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Improving Arabica Coffee Quality Using Anaerobic Carbonic Maceration Techniques in East Lombok Regency

Sari Novida [1*], Narita Amni R[1], Nirmawati[2]

[1] Program studi Agribisnis, Fakultas Pertanian, Universitas Islam Al-Azhar, Mataram, Nusa Tenggara Barat, Indonesia.
[2] Program studi Agroekoteknologi, Fakultas Pertanian, Universitas Islam Al-Azhar, Mataram, Nusa Tenggara Barat, Indonesia.

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Corresponding Author:
Sari Novida
sarinovida@unizar.ac.id

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Abstract: There are various post-harvest coffee techniques to improve quality, one of which is the anaerobic technique of carbonic maceration method. The research objectives are to know the process of improving the quality of arabica coffee quality through anaerobic semi carbonic maceration technique; to know the taste of arabica ground coffee after using anaerobic semi carbonic maceration technique. This research method is experimental with the aim of seeing the quality of coffee beans produced from the semi-carbonic maceration technique. Based on the research results, the anaerobic semi-carbonic maceration coffee fermentation engineering technique was successfully carried out in Sajang Village, Sembalun District, East Lombok Regency for 2 months. Based on the results of research and favorability tests on 30 respondents by comparing coffee produced from anaerobic semi-carbonic maceration techniques and natural processes, the following results were obtained: Arabica coffee using anaerobic semi-carbonic maceration technique received a score of 4.71 for aroma, score of 4.53 for flavor, score of 4.16 for body and score of 4.20 for sweetness. Arabica coffee brewed with anaerobic semi-carbonic technique is more favored by consumers compared to natural arabica coffee brewing technique.

Keywords: Anaerobic; Arabica; Favorability test; Maceration; Semi carbonic

Introduction

Sajang Village, East Lombok Regency, is one of the largest Arabica coffee production centers in West Nusa Tenggara (NTB) and has been designated by the NTB Regional Government as the largest and best center for Arabica coffee cultivation (Novida, 2022). Arabica coffee beans are one of the most popular coffee beans, both nationally and internationally, resulting in increasing demand for Arabica coffee annually (Zakaria et al., 2017).

Arabica coffee beans command a high selling price (Saputra et al., 2020). To improve quality and price, specific efforts are needed to produce high-quality, aromatic coffee beans (Franca & Oliveira, 2008; Girma & Sualeh, 2022; Muhie, 2022). Good coffee quality is achieved through quality raw materials, both in terms of the physical appearance of the beans and their processing methods (Al-Ghamdi et al., 2024). The physical quality of coffee beans can be directly observed and assessed by examining the beans for good shape, defects, or damage (Edowai & Tahoba, 2018), while the aroma and flavor of coffee can only be determined through taste testing (Metafindo et al., 2024).

Roasting is key to the coffee powder production process before flavor testing (Pamungkas et al., 2021). The roasting process using the correct roasting degree can produce distinct flavors even when using the same raw materials (Maligan et al., 2022). Post-harvest processing also impacts the quality of the beans (Susanty et al., 2024). Harvested fruit must be fully ripe physiologically (Palmer & Kaminski, 2013). Visually, the parameter is the red colour of the cherries; red cherries tend to be perfectly ripe (Azmi et al., 2022). After

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harvesting coffee cherries, the next step is post-harvest processing, which includes peeling the coffee cherries and drying them in the sun (Pradita et al., 2024).

Correct post-harvest techniques will produce high-quality coffee beans (Hariyadi et al., n.d.). There are five common post-harvest processing methods: (1) Full wash-dry hulling; (2) Full wash-wet hulling; (3) Semi-wet processing (semi-wet processing/natural pulp); (4) Natural dry processing of coffee cherries; (5) Dry processing of broken-hulled coffee cherries (Melati & Maligan, 2023). Each post-harvest processing process involves fermentation (Aprilianti et al., 2024). Fermentation is a chemical reaction involving microorganisms to aid in the decomposition process. Microorganisms in this fermentation process help coffee release many substances, enzymes, ethylene, sugar and others (Putri et al., 2022).

