

6. Robusta BP-42 coffee

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Robusta BP-42 coffee bean extract is a new anti-tyrosinase candidate to reduce melanogenesis activity



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ABSTRACT

Background: Skin graft is one of the best options for wound closure. This method is the gold standard for skin burns and large open wounds. Coffee, or Robusta coffee (BP-2) is believed to reduce the level of hyperpigmentation due to chlorogenic acid, a major polyphenolic found in coffee with anti-tyrosinase activity. However, the anti-tyrosinase activity of BP-42 coffee extract is unknown. This study aims to measure the chlorogenic acid content of BP-42 coffee bean extract and its anti-tyrosinase activity.

Methods: BP-42 coffee beans were extracted using ethanol by maceration technique. Then, the thin-layer chromatography (TLC) profile of the BP-42 coffee bean extract was made to determine the chlorogenic acid content. At the same time, its anti-tyrosinase activity was performed using the spectrophotometric method. The chlorogenic acid's content was determined using the TLC-densitometric method. Data were analyzed using SPSS version 20.0 for Windows.

Results: BP-42 coffee bean extract had chlorogenic acid concentrations at 12.452 mg/g extract. As expected, the extract exhibited anti-tyrosinase activity with IC_{50} at 312.213 ppm, while kojic acid showed higher bioactivity ($IC_{50} = 30.696$ ppm).

Conclusion: BP-42 coffee bean extract showed a notable anti-tyrosinase activity, promising to be used as the natural anti-pigmentation candidate.

Key words: Chlorogenic acid, hyperpigmentation, IC_{50} , kojic acid, tyrosinase.

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INTRODUCTION

The skin graft is one of the best options for wound closure. This method is a gold standard for skin burn treatment.¹ Skin graft also becomes an option to wound closure for mammae areola reconstruction and vitiligo therapy because it gives an excellent appearance.²⁻⁴ Two types of skin graft are Split Thickness Skin Graft (STSG) and Full Thickness Skin Graft (FTSG).⁵ These two methods not only give patients an outstanding benefit but also provide some problems such as complications and hyperpigmentation. Some patients often feel less beautiful, and their quality-of-life decrease. Hyperpigmentation becomes a severe cosmetic issue, especially if it happens on the face and neck.⁶

Hyperpigmentation occurs due to the increase of DOPA reaction at one to three weeks after skin graft surgery. Other research shows a significant increase in melanin enzymes such as Tyrosinase, Tyrosinase-Related Protein (TYRP1), and

DOPA-chrome Tautomerase (TYRP2).⁶ Those enzymes will be overexpressed for four weeks after the skin graft.⁷ In addition, hyperpigmentation occurs due to increased levels and expression of α -Melanocyte-Stimulating Hormone (α -MSH) and Adrenocorticotropic Hormone (ACTH) that appear early in the skin graft healing process. The increased expression of α -MSH correlated significantly with the increase in the function of melanin transfer in melanocytes and the amount of melanin in the skin autograft pigmentation process.⁸ Other studies also mention that the contraction process of the skin graft causes melanin accumulation and aggravates the degree of pigmentation. Other evidence shows that melanosomes in skin grafted larger, more pigmented, and resistant to lysosomes.⁹

Various efforts have been made to reduce the occurrence of complications of hyperpigmentation, both in the clinical and laboratory fields. Many

researchers use kojic acid to reduce the effect of pigmentation. Kojic acid inhibits tyrosinase and has been extensively studied in the cosmetic industry. Kojic acid and its derivatives have radioprotective and whitening properties. Due to its tyrosinase inhibitory activity, kojic acid protects the skin from ultraviolet (UV) rays, reduces hyperpigmentation, and prevents melanogenesis. It is produced by several types of fungi and is also a byproduct of the fermentation process of certain foods, such as soy sauce and sake.¹⁰ Although kojic acid isn't toxic in acute, chronic, reproductive, and genotoxicity studies, some reports said that some people's skin becomes more sensitive due to 2% kojic acid usage. Other reports find that kojic acid poses a risk to potential thyroid side effects.^{10,11}

