

Article

Effect of Washed Process Fermentation on Specialty Coffee Flavor

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Abstract

Specialty coffee represents a high-value agricultural commodity whose overall quality is profoundly influenced by post-harvest processing parameters, with fermentation constituting a critical determinant in the development of its distinctive sensory profile. Among various processing techniques, the washed process, characterized by controlled wet fermentation has been widely recognized for its capacity to generate unique and refined flavor attributes. The present study sought to investigate the influence of differential fermentation durations within the washed process framework on the sensory characteristics of Arabica specialty coffee. A sensory evaluation was conducted using the standardized cupping test in accordance with Specialty Coffee Association (SCA) protocols, employing trained panelists to assess multiple flavor dimensions. Analytical observations indicated discernible variations in sensory attributes as a function of fermentation duration, thereby reinforcing the necessity of stringent quality control measures with particular emphasis on fermentation management. These insights highlight the pivotal role of optimizing fermentation time in enhancing flavor complexity while mitigating the emergence of undesirable off-flavors. It is further recommended that subsequent research endeavors explore the targeted application of defined microbial starters in conjunction with the systematic optimization of fermentation parameters, in order to advance both the consistency and the sensory excellence of specialty coffee production.

Keywords: Coffee, Fermentation, Washed Process, Sensory Evaluation, Specialty Coffee

1. Introduction

Coffee is an agricultural commodity with high economic value and is a popular beverage worldwide. Indonesia is one of the largest coffee producers, known for its diverse varieties and unique flavor characteristics. In recent decades, the coffee industry has shifted toward improving quality with the emergence of the specialty coffee concept, namely coffee with high flavor quality assessed through cupping score parameters by international institutions such as the Specialty Coffee Association (SCA) [1] [2] [3]. One important factor influencing coffee flavor is the post-harvest process, particularly the fermentation method. Fermentation in coffee not only functions to separate the mucilage from the beans

but also influences the formation of volatile compounds that contribute to aroma and flavor [4].

The washed process, or wet fermentation, is known as a technique that can produce a cleaner flavor profile, brighter acidity, and more complex flavors compared to the dry process (natural process) [5] [6]. Fermentation in the washed process involves microorganisms, such as lactic acid bacteria, yeast, and acetic acid bacteria, which play a role in the degradation of polysaccharide compounds and the formation of secondary metabolites [7]. Variations in fermentation conditions such as time, temperature, and the dominance of certain microbes can produce significant differences in the flavor profile of specialty coffee [8] [9]. Therefore, research on the

effect of washed process fermentation on the flavor of specialty coffee is important, not only to improve product quality but also to strengthen the competitiveness of Indonesian coffee in the global market.

Superior Arabica coffee quality can be achieved through the proper roasting process, as this stage plays a crucial role in shaping the flavor and aroma profiles of the beans. Further evaluation of coffee flavor quality is carried out through a cupping test, a sensory assessment method aimed at identifying and differentiating the flavor characteristics of each coffee variety. Given that each type of coffee has unique sensory attributes, the cupping test allows for a more objective analysis of these differences. Therefore, the cupping test is a crucial instrument in determining the flavor quality of Arabica coffee based on systematic sensory evaluation [10].

This study aims to explore the effect of washed process fermentation on the flavor characteristics of specialty coffee. By understanding the role of fermentation in flavor formation, it is hoped that more targeted post-harvest strategies can be developed to increase the added value of Indonesian specialty coffee.