There are two stages in the coffee fermentation process: aerobic fermentation and anaerobic fermentation. Aerobic fermentation occurs when the cherries still contain sufficient oxygen (Budiman et al., 2021). The fermentation process is quite simple: simply place freshly harvested coffee cherries in a soaking tub or tank and let the microorganisms work on their own, of course, while continuously controlling the temperature and time and analyzing their progress. Aerobic fermentation is carried out by placing the cherries in the tank, either after pulping or in log form, which is then soaked in water. The soaked coffee is left for a specific time and temperature, allowing the microorganisms to work on their own. Both fermentation processes are possible, but anaerobic fermentation is easier than aerobic fermentation due to its perceived complexity (Andryana & Andani, 2024).

Anaerobic coffee fermentation engineering techniques using the carbonic maceration method can be applied to all types of coffee, but Arabica coffee has the most interest and is quite expensive, so the application of this process is very appropriate to increase the selling price and obtain the best coffee quality, meaning the price is directly proportional to the quality of the coffee beans. This technique is slightly different from anaerobic techniques in general, where in the fermentation process CO_2 can enter and exit, but in the process of anaerobic coffee fermentation engineering techniques using the carbonic maceration method only oxygen and good bacteria can enter, CO_2 in the container can exit but cannot re-enter. Anaerobic coffee fermentation engineering techniques using the carbonic maceration method are still very new in implementation and testing, the results of the first trial based on the results of content and nutrient tests successfully improved quality. If the anaerobic coffee fermentation engineering techniques using the carbonic maceration method are successful, then it can be used as a new permanent technology to improve the quality of coffee beans (Hariyanto et al., 2022).

Method

The research location was determined using purposive random sampling in Sajang Village, Sembalun District, East Lombok Regency. The village is the largest Arabica coffee production center in West Nusa Tenggara (NTB) and has a farmer group that implements anaerobic coffee fermentation techniques using the carbonic maceration method. The partner in this research was UD. *Kopi Lasingan*, which has been conducting trials of anaerobic coffee fermentation techniques using the carbonic maceration method for two years and has conducted laboratory tests comparing results with and without the anaerobic coffee fermentation techniques using the semi-carbonic maceration method. This is an experimental study, aimed at assessing the quality of the results obtained using the semi-carbonic maceration technique. The following are the steps taken to produce coffee beans (green beans) using the semi-carbonic maceration technique.

Figure 1. Stages of implementation in research

Coffee beans produced using the semi-carbonic maceration technique must be tested for quality. This quality test is conducted using a hedonic test, which measures consumer preference for product quality

(Azmi et al., 2022). For the hedonic test, 30 respondents were selected. The respondents were drawn from coffee enthusiast communities, the general public, and students. Each respondent provided an assessment of two different coffee products: a comparison coffee produced through the natural process (A) and a semi-carbonic maceration coffee (B). The hedonic tests conducted in this study included: (1) aroma; (2) flavor; (3) body/density; and (4) sweetness. Respondents were gathered in one location on the same day to conduct testimonials/preference tests for product A (coffee produced through the natural process) and product B (coffee produced through the semi-carbonic maceration technique).

Both coffee products were assessed using a scoring system: score 1 = dislike very much, score 2 = dislike, score 3 = neutral, score 4 = like, score 5 = like very much. The following is a diagram of the stages carried out in the study.

Result and Discussion

The process of producing Arabica coffee beans using the anaerobic semi-carbonic maceration technique takes 1.5 months after the coffee cherries are harvested (Jitjaroen et al., 2023). The Arabica coffee harvest took place in August 2023, followed by the process of producing green beans using the anaerobic semi-carbonic maceration technique. The equipment required for this technique are 50 L plastic barrel, 1.5 L mineral water bottle, small hose, Arabica coffee, and water.