Coffee is very abundant in Indonesia, especially in Jember Regency. Indonesia is the third largest country in green coffee robusta production.¹² One of the best

robusta coffee strains is BP-42, provided by the Indonesian Coffee and Cocoa Research Institute, Jember Regency, East Java. BP-42 coffee has the highest quality grain and highest organoleptic score compared to other strain.¹³

Coffee is believed to reduce the amount of hyperpigmentation on the skin. Reported that coffee consumption as a diet can significantly reduce photoaging UV spots in 244 Japanese females.¹⁴ Others report that coffee extract has anti-aging and skin-lightening effects by inhibiting elastase. The coffee extract contains caffeine and chlorogenic acid that could reduce oxidative stress and inflammation.^{15,16} But the anti-tyrosinase inhibitory activity of coffee extract compared to kojic acid is not well known. This study shows a concentration comparison between kojic acid and coffee bean extract levels of anti-tyrosinase inhibitory activity.

MATERIAL AND METHODS

Coffee Extract Solution

Ground coffee beans strain BP-42 provided by the Indonesian Coffee and Cocoa Research Institute. The inclusion criteria of this coffee bean are homogenous and passed the quality control by the Indonesian Coffee and Cocoa Research Institute. We used all the extract; no randomization was needed because it was already homogenous. We prepared six concentrations: 52 ppm, 102 ppm, 156 ppm, 204 ppm, 260 ppm, and 306 ppm. We begin with making the primary solution 520 ppm and 1020 ppm. To make a 520 ppm solution, 1% DMSO (0.1 ml) was added to 5.2 mg of grounded coffee beans. After that, it dissolved with phosphate buffer pH 6.5 to 10 ml. To make a 1020 ppm primary solution, 1% DMSO (0.1 ml) was added to 10.2 mg of grounded coffee beans. After that, it dissolved with phosphate buffer pH 6.5 to 10 ml. Furthermore, the primary solution that has been made is diluted with phosphate buffer pH 5.6 to make each concentration of 52 ppm, 102 ppm, 156 ppm, 204 ppm, 260 ppm, and 306 ppm.

High-Performance Thin Layer Chromatography (HPTLC)

Spotting was carried out on the silica gel F245 TLC plate. Made a ratio of toluene

eluent: ethyl acetate: water: formic acid (1.5: 9: 0.5: 0.5). Added 1.5 ml of toluene in a 25 ml glass beaker and homogenized. Then the eluent was put in the chamber until the elution process marked by the eluent reached the upper limit on the filter paper. In addition to the elution process with ascending expansion, 2 spots of 1 mM standard solution were applied (1420 ng, 2130 ng) and 3 spots (2 µl) of the sample. Next, the plate is inserted into the TLC chamber saturated with the eluent and allowed to elude to the mark. The plates were dried, and the stains formed were observed in light UV 365 nm.

Kojic Acid Solution

Kojic acid solution was prepared in 6 concentrations: 0.05 mM, 0.1 mM, 0.15 mM, 0.2 mM, 0.25 mM, and 0.3 mM (equivalent to 7, 14, 21, 28, 35, and 42 ppm). The preparation begins with 1 mM kojic acid primary solution by dissolving 1.4 mg of kojic acid into 10 ml phosphate buffer pH 5.6. After that, the primary solution that has been made is diluted with phosphate buffer pH 5.6 to obtain solutions with concentrations of 0.05 mM, 0.1 mM, 0.15 mM, 0.2 mM, 0.25 mM, and 0.3 mM.

L-Tyrosinase Substrate Solution

8.119 mg of L-Tyrosine was dissolved in 10 ml phosphate buffer pH 6.5 to obtain 10 mM L-Tyrosine. Then the solution was diluted by pipetting 1 ml of the primary solution and then stirred with phosphate buffer pH 6.5 to a volume of 10 ml to obtain a 1 mM L-Tyrosine solution.