2. Materials and Methods

The main material used in this study was Arabica coffee cherries sourced from coffee farmers in Nagari Aie Dingin, Alahan Panjang, Solok Regency, West Sumatra, Indonesia. Other materials used included distilled water, well water, and 70% ethanol. The equipment used included: sterile plastic/bottles, ice boxes, ice packs/gels, marker pens, gloves, digital scales, pH paper, masks, Brix refractometers, room thermometers, filters, plastic pumps, roasters, cups, ziplock bags, dry tissues, wet tissues, and filter cloths. The study was conducted using various fermentation durations in the washed process. The treatments consisted of varying fermentation durations: 0 hour, 12 hours, 24 hours, and 36 hours. Fermentation of the coffee cherries was carried out by first washing the harvested coffee cherries, separating them from debris. The coffee cherries were then fermented in a container filled with well water for varying fermentation times of 0, 12, 24, and 36 hours. Fermentation was carried out at room temperature in a closed container.

The pH of the fermented water was then measured using pH paper and a digital pH meter at 0, 12, 24, and 36 hours of fermentation. Changes in pH were observed as an indicator of microbial activity during the fermentation process. The Brix value of the fermented water was measured using a digital refractometer at each fermentation time point (0, 12, 24, and 36 hours). This measurement was used to determine sugar degradation by the microorganisms involved in the fermentation. The next step after the 36-hour fermentation process was to wash and dry the coffee cherries to the desired moisture content. They were then roasted to a light roast. The taste was evaluated using a cupping test based on the Specialty Coffee Association (SCA) protocol. Parameters assessed included aroma, flavor, aftertaste, acidity, body, uniformity, balance, sweetness, clean cup, and overall score. The taste testing was carried out by a Q-Grader who had obtained a Q-Grader certificate.

3. Results and Discussion

3.1 Measurement of pH value

The results of measuring the pH value of coffee fermented water in Figure 1 show The results of measuring the pH value of coffee fermented water show a decrease in pH value along with the length of fermentation time from 0 to 36 hours. At the beginning of fermentation (0 hour), the pH value is in the neutral range (around 7), then decreases gradually until it reaches around 3 at the 36th hour. This decrease in pH is the main indicator of the activity of microorganisms during the coffee fermentation process. The decrease in pH is caused by microbial activity, especially lactic acid bacteria (LAB), yeast, and acetic acid bacteria that degrade simple sugar compounds from mucilage into various metabolites, including organic acids (lactic acid, acetic acid, and citric acid) [11].

The accumulation of these organic acids causes a progressive decrease in pH [12]. Furthermore, the microbial dynamics in coffee fermentation occur sequentially: yeast tends to dominate in the early stages, producing ethanol and other volatile compounds, then lactic acid

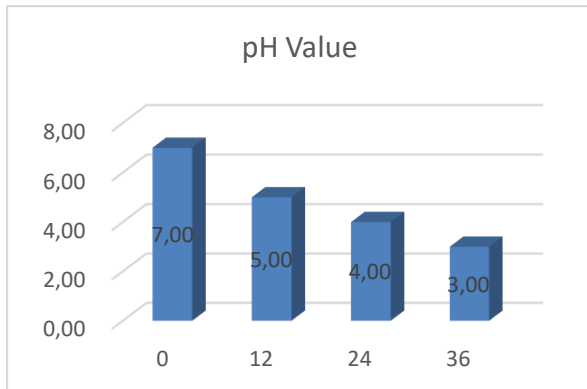


Fig. 1. pH value

bacteria play a role in the middle phase with the production of lactic acid, and acetic acid bacteria dominate in the final stage by producing acetic acid [13]. We elaborated that the decrease in pH was associated with microbial metabolism during fermentation, particularly the activity of lactic acid bacteria, yeast, and acetic acid bacteria producing organic acids such as lactic acid and acetic acid. Furthermore, longer fermentation duration promoted biochemical transformations contributing to flavor complexity, acidity balance, sweetness perception, and body characteristics in specialty coffee. The combination of these microbial activities results in increasingly acidic fermentation conditions. The pH value of the fermentation liquid decreases gradually over time, this is related to the accumulation of organic acids during the fermentation process [14]. The decrease in pH is one indicator to determine the end of coffee fermentation, because microbial metabolism converts sugars into acids. Thus, the decrease in pH not only marks the progress of fermentation but is also closely related to the sensory changes that occur in coffee [15].