The stages of the semi-carbonic anaerobic process used in this research are: sorting the coffee cherries, separating the floating and sinking cherries; take the sinking cherries and weigh them to a weight of 30 kilograms; place the weighed cherries into a prepared barrel (without water), then seal it tightly. The barrel lid is fitted with a hose connected to a used bottle filled with 500 ml of water. This allows CO_2 to escape from the barrel, preventing external oxygen from entering; observe for the desired time, which is 6 days; after 6 days, remove the coffee cherries from the barrel and dry them on a drying rack (approximately 25 days) until the moisture content reaches 12%; hulling is then carried out, separating the coffee beans from the skin using a machine; then sort the defective coffee beans; roast the coffee beans that are grade 1 (after sorting); and huller 2 kilograms of roasted coffee for the hedonic/preference test on 30 respondents.

This study did not use water to soak the coffee cherries in barrels; some studies have done so by soaking the cherries in barrels. In the semi-carbonic maceration fermentation process, soaking the cherries has several advantages, including accelerating anaerobic fermentation conditions, better control of the fermentation process, and more uniform temperature and pH values. Without water soaking, oxygen gas can easily penetrate the gaps between the coffee cherries that are not submerged in water (Hariyanto et al., 2022; Poltronieri & Rossi, 2016).

After harvesting Arabica coffee beans in Sajang Village, Sembalun District, East Lombok Regency in August 2023, the study continued with a semi-carbonic maceration fermentation process for six days. The selected Arabica coffee cherries, weighing 30 kg, were placed in airtight barrels without water soaking. A closed barrel is fitted with a small hose that flows into a 1.5 L plastic bottle filled with 500 L of water. This serves to remove CO_2 from the barrel and prevent outside air (O_2) from entering the barrel. The following image of the barrel used for the semi-carbonic anaerobic maceration process.

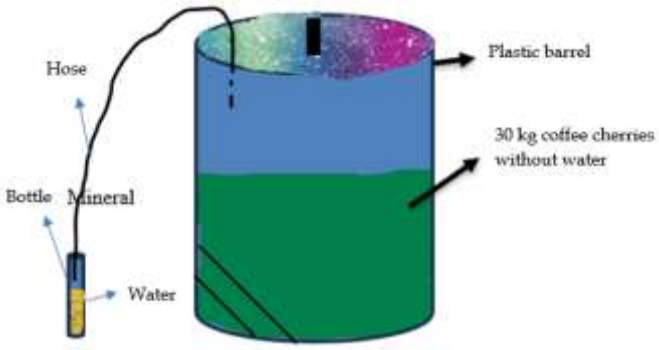

Figure 2. Tools used in producing Arabica coffee, Anaerobic semi-carbonic maceration technique.

After 6 days, the coffee cherries are removed from the barrels and dried on a drying rack (a coffee bean drying area). This drying process takes 20-25 days, depending on the weather. The more humid the air, the longer the drying process. The hotter the air, the faster the drying process. The coffee beans are dried until their moisture content reaches 12%. The following is a picture of the coffee bean drying process.

The dried coffee is then hulled, which is the process of separating the skin and dried coffee beans using a machine. After the hulling process is complete, the resulting coffee beans are sorted into good and bad quality. The following is a picture of the hulling process for dry coffee to produce Arabica coffee beans (green beans). In this study, the green beans produced through the anaerobic semi-carbonic maceration technique were 1: 6, meaning that 30 kg of coffee cherries produced 5 kg of green beans.

The green Arabica beans are then roasted for 12 minutes, or according to the desired coffee color (Alamri et al., 2023; Madihah et al., 2013; Pramudita et al., 2017; Selmar et al., 2008). In this study, the coffee color was

medium to dark. Below is a picture of the roasting process using a roasting machine, converting green beans into Sangria coffee beans with a medium to dark coffee density.