Enzyme Dilution

We dissolved the enzyme in 10 ml phosphate buffer pH 6.5 to obtain a concentration of 2,499.882 units/ml. After that, the tyrosinase solution was diluted with phosphate buffer pH 6.5 to 10 ml to obtain a concentration of 500 units/ml. Next, a second derivative was made by diluting it with 10 ml of Ph 6.5 phosphate buffer to obtain a concentration of 350 units/ml.

Inhibition of Tyrosinase Activity

In each well of the 96-well plate, 70 µL of coffee extract or kojic acid standard was added, 40 µL of tyrosinase enzyme (350

units/mL) was added and then incubated for 5 minutes at room temperature. After incubation, 110 µL L-tyrosine 1 mM was added to each hole and incubated for 45 minutes at room temperature. This incubation time is based on the kinetic experiments performed. Next, sample absorbance was observed with a microplate reader at a wavelength of 510 nm to determine the percent inhibition and the value of the 50% inhibitory concentration (IC50).

Statistical Analysis

Tyrosinase inhibitory activity data were expressed as mean±SD. Significant differences between groups were assessed by one-way ANOVA followed by group-to-control comparisons by Tukey's test; $p < 0.005$ was considered significant. Data were analyzed using SPSS version 20.0 for Windows.

RESULTS

The elution of the TLC plate is seen on 365 nm UV light in Figure 1, while Table 1 shows that all samples have damped stains. Coffee extracts have a similar Rf value to the chlorogenic acid standard, as shown by the arrow in Figure 1. The results of the spectral assessment of standard chlorogenic acid in Figure 1 showed that the spectra have a maximum wavelength of (λ) 328 and an average absorbance value of 456 AU. Then, the wavelength is used to analyze the levels of chlorogenic acid in the extract. Purity is seen based on the value of r(m,e), which indicates a correlation between the spectra at the peak position (m) and the end of the peak (e). Table 1 shows that the correlation value of chlorogenic r(m,e) acid is more than 0.99. We reckoned that the chromatogram spot/peak is pure.

The purity and identity test results showed a correlation between the spectra of the standard line and the sample. Both have the same concentration. The correlation value is more than 0.99. This value means that coffee extract is identical to the chlorogenic acid standard. Figure 2 shows the coffee spectra wave represented by light green. Dark green and orange coincide and have the same peak as the standard defined by dark purple and light purple. We reckoned that the coffee extract

Table 1. The identity and purity of chlorogenic acid spots in the TLC profile of Robusta BP-42 Coffee extract.

Track	Rf	Assigned Substance	Maximum Signal	r(s,m)	r(m,e)
1	0.19	Chlorogenic Acid	432 AU @ 327 nm	0.999176	0.999871
2	0.18	Chlorogenic Acid	546 AU @ 328 nm	0.999525	0.999354
3	0.18	Chlorogenic Acid	432 AU @ 328 nm	0.999181	0.999664
4	0.18	Chlorogenic Acid	448 AU @ 329 nm	0.999517	0.999697
5	0.19	Chlorogenic Acid	432 AU @ 328 nm	0.999594	0.999754

Rf: Retention factor; AU: Absorbance Units; e: peak end position; m: peak apex position

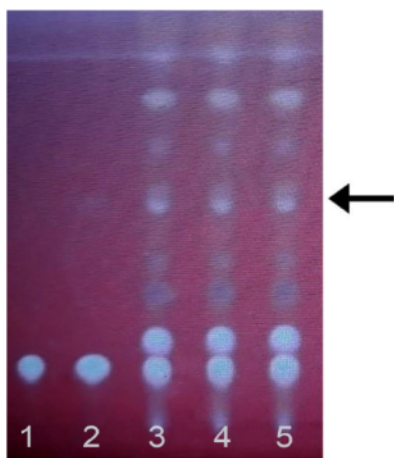


Figure 1. The TLC profile of Robusta BP-42 coffee extract under UV 365 nm light. (1) 1420 ng chlorogenic standard; (2) 2130 ng chlorogenic standard; and (3-5) 2 μ l of the sample BP-42 coffee extract.

compound detected is identical to the chlorogenic acid. We also calculated the chlorogenic acid content at BP-42 coffee bean extract from high-performance thin-layer chromatography results. We have generated that the chlorogenic acid content of our coffee bean extract was 12.452 mg/g.