3.2 Measurement of Brix value

The results of the Brix value measurements of the coffee fermentation water in Figure 2 show a gradual increase during fermentation: from 0 at 0 hours, then increasing to 0.2 at 12 hours, 0.3 at 24 hours, and reaching 0.4 at 36 hours. This pattern reflects the degradation and release of sugars and other soluble compounds into the fermentation medium, along with microbial activity. There was a significant decrease during the 72-hour fermentation, reported a similar phenomenon [16]. Although the direction of change in their

study was a decrease, the indication of an active dynamic between sugar consumption and release is important for observing fluctuations in Brix values during coffee fermentation [17]. Variations in raw materials, differences in local practices, and diverse environmental conditions are determinants that contribute to the dynamics of microbial communities in fermented food products. These differences not only affect the composition and activity of microorganisms involved in the fermentation process, but also have a significant impact on the formation of sensory characteristics, including taste and texture, as well as modifying the nutritional content of the final product [18].

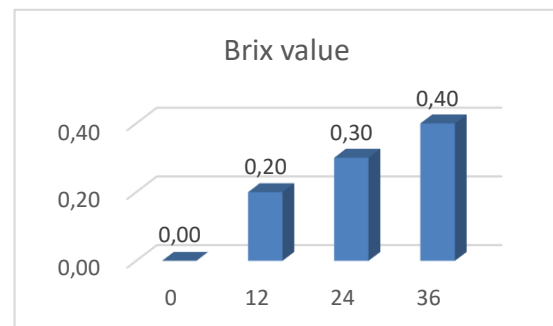


Fig. 2. Brix value

The results of this study indicate that increasing Brix values indicate the potential for the development of a sweeter flavor profile and a fuller body as fermentation progresses. The increase in Brix values during the fermentation process not only reflects the accumulation of soluble compounds, particularly sugars and metabolites resulting from microbial activity, but also indicates the potential for the development of a sweeter flavor profile. This increase in Brix values correlates with an intensification of sensory complexity in coffee, including the formation of a more balanced flavor and an increase in a fuller body character. Thus, the dynamics of changes in Brix values can be seen as an important parameter in predicting the final quality of fermented coffee, both in terms of organoleptic aspects and chemical characteristics that contribute to the consumption experience.

3.3 Taste assessment using the cupping method

The most widely used method internationally for assessing the sensory quality of coffee is cupping, which has been standardized by the Specialty Coffee Association of America (SCAA). This procedure is carried out by brewing and tasting coffee directly by a certified tester (cupper), using special procedures designed to reduce the influence of external factors so that the taste assessment can be done objectively. In this method, coffee is brewed and tasted directly by a certified tester (cupper) to assess sensory attributes, with procedures that have been specifically designed to minimize the influence of external factors on taste perception [19]. The results of the cupping assessment are greatly influenced by the geographical conditions where the coffee is grown, the fertilization process, and the density of shade plants that contribute to the chemical composition of the coffee beans [20]. The assessment system formulated by the SCAA establishes a number of quality assessment attributes, as the main parameters in describing the sensory quality of coffee [21].

The image shows the Specialty Coffee Association Arabica Cupping Form. It includes a header with the SCAA logo and the text 'Specialty Coffee Association Arabica Cupping Form'. Below this are fields for 'Name:', 'Date:', and 'Table no:'. A 'Quality Scale' table is provided, and the main body of the form contains various sensory attributes with corresponding scales and checkboxes.

4.00 - GOOD	5.00 - VERY GOOD	6.00 - EXCELLENT	7.00 - OUTSTANDING
4.25	5.25	6.25	6.75
4.50	5.50	6.50	6.50
4.75	5.75	6.75	6.75

Fig 3. Form to measure Cupping Test.

