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Extraction Method of Ultrasound-Assisted Extraction (UAE) of Robusta Coffee Skin Waste using 96% Ethanol Solution in Tanah Wulan Village, Maesan District, Bondowoso Regency

Miftakhul Ulum[a], Fitriah Novita Sari[b], Helda Wika Amini[a*], Hanggara Sudrajat[c]

[a] Department of Chemical Engineering, University of Jember, Indonesia
[b] SMA Ra'iyaul Husna Bondowoso, Indonesia
[c] National Research and Innovation Agency (BRIN), Indonesia

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Abstract. Argopuro Mountains, Tanah Wulan Village, Maesan District, Bondowoso Regency, East Java, Indonesia is one of the Robusta coffee-producing areas. Robusta coffee beans that are processed can produce quite a lot of by-products in the form of underutilized waste. It is known that coffee skin waste still has a lot of remaining content and it is possible to take these bioactive compounds using extraction methods. Bioactive compounds in natural materials can be done by extraction. Extraction is the process of separating substances in a sample based on different solubilities. The extraction method used is the ultrasonication method (nonconventional). Extraction of the ultrasonication method only requires a relatively shorter time with the help of an ultrasonicator. There is a lot of content in the coffee skin waste powder that needs further testing. The results of this study are expected to provide economic value to robusta coffee husk waste.

Keywords: *Coffee husk waste powder, ultrasonication*

1. Introduction

Indonesia is one of the largest coffee-producing countries in the world. Indonesia is also in fourth place after Brazil, Vietnam, and Colombia. Coffee production in Bondowoso Regency, East Java Province reached 2,900 tons in 2019 (BPS 2019). In the coffee processing process, coffee husk waste reaches 30-35% and is the largest waste from the coffee fruit processing process. Utilization of coffee husk waste is only used simply, some of which are as animal feed and fertilizer. The use of coffee skin waste needs attention because there is still minimal information about the use and content of coffee skin waste and a lack of attention to the economic value of coffee skin waste (Pujianto, 2007; Juwita, et al., 2017).

Coffee plants produced in Indonesia generally consist of two types of coffee, namely Robusta coffee and arabica coffee. Indonesia has an increase in coffee production from year to

*Corresponding author: heldawikaamini@unej.ac.id

year. All regions of Indonesia are capable of producing coffee, except for the DKI Jakarta area. South Sumatra Province has the largest coffee area, which is 277,542 Ha, and produces coffee production of 140,812 tons per year. Meanwhile, the highest coffee production was produced by Lampung Province, which was 142,599 tons with a land area of 166,058 Ha (Adline et al., 2013). This study uses coffee husk waste from Robusta coffee plantations in the Argopuro Mountains area, Tanah Wulan Village, Maesan District, Bondowoso Regency because of its closer location making it easier for researchers to obtain samples of coffee husk waste.

Coffee husk waste is a by-product that is underutilized to the maximum (Adeline et al., 2013). There is a lot of content left in the coffee husk waste so it is possible to reuse it by extracting the coffee skin waste. Extraction is a process of separating substances in materials based on different solubilities. Two factors can affect the content of bioactive compounds in the resulting extract, namely solvents concentration, and temperature. Based on this, the higher the concentration of the solvent used, the higher its ability to remove bioactive compounds in the material to be extracted. This can facilitate the contact that occurs between the solvent and the extracted material.

Extraction is the process of separating and withdrawing the chemical content contained in a material that is easily soluble so that it is clear if there is an insoluble material using a liquid solvent. The extraction process can be carried out using several methods, one of which is the ultrasonication method (Ministry of Health, 2000). The Ultrasonic-Assisted Extraction (UAE) method is an ultrasonication-assisted extraction method. Ultrasonic-assisted extraction can increase yield, and antioxidant effectiveness and reduce the extraction time of coffee husk waste.

Ultrasonic-assisted extraction (UAE) is one of the extraction methods assisted by ultrasonication. Ultrasonic waves are sound waves that have a frequency above human hearing (≥ 20 kHz). The ultrasonication method is non-destructive and non-invasive so it can be easily adapted to various applications (Rochmani, 2009). With the help of ultrasonication, the process of extracting organic compounds in plants using organic solvents can take place more quickly. The cell wall of the material is broken down by ultrasonication vibrations so that the contents in it can come out properly (Rochman, 2005).