Figure 3. Coffee bean drying process for 20-25 days

The preference test or hedonic test conducted in this study was a group of coffee connoisseurs in Sajang Village, Sembalun District, East Lombok Regency and students with a total of 30 respondents. This preference test is Each respondent provides an assessment of two different coffee products, namely an assessment of preference for coffee produced through a natural process (A) as a comparison and coffee produced by the semi-carbonic maceration technique (B). The hedonic test conducted in this study includes: (1) aroma test; (2) taste; (3) body/density and (4) sweetness. Respondents were gathered in one place on the same day to provide testimonials/preference tests for product A (coffee produced from the natural process) and product B (coffee produced by the semi-carbonic maceration technique). Both coffee products were assessed using a score, namely score 1 = very dislike, score 2 = dislike, score 3 = neutral, score 4 = like, score 5 = very like. The following is a table of the levels of preference generated in this study.

Table 1. Comparison of the level of preference of arabica coffee produced through the natural process and the semi-carbonic technique

Classification	Semi Carbonic	Natural
Aroma	4.71	4.22
Taste	4.53	4.11
Body/Density	4.16	3.98
Sweetness	4.20	4.60

Based on the Preference Test conducted in this study, the results obtained showed that in general respondents preferred Arabica coffee brews processed using the anaerobic semi-carbonic maceration technique. The results of the study proved that the anaerobic semi-carbonic technique had a preference level for aroma, taste, density/body, and sweetness with a score of 4.71; 4.53; 4.16; and 4.20, respectively, while the preference level for coffee brews with the Natural process for aroma, taste, density/body and sweetness with a score of 4.22; 4.11; 3.98; and 4.60.

Conclusion

Based on the results of the research conducted, there are several conclusions obtained, i.e: Anaerobic coffee fermentation engineering technique with semi-carbonic maceration method was successfully carried out in Sajang Village, Sembalun District, East Lombok Regency for 2 months of the process from harvesting coffee cherries to producing Arabica coffee beans. Based on the results of the research and preference test on 30 respondents by comparing coffee produced from anaerobic semi-carbonic maceration technique and the natural process, the following results were obtained: (a) the preference for Arabica coffee using anaerobic engineering technique with carbonic method got a score of 4.71 for aroma, a score of 4.53 for taste, a score of 4.16 for density/body and a score of 4.20 for sweetness. Arabica coffee brewing with anaerobic semi-carbonic technique was preferred by consumers in the study when compared to Arabica coffee brewing with natural technique.

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Conceptualization, S.N methodology, N. A. R; writing—original draft preparation, S. N and N. A. R.; writing—review and editing, N; funding acquisition, S. N., N. A. R., and N. All

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Conflicts of Interest
The authors declare no conflict of interest.

References

Al-Ghamdi, S., Alfaifi, B., Elamin, W., & Lateef, M. A. (2024). Advancements in coffee manufacturing: From dehydration techniques to quality control. *Food Engineering Reviews*, *16*(4), 513–539. https://doi.org/10.1007/s12393-024-09383-5

Alamri, E. S., Altarawneh, G. A., Bayomy, H. M., & Hassanat, A. B. (2023). Machine learning classification of roasted arabic coffee: Integrating color, chemical compositions, and antioxidants. *Sustainability*, *15*(15), 11561. https://doi.org/10.3390/su151511561

Andryana, S., & Andani, A. N. (2024). Penentuan Wilayah Pemasaran Kopi Colol Dengan Metode AHP-TOPSIS. *Jurasik (Jurnal Riset Sistem Informasi Dan Teknik Informatika)*, *9*(1), 433–441. Retrieved from https://paperity.org/p/340514920/penentuan-wilayah-pemasaran-kopi-colol-dengan-metode-ahp-topsis

Aprilianti, Y., Novida, S., & Rengganis, B. S. (2024). Analisis Marjin Dan Efisiensi Pemasaran Kopi Robusta Di Desa Karang Sidemen Kecamatan Batukliang Utara Kabupaten Lombok Tengah. *Jurnal Ekonomi Dan Bisnis*, *4*(2), 243–250. Retrieved from http://e-jurnal.stiebii.ac.id/index.php/ekonomibisnis/article/view/278

Azmi, N., Abubakar, Y., Juanda, J., & Satriana, S. (2022). Tingkat kesukaan konsumen terhadap kopi wine gayo pada beberapa derajat penyangraian. *Jurnal Ilmiah Mahasiswa Pertanian*, *7*(2), 324–329. Retrieved from https://jim.usk.ac.id/JFP/article/view/19886/9658

Budiman, I., Wahyudi, F., Yunardi, Y., & Meilina, H. (2021). Studi fermentasi biji kopi menggunakan enzim proteolitik. *Jurnal Serambi Engineering*, *6*(4), 2228–2235. Retrieved from https://shorturl.asia/7tyFB

Edowai, D. N., & Tahoba, A. E. (2018). Proses produksi dan uji mutu bubuk kopi arabika (coffea arabica L) asal kabupaten Dogiyai, Papua. *Jurnal Agriovet*, *1*(1), 1–18. Retrieved from https://ejournal.kahuripan.ac.id/index.php/agriovet/article/view/171

Franca, A. S., & Oliveira, L. S. (2008). Chemistry of defective coffee beans. *Food Chemistry Research Developments*, *4*(1), 105–138. Retrieved from https://shorturl.asia/aWHV7

Girma, B., & Sualeh, A. (2022). A review of coffee processing methods and their influence on aroma. *Int. J. Food Eng. Technol*, *6*(7), 7–16. Retrieved from https://www.researchgate.net/profile/Abrar-Sualeh/publication/359746797_Bealu_Girma_Abrar_Sualeh_A_Review_of_Coffee_Processing_Methods_and_Their_Influence_on_Aroma/links/624ca2bdd726197cfd3e1403/Bealu-Girma-Abrar-Sualeh-A-Review-of-Coffee-Processing-Methods-and-Their-Influence-on-Aroma.pdf

Hariyadi, T., Abdulloh, S. H., & others. (n.d.). Pengaruh konsentrasi mikroorganisme lokal pada fermentasi biji kopi arabika menggunakan fermentor skala pilot plant. *Jurnal Rekayasa Proses*, *18*(1), 26–33. Retrieved from https://journal.ugm.ac.id/v3/jrekpros/article/view/13247

Hariyanto, B., Fanani, F., Nugroho, S. E., & others. (2022). Rekayasa Fermentasi Kopi An Aerobik dengan Metode Karbonik dan Semi Karbonik Maserasi. *Jurnal Pengembangan Potensi Laboratorium*, *1*(2), 79–85. https://doi.org/10.25047/plp.v1i2.3098

Jitjaroen, W., Kongngoen, R., & Panjai, L. (2023). Aroma profiles and cupping characteristics of coffee beans processed by semi carbonic maceration process. *Coffee Science-ISSN 1984-3909*, *18*, e182119--e182119. https://doi.org/10.25186/.v18i.2119

Madihah, K. Y. K., Zaibunnisa, A. H., Norashikin, S., Rozita, O., & Misnawi, J. (2013). Optimization of roasting conditions for high-quality Arabica coffee. *International Food Research Journal*, *20*(4), 1623. Retrieved from https://www.proquest.com/openview/0ca0848dbfe081a82a93aa965a191611/1?pq-origsite=gscholar&cbl=816390

Maligan, J. M., Wibowo, A. T. E., & Zefanya, N. (2022). Karakter sensoris kopi arabika Semeru natural. *Prosiding Seminar Nasional Instiper*, *1*(1), 292–298. https://doi.org/10.55180/pro.v1i1.265

Melati, R. K. P., & Maligan, J. M. (2023). Kajian Pustaka: Potensi Teknologi Fermentasi Metode Carbonic Maceration sebagai Upaya Pengembangan Kualitas Citarasa Kopi. *Prosiding Seminar Nasional Teknologi Pangan*, *1*(1), 121–129. Retrieved from https://sntp.upnjatim.ac.id/fstproceeding/index.php/sntp/article/view/13

Metafindo, B. Y. D., Mahardika, C. B. D. P., & Kantur, D. (2024). Tingkat Penerapan Penanganan Panen Dan Pascapanen Kopi Arabika Sesuai Good Handling