The SCAA established an official cupping and grading protocol for Arabica coffee, originating from a specialty coffee promotion program initiated by the International Coffee Organization in 1999. Although the program involved five countries, the initial development of the cupping protocol focused on Brazilian Arabica coffee. Cupping requires standardized procedures, both in testing and in the roasting and serving processes. Through a five-year development process involving trial and error, the SCAA finally established ten key quality attributes, each rated with a maximum score of ten points, resulting in a 100-point scale evaluation system. This scale was chosen because it is easily understood by both industry and the general public. The 10 important quality assessment attributes for coffee are

fragrance/aroma, flavor, aftertaste, acidity, body, uniformity, balance, clean cup, sweetness, and overall. Based on the SCAA cupping protocol, sensory testing is conducted to identify differences between coffee samples, describe the characteristics of each coffee quality attribute, and determine the level of preference for a coffee product to achieve the desired coffee quality. The cupping method is considered suitable for assessing coffee quality across various attributes. Quality determination refers to the SCAA international standard as a parameter for determining coffee quality.

3.4 Cupping results of fermented Arabica coffee

The cupping results showed a total overall score of 83.75, which falls into the “Very Good specialty coffee” category according to SCA standards. This score indicates that the coffee has good quality characteristics with a slight possibility of retaining certain specialty attributes. In the context of washed process fermentation, a cupping score of 83.75 indicates that fermentation has run optimally, producing flavor complexity without the emergence of significant off-flavors. The appropriate fermentation process including timing, condition control, and microbe dynamics has helped achieve this flavor profile [22] [23].

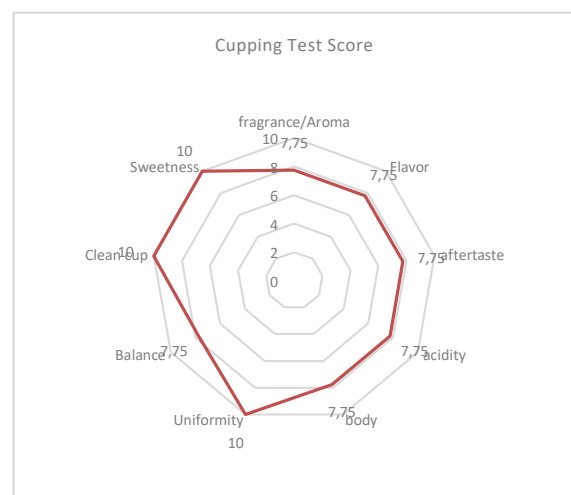


Fig. 4. Results of the Fermented Coffee Cupping Test Assessment

The results of the cupping test show that the fragrance/Aroma assessment attribute gets a score of 7.75, flavor 7.75, aftertaste 7.75, acidity 7.75, body 7.75, uniformity 10, balance 7.75, clean

cup 10, sweetness 10. The assessment of coffee taste using the cupping test method is a reference in assessing specialty coffee [24]. The process of processing coffee beans in the roasting process forms the character of the coffee so that it becomes a characteristic of the coffee, which can be discussed from the sensory aspect, coffee taste, and the overall score of the coffee itself [25].

4. Conclusions

The results of this study indicate that the washed process fermentation process affects coffee flavor. During fermentation, a decrease in pH indicates the activity of microorganisms in decomposing organic compounds, while an increase in the Brix value indicates the release and transformation of simple sugars from the coffee pulp into the fermentation medium. Both phenomena contribute to the formation of more complex flavor characteristics, thus categorizing the fermented coffee as a very good specialty coffee according to SCA standards. Therefore, controlled fermentation at the appropriate duration can produce a balanced, clean specialty coffee flavor profile and have the potential for competitive advantage in the premium coffee market. The recommendations from this study are the need for more precise fermentation timing and further study of fermentation microbiota variations, so that the quality of specialty coffee flavor can be continuously improved and contribute to the development of Indonesian coffee quality in the global market.

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