UAE studies are used to produce higher yield values and many extraction activities have been carried out. (Balachdran et al., 2006) performed ultrasonication-assisted extraction which can increase the yield by 30% and reduce the extraction time. The quality of the extract in the extraction process is influenced by the extraction technique, extraction time, temperature, type of solvent, solvent concentration, and material-solvent ratio. The time or length of the extraction process determines the content of compounds that come out of the material. as well as the ratio of the material-solvent, and the amount of extractant involved in the diffusion process which will affect the content of the compound. Because the extraction process is influenced by various factors, it is necessary to research the extraction of coffee husk waste using the maceration method and the ultrasonication method.

This research was conducted by extracting coffee husk waste using the ultrasonication method. So this research was conducted to determine the value of the percent yield of the ultrasonic extraction method with variations in time and variations in particle size.

2. Materials And Methods

2.1 Materials

The raw material used in this research is robusta coffee husk waste obtained directly from coffee farmers in Tanah Wulan Village, Maesan District, Bondowoso Regency, East Java, Indonesia. The other ingredient is 96% ethanol.

2.2 Simplified Preparation of Coffee Peel Waste

Simplicia dried coffee husk waste was obtained directly from robusta coffee farmers, precisely in the Tanah Wulan area, Bondowoso Regency, East Java Province, Indonesia. Then the simplicia is dried in the sun for approximately 1 day to avoid wet coffee husk waste, after making sure it is completely dry then mashed using a grinder (selep), after the coffee husk waste becomes powder then it is sifted with various sieves, namely by sizes of 60, 80, and 100 mesh because the principle of the maceration and ultrasonication method is to apply the concentration equilibrium principle, namely between the concentration of the solvent and the concentration of the sample cells so that if it reaches a fixed equilibrium (constant) then the extraction process will stop or even decrease. The optimum limit for the particle size of coffee husk waste is below 60 mesh, so variations in particle size of 60, 80, and 100 mesh are used.

2.3 Water Content Analysis

The water content of coffee skin waste was determined using the oven method (Noorhamdani, et al., 2012). A total of 5 grams of the sample was put in a weighing dish and then dried in an oven at 65°C for 3 hours then weighed, put in the oven again for 10 minutes, then weighed again, and repeated twice. Drying was carried out until a constant weight was obtained. The determination of water content is calculated by equation (1)

$$\text{Water Content (\%)} = \frac{\text{initial mass(g)} - \text{final mass (g)}}{\text{initial mass of coffee skin (g)}} \text{x}100\% \quad (1)$$

2.4 Extraction of Coffee Peel Waste

Extraction was carried out by dissolving 50 grams of coffee husk waste in 100 ml of 96% ethanol in a beaker. There are several variations used, namely: (a) Variations in time starting from 0, 5, 15, 30, and 45 minutes. This time variation was chosen to determine the percent yield value without any ultrasonication treatment (0 minutes) and to determine the effect of ultrasonication over the length of time used. (b) Variations in particle size of 60, 80, and 100 mesh as a comparison in the ultrasonication method. The amplitude used is 30 which is set through the generator panel with the converter, probe, and temperature sensor dipped in the solution. The extraction results were filtered and concentrated using an oven at a temperature of 65^{o}C to remove the solvent.

3. Results

3.1 Simplified Preparation of Coffee Peel Waste

Simplicia coffee husk waste was obtained directly from robusta coffee farmers in Tanah Wulan Village, Bondowoso Regency, East Java Province, Indonesia. Simplicia is a natural ingredient that is used and has not undergone any process changes (Ministry of Health, 2019). The simplicia preparation process was carried out at the Basic and Process Laboratory, Faculty of Engineering, University of Jember. Simplicia was obtained in a semi-dry condition. Then the drying treatment was carried out for 8 hours under the hot sun to dry the coffee skin waste. Figure 1 shows the waste of coffee husks when dried.