Kojic acid has a higher inhibition rate compared to BP-42 coffee bean extract. At every concentration, kojic acid shows a higher inhibition rate than coffee extract. But at higher concentrations, BP-42 coffee bean extract shows much difference to kojic acid than at lower concentrations, as shown in Figure 3. The IC_{50} value indicates the inhibitory activity of the tyrosinase enzyme. The concept of concentration value at 50% inhibition (IC_{50}) is widely used in pharmaceuticals to measure effectiveness in inhibiting biological or biochemical functions. IC_{50}

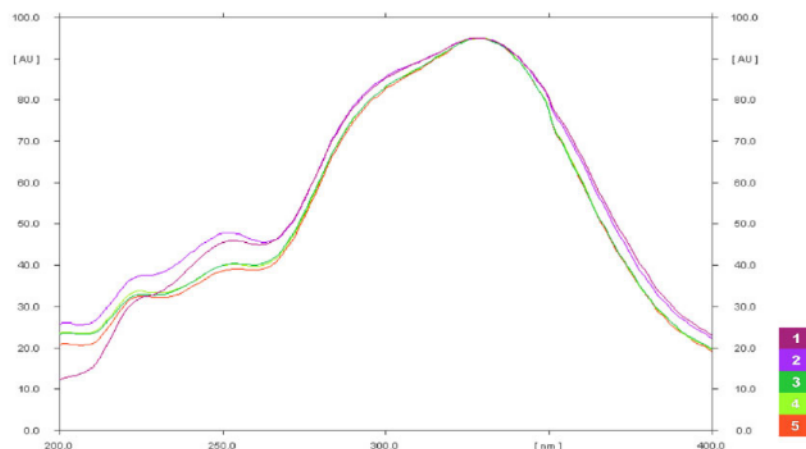


Figure 2. The spectra of thin layer chromatography profile. (1) 1420 ng chlorogenic acid; (2) 2130 ng chlorogenic acid; and (3-5) Various concentrations of chlorogenic acid found in the BP-42 coffee extracts.

is a concentration that can inhibit 50% (half) of enzyme activity. The IC_{50} value is essential to determine the inhibitor's potential in inhibiting enzymatic reactions. The result showed that the IC_{50} of the BP-42 coffee bean extract and kojic acid were 312.213 ppm and 30.696 ppm. Respectively as seen in Figure 4.

DISCUSSION

Our study proved that BP-42 coffee extract contains chlorogenic acid at 12.452 mg/g. This concentration is relatively high compared to other strains of coffee. The chlorogenic acid content from Africa robusta green coffee extract is 11.3 mg/g.¹⁷ Robusta coffee generally has higher chlorogenic acid than arabica coffee. Arabica coffee only has chlorogenic acid at 0.543 mg/g; it's subpar than any robusta.¹⁸ Jember as a place to grow BP-42 coffee has met the criteria to make an excellent coffee. Requirements for robusta are grown at lower elevations (<1400 m). Roughly 90% of Jember's area is below 1000m; it became very suitable for robusta coffee growth. The high yearly rain in the

Jember area also supports excellent coffee growth. Indonesian soil is also essential because it's primarily volcanic and has plenty of nutrients and compounds to support coffee growth. Coffee from Indonesia, especially Jember, is one of the best in the world.¹⁹⁻²³

Chlorogenic acid is well known for its anti-inflammatory effect. In-silico studies by other Indonesian researchers suggest chlorogenic acid can be an anti-hyperpigmentation agent by inhibiting the tyrosinase enzyme.^{24,25} Other investigations in Thailand revealed that a combination of chlorogenic acid and caffeine possesses excellent biological activity to reduce tyrosinase activity and has a good potential for further development for cosmetics and anti-aging products.^{26,27}

BP-42 coffee extract had an IC_{50} of tyrosinase activity at 312.213 ppm compared to kojