupper are available in smaller amounts. These minerals are functioned as catalyst biochemical reaction during roasting [13]. Last is carbohydrate, which is in roasted bean majorly presents as arabinogalactans, mannan, glucan and cellulose [18]. The small amounts of carbohydrate also presents as sucrose and reducing sugars [8]. The carbohydrate is responsible for the sweetness and releasement of volatile compounds in Maillaird and caramelization reactions [13]. For coffee with torrefacto roasting, the sugar is added to mask the negative flavors and produce coffee with dark brown color, intense aroma and strong taste and bitterness, and has flavor of roasty, burnt and intensive caramel. This is an impact of sugar addition, the pyrazines, furans and pyridines are formed out in larger amount than conventional roasting [6]. In this studies, most of experimental roasting produced high amount of carbohydrate, this is might be occurred due to the amount of water released in experimental roasting is higher than commercial one.

4. Conclusion

Taking everything into consideration it can be stated that quality of coffee as brewe drink is manifestation of all process involved from farm to cup. Roasting is an industrial process which evaporate the moisture contents, transform the non-volatile compounds i.e. protein and carbohydrate through Maillard reaction in order to release volatile compounds or forming out the aromatic compounds such as melanioidins, pyrazines, furans and pyridines. The intensive research should be done to explore and investigate the specific chemical compounds whichare reported to have important contribution of coffee cupping quality such as chlorogenic acids, trigonelline, melanoidins and others.

Acknowledgements

The team of authors proudly acknowledges all of supportive members of this research.

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