Figure 1. Coffee Peel Waste When Drying

After the simplicia, the coffee husk waste is dried in the sun and then mashed using a grinder (selep). The coffee husk waste that has been smoothed and turned into powder as shown in Figure 2 is sieved with various sieves, namely 60, 80, and 100 mesh.

Figure 2. Coffee Peel Waste Powder

3.2 Analysis of Water Content Simplicia Coffee Peel Waste

Moisture content is one of the simplicia standardization. The presence of water in the simplicia extract of coffee skin waste will allow the growth of microbes. In addition, the water content also affects the shelf life. Therefore, water content is one important factor that must be considered. Determination of water content was carried out to determine the water content contained in simplicia and coffee skin waste extract, which could affect the growth of microorganisms and adversely affect the content of active compounds during the storage process. To measure the water content, a sample of coffee husk waste was used with variations in the size of a 60 mesh sieve of 5 grams and put in an oven with a temperature of 65ºC for 3 hours. Then the sample was weighed using an analytical balance, in the oven again for 10 minutes as shown in Figure 4.3. This treatment was carried out until the sample mass was constant. If the sample has a constant mass, it indicates that all the water in the sample has evaporated. The final mass of coffee skin waste after being in the oven was 4.53 grams. So the water content can be calculated as follows :

$$\text{Water Content (\%)} = \frac{5{,}00 - 4{,}53\ (\text{g})}{5{,}00\ (\text{g})} \text{x } 100\% \ = \frac{0{,}47\ (\text{g})}{5{,}00\ (\text{g})} \text{x } 100\% \ = \ 9{,}4\%$$

Coffee husk waste samples have a moisture content of 9.4%. The water content value is following the simplicia standard, which is below 10% (Prastuwo et al., 2010).

3.3 Extraction of Coffee Peel Waste

Extraction is a process of withdrawing secondary metabolites with the help of a solvent. Extraction will be faster at high temperatures, but this can result in some components being damaged (Harborne, 2007). The extraction method used in this study is the ultrasonication method (non-conventional). The ultrasonication method is one of the modern methods that can speed up the extraction process.

3.3.1 Extraction Method Ultrasonic Assisted Extraction (UAE)

The ultrasonication method is a method that uses ultrasonic waves, namely waves with a frequency greater than 16-20 kHz (Suslick, 2008). According to Kuldiloke (2002) one of the benefits of the ultrasonication, extraction method is to speed up the extraction process. This is evidenced by the research of Cameron and Wang (2006) on extraction using ultrasonication can take place more quickly. The cell wall of the material is broken down by ultrasonication vibrations so that the contents in it can come out easily (Mason, 2000). Some of the advantages of using ultrasonication technology in its application (Lida, 2002) are: the ultrasonication process does not require the addition of chemicals and other additives, the process is fast and easy, which means the process does not require high costs, the process does not result in significant changes to the chemical structure, particles, and the compounds used.

3.3.1.1 Particle Size Variations

The results of the variation in particle size of the ultrasonication method are as follows:

Table 1. Results of Particle Size Variations in the Ultrasonic Method

Mass (g)	Particle Variation (mesh)	Volume of Ethanol 96%	Ultrasound time (minutes)	Extracted Mass (g)	% Yield
50	60	100	15	0.75	1.50
50	80	100	15	2.18	4.36
50	100	100	15	2.24	4.48
			Average	1.72	3.44

Table 1 shows the % yield of ultrasonication extraction with variations in particle size in the ultrasonication method with a simplicia mass of 50 g, ethanol volume of 100 mL, and an ultrasonication time of 15 minutes. The average yield of the extraction results was 3.44%. The highest yield was at the particle variation of 100 mesh, which was 4.48%, while the lowest yield was at the particle variation of 60 mesh, which was 1.5%. This shows that the smaller the particle size, the greater the % yield. This happens because in the ultrasonication method, the smaller the particle size can cause the breakdown of cell walls and membranes in the coffee husk waste powder, resulting in many damaged cell walls which can then make it easier for compounds in the material to rise to the surface. So that the finer the coffee skin waste powder used, the greater the percentage of yield produced (Alfian and Susanti., 2012).