Practices Di Desa Colol. *Penyuluhan & Komunikasi Pembangunan Pertanian*, *1*(1), 10–16. Retrieved from https://ejurnal.politanikoe.ac.id/index.php/jpkpp/article/download/317/255

Muhie, S. H. (2022). Strategies to improve the quantity and quality of export coffee in Ethiopia, a look at multiple opportunities. *Journal of Agriculture and Food Research*, *10*, 100372. https://doi.org/10.1016/j.jafr.2022.100372

Novida, S. (2022). Profil usaha pengolahan kopi lasingan di Kota Mataram. *Jurnal Ilmiah Hospitality*, *11*(1), 557–562. Retrieved from https://ejournal.stpmataram.ac.id/JIH/article/view/1709

Palmer, J. J., & Kaminski, C. (2013). *Water: A comprehensive guide for brewers*. Brewers publications.

Pamungkas, M. T., Masrukan, M., & others. (2021). Pengaruh suhu dan lama penyangraian (roasting) terhadap sifat fisik dan kimia pada seduhan kopi arabika (coffea arabica l.) dari Kabupaten Gayo, Provinsi Aceh. *Agrotech: Jurnal Ilmiah Teknologi Pertanian*, *3*(2), 1–10. https://doi.org/10.37631/agrotech.v3i2.278

Poltronieri, P., & Rossi, F. (2016). Challenges in specialty coffee processing and quality assurance. *Challenges*, *7*(2), 19. https://doi.org/10.3390/challe7020019

Pradita, N., Hayati, H., Swardji, S., Muktasam, M., & Mulyati, M. (2024). Analisis Keberlanjutan Dimensi Ekologi Kopi Arabika Di Lahan Kering Desa Sajang Kecamatan Sembalun Kabupaten Lombok Timur. *AGROTEKSOS*, *34*(2), 383–391. https://doi.org/10.29303/agroteksos.v34i2.1055

Pramudita, D., Araki, T., Sagara, Y., & Tambunan, A. H. (2017). Roasting and colouring curves for coffee beans with broad time-temperature variations. *Food and Bioprocess Technology*, *10*(8), 1509–1520. https://doi.org/10.1007/s11947-017-1912-5

Putri, A. A. D. A., Proborini, M. W., & Devi, P. S. (2022). Efektivitas Filtrat Trichoderma asperellum TKD terhadap Pertumbuhan Aspergillus flavus pada Biji Kopi Arabika (Coffea arabica). *Biota: Jurnal Ilmiah Ilmu-Ilmu Hayati*, 189–198. https://doi.org/10.24002/biota.v7i3.6077

Saputra, M., Kusrini, K., & Kurniawan, M. P. (2020). Identifikasi Mutu Bij Kopi Arabika Berdasarkan Cacat dengan Teknik Convolutional Neural Network. *Inspiration: Jurnal Teknologi Informasi Dan Komunikasi*, *10*(1), 27. https://doi.org/10.35585/inspir.v10i1.2533

Selmar, D., Bytof, G., & Knopp, S.-E. (2008). The storage of green coffee (Coffea arabica): Decrease of viability and changes of potential aroma precursors. *Annals of Botany*, *101*(1), 31–38. https://doi.org/10.1093/aob/mcm277

Susanty, S., Murianto, M., & Sriwi, A. (2024). Pola Kemitraan Pentahelix Dalam Pengembangan Desa Wisata Buwun Sejati, Lombok Barat Ntb. *Media Bina Ilmiah*, *18*(6), 1321–1342. https://doi.org/10.33758/mbi.v18i6.583

Zakaria, A., Aditiawati, P., & Rosmiati, M. (2017). Strategi pengembangan usahatani kopi arabika (kasus pada petani kopi di desa Suntenjaya Kecamatan Lembang Kabupaten Bandung Barat, Provinsi Jawa Barat). *Jurnal Sosioteknologi*, *16*(3), 325–339. https://doi.org/10.5614/sostek.itbj.2017.16.3.7