3.3.1.2 Time variation

The results of the time variation of the ultrasonication method are as follows:

Table 2. Results of Time Variations of Ultrasonic Method

Mass (g)	Particle Variation (mesh)	Volume of Ethanol 96%	Ultrasound time (minutes)	Extracted Mass (g)	% Yield
50	60	100	0	0.27	0.54
50	60	100	5	0.48	0.96
50	60	100	15	0.75	1.50
50	60	100	30	1.07	2.14
50	60	100	1545	1.40	2.80
			Average	0.79	1.58

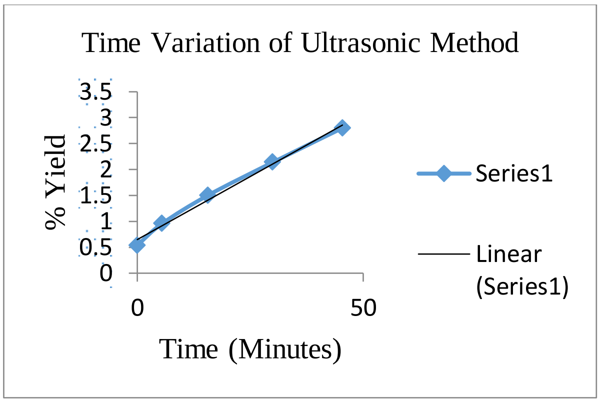

Figure 3. Time Variation of Ultrasonic Method

Table 2 shows the % yield of ultrasonication extraction with variations in the size of the ultrasonication time with a mass of 50 g simplicia, 100 mL ethanol volume, and a particle size of 60 mesh. The average yield of the extraction results was 1.58%. The percentage yield without ultrasonication treatment (0 minutes) showed the lowest yield, which was 0.54%. Figure 3 shows that the longer ultrasonication time (0-45 minutes) results in an increase in the yield of coffee husk waste extraction obtained. The highest yield occurred in the 45 minute ultrasonication time variation, which was 2.80%. This happens because the longer the ultrasonication time causes the longer the contact between the solid and the solvent (solvent) so that it increases the number of broken cells. So the longer the extraction time used, the greater the percentage of yield obtained (Agoes, 2007).

4. Conclusion

The percentage of the average yield of the extraction method of ultrasonication of particle size variation is 3.44%. The percentage yield of the ultrasonication extraction with a variation of the average time of the extraction yield is 1.58%. The finer the coffee husk waste powder used, the greater the percentage of yield produced, and the longer the extraction time used, the greater the percentage of yield obtained.

5. Suggestions

Suggestions for this research are to do further research on the Test antioxidant robusta coffee husk waste.

REFERENCES

Advanced free radical reactions for organic synthesis 2004 - Togo by izulthea djamhari - issuu. (n.d.). Retrieved July 14, 2021, from

https://issuu.com/izulthea/docs/radicals_reaction

Ahda, M. (2015). Ethanol Concentration Effect of Mangoesten Pell Extract to Total Phenol Content. *EKSAKTA: Journal of Sciences and Data Analysis*, *14*(2), 62–70. https://doi.org/10.20885/EKSAKTA.VOL14.ISS2.ART6

Aprilia, A. A. (2013). *Antimicrobial and Antioxidant Activities of Microwave-Assisted Extracts From Coffee Ground Residue in Chiang Rai Province, Thailand*.

http://repository.ipb.ac.id/handle/123456789/63458

Badan Pusat Statistik. 2019.(n.d.). Retrieved July 14, 2021, from https://www.bps.go.id/

Blainski, A., Lopes, G., & Mello, J. de. (2013). Application and Analysis of the Folin Ciocalteu Method for the Determination of the Total Phenolic Content from Limonium Brasiliense L.

Molecules, *18*(6), 6852–6865. https://doi.org/10.3390/MOLECULES18066852

Buku Ajar Analisis Hayati / DR. Harmita, Apt DR.Maksum Radji,M.Biomed Perpustakaan Poltekkes Kemenkes Jambi. (n.d.). Retrieved July 14, 2021, from http://library.poltekkesjambi.ac.id/opac/detail-opac?id=1594

Cameron, D. K., & Wang, Y.-J. (2006). Application of Protease and High-Intensity Ultrasound in Corn Starch Isolation from Degermed Corn Flour. *Cereal Chemistry*, *83*(5), 505–509. https://doi.org/10.1094/CC-83-0505

Dachriyanus. (2004). *Analisis Struktur Senyawa Organik Secara Spektroskopi*. Andalas University Press.

Dai, J., & Mumper, R. J. (2010). Plant phenolics: Extraction, analysis and their antioxidant and anticancer properties. *Molecules*, *15*(10), 7313–7352. https://doi.org/10.3390/MOLECULES15107313

DepositOnce: Effect of ultrasound, temperature and pressure treatments on enzyme activity and quality indicators of fruit Ana vegetable juices. (n.d.). Retrieved July 14, 2021, from https://depositonce.tu-berlin.de/handle/11303/835

Dewick, P. M. (2009). Medicinal Natural Products: A Biosyntese Approach. *Journal of Chemical Information and Modeling*, *53*(9), 190–210.

Dykes, L., & Rooney, L. W. (2006). Sorghum and millet phenols and antioxidants. *Journal of Cereal Science*, *44*(3), 236–251. https://doi.org/10.1016/J.JCS.2006.06.007

Fatimah, F., Larasati, N. C., Wicaksono, R., & Naufalin, R. (2019). Optimization of temperature and time of extraction of kecombrang stem and leaf (etlingera elatior) based on the quality of product bioactive components. *IOP Conference Series: Earth and Environmental Science*, *406*(1), 012015. https://doi.org/10.1088/1755-1315/406/1/012015

Fibrianto, K., & Ramanda, M. P. A. D. (2018). Perbedaan Ukuran Partikel Dan Teknik Penyeduhan Kopi Terhadap Persepsi Multisensoris: Tinjauan Pustaka. *Jurnal Pangan Dan Agroindustri*, *6*(1), 12–16. https://doi.org/10.21776/ub.jpa.2018.006.01.2

Ghosh, D., & Konishi, T. (2007). Anthocyanins and anthocyanin-rich extracts: Role in diabetes and eye function. *Asia Pacific Journal of Clinical Nutrition*, *16*(2), 200–208. https://doi.org/10.6133/APJCN.2007.16.2.01

GUNAWAN, D. (2010). *Ilmu Obat Alam (Farmakognosi). Jilid 1*. //library.unej.ac.id/index.php?p=show_detail&id=148964&keywords=

Harahap, M. E., & Tjahjono, E. W. (2016). Kajian Teknologi Proses Pembuatan Gas Sintetik Dari Batubara Dan Prospek Pemanfaatan Pada Industri

Hilirnya = Technology Review Process of Synthetic Gas From Coal Utilization and Prospect in Downstream Industries. *Majalah Ilmiah Pengkajian Industri*, *10*(1), 61–70. https://doi.org/10.29122/mipi.v10i1.104

Hinman, J. J., & Suslick, K. S. (2017). Nanostructured Materials Synthesis Using Ultrasound. *Topics in Current Chemistry*, *375*(1). https://doi.org/10.1007/S41061-016-0100-9

Hismath, I., Aida, W., & Ho, *. (2011). Optimization of extraction conditions for phenolic compounds from neem (Azadirachta indica) leaves. *International Food Research Journal*, *18*(3), 931–939.

Ibrahim, A. M., Yunianta, Y., & Sriherfyna, F. H. (2014). Pengaruh Suhu Dan Lama Waktu Ekstraksi Terhadap Sifat kimia Dan Fisik Pada Pembuatan Minuman Sari Jahe Merah (Zingiber Officinale Var. Rubrum) Dengan Kombinasi Penambahan Madu Sebagai Pemanis [In Press April 2015].

Indraswari, A. (2008). Optimasi Pembuatan Ekstrak Daun Dewandaru (Eugenia Uniflora L.) Menggunakan Metode Maserasi Dengan Parameter Kadar Total Senyawa Fenolik Dan Flavonoid. *Undefined*.

Janeiro, P., & Oliveira Brett, A. M. (2004). Catechin electrochemical oxidation mechanisms. *Analytica Chimica Acta*, *518*, 109–115. https://doi.org/10.1016/j.aca.2004.05.038

Javanmardi, J., Stushnoff, C., Locke, E., & Vivanco, J. M. (2003). Antioxidant activity and total phenolic content of Iranian Ocimum accessions. *Food Chemistry*, *83*(4), 547–550.

https://doi.org/10.1016/S0308-8146(03)00151-1

Jason, C. (2021). *Ekstraksi etanol dan etil asetat daun gedi sebagai pengawet fillet ikan nila = Ethanol and ethyl acetate extraction of gedi leaf as nile tilapia fillet preservative*.

Lokasi: Kopi : budidaya dan penanganan lepas panen / Sri Najiyati, Danarti. (n.d.). Retrieved July 14, 2021, from

https://onesearch.id/Record/IOS4680.JATIM000000000031639

Lopez, S. J., & Snyder, C. R. (2003). *Positive psychological assessment : a handbook of models and measures*. 495.

OPTIMASI PEMBUATAN EKSTRAK DAUN DEWANDARU (Eugenia uniflora L.) MENGGUNAKAN METODE MASERASI DENGAN PARAMETER KADAR TOTAL SENYAWA FENOLIK DAN FLAVONOID - UMS ETD-db. (n.d.). Retrieved July 14, 2021, from http://eprints.ums.ac.id/983/

Panggabean, J. E., Dotulong, V., Montolalu, R. I., Damongilala, L. J., Harikedua, S. D., & Makapedua, D. M. (2018). EKSTRAKSI KARAGINAN RUMPUT LAUT MERAH

(Kappaphycus alvarezii) DENGAN PERLAKUAN PERENDAMAN DALAM LARUTAN BASA. *Media Teknologi Hasil Perikanan*, *6*(3), 65–70. https://doi.org/10.35800/MTHP.6.3.2018.20642

Proestos, C., Sereli, D., & Komaitis, M. (2006). Determination of phenolic compounds in aromatic plants by RP-HPLC and GC-MS. *Food Chemistry*, *95*(1), 44–52. https://doi.org/10.1016/J.FOODCHEM.2004.12.016

Prior, R. L., Wu, X., & Schaich, K. (2005). Standardized methods for the determination of antioxidant capacity and phenolics in foods and dietary supplements. *Journal of Agricultural and Food Chemistry*, *53*(10), 4290–4302. https://doi.org/10.1021/JF0502698

Rastuti, U., & Purwati, P. (2012). UJI AKTIVITAS ANTIOKSIDAN EKSTRAK DAUN KALBA (Albizia falcataria) DENGAN METODE DPPH(1,1-Difenil-2-pikrilhidrazil) DAN IDENTIFIKASI SENYAWA METABOLIT SEKUNDERNYA Undri Rastuti* dan Purwati. *Molekul*, *7*(1), 33–42. https://doi.org/10.20884/1.JM.2012.7.1.104

RI, D. (2000). *Parameter Standar Umum Ekstrak Tumbuhan Obat*.

Rohman, A., & Riyanto, S . (2017). Aktivitas Antioksidan Ekstrak Buah Mengkudu (Morinda citrifolia, L). *AgriTECH*, *25*(3), 131–136. https://doi.org/10.22146/AGRITECH.13347

Ronald L. Prior, *,†, Xianli Wu, † and, & Schaich§, K. (2005). Standardized Methods for the Determination of Antioxidant Capacity and Phenolic in Foods and Dietary Supplements. *Journal of Agricultural and Food Chemistry*, *53*(10), 4290–4302. https://doi.org/10.1021/JF0502698

S, B., SE, K., R, M., & M, A. (2006). Ultrasonic enhancement of the supercritical extraction from ginger. *Ultrasonics Sonochemistry*, *13*(6), 471–479.

https://doi.org/10.1016/J.ULTSONCH.2005.11.006

Sari, D. K., Wardhani, D. H., & Prasetyaningrum, A. (2012). PENGUJIAN KANDUNGAN TOTAL FENOL Kappahycus alvarezzi DENGAN METODE EKSTRAKSI ULTRASONIK DENGAN VARIASI SUHU DAN WAKTU. *Prosiding SNST Fakultas Teknik*, *1*(1). https://publikasiilmiah.unwahas.ac.id/index.php/PROSIDING_SNST_FT/article/view/19/17

Septiana, A. T., & Asnani, A. (2012). KAJIAN SIFAT FISIKOKIMIA EKSTRAK RUMPUT LAUT COKLAT Sargassum duplicatum MENGGUNAKAN BERBAGAI PELARUT DAN METODE EKSTRAKSI. *AGROINTEK*, *6*(1), 22–28. https://doi.org/10.21107/AGROINTEK.V6I1.1950

Shahidi, F., & Naczk, M. (2002). *Food phenolics : sources, chemistry, effects and applications*.

http://www.worldcat.org/title/food-phenolics-sources-chemistry-effects-and-applications/oclc/50525548?referer=di&ht=edition

Shirsat HS, Epari S, Shet T, Bagal R, Hawaldar R, Desai SB. HER 2 status in invasive breast cancer: immunohistochemistry, I fluorescence in-situ hybridization and chromogenic in-situ hybridization. Indian J Pathol Microbiol. 2012. 55(2): 175-9. (n.d.). Retrieved July 14, 2021, from http://www.sciepub.com/reference/90588

Sulistyaningtyas, A. (2017). Prosiding Seminar Nasional Publikasi Hasil-Hasil Penelitian dan Pengabdian Masyarakat "Implementasi Penelitian dan Pengabdian Masyarakat Untuk Peningkatan Kekayaan Intelektual" PENTINGNYA PENGOLAHAN BASAH (WET PROCESSING) BUAH KOPI ROBUSTA (Coffea robusta. *Pentingnya Pengolahan Basah (Wet Processing) Buah Kopi Robusta (Coffea Var. Robusta) Untuk Menurunkan Resiko Kecacatan Biji Hijau Saat Coffe Grading*, 90–94. Uji, D., Antioksidan Dengan, A., & Dpph, M. (n.d.). *PENETAPAN KANDUNGAN FENOLIK TOTAL*.

Usman, S. (2019). Pengaruh Metode Ekstraksi Terhadap Rendemen Dan Kadar Fenolik Ekstrak

Vinatoru, M., & Mason, T. J . (2021). Jean-Louis Luche and the Interpretation of Sonochemical Reaction Mechanisms. *Molecules 2021, Vol. 26, Page 755*, *26*(3), 755. https://doi.org/10.3390/MOLECULES26030755

Wang, C.-Y., & Wu, L.-W. (2011). Reference Effects on Revisit Intention: Involvement as a Moderator. *Http://Dx.Doi.Org/10.1080/10548408.2011.623041*, *28*(8), 817–827.

https://doi.org/10.1080/10548408.2011.623041

Widyasanti, A., Nurlaily, N., & Wulandari, E. (2008). Karakteristik Fisikokimia Antosianin Ekstrak Kulit Buah Naga Merah Menggunakan Metode UAE Physicochemical Characteristics of Red Dragon Fruit Skin Anthocyanin Extracts using UAE Method. *Jurnal Ilmiah Rekayasa Pertanian Dan Biosistem*, *6*(1), 27–38. https://doi.org/10.29303/jrpb.v6i1.63

Winata, E. W., & Yunianta, Y. (2014). Ekstraksi Antosianin Buah Murbei (Morus Alba L.) Metode Ultrasonic Bath (Kajian Waktu Dan rasio Bahan : Pelarut) [In Press April 2015]. *Jurnal Pangan Dan Agroindustri*, *3*(2), 773–783. https://jpa.ub.ac.id/index.php/jpa/article/view/199

Zhang, P., Tang, Y., Li, N. G., Zhu, Y., & Duan, J. A. (2014). Bioactivity and chemical synthesis of caffeic acid phenethyl ester and its derivatives. *Molecules*, *19*(10), 16458–16476. https://doi.org/10.3390/molecules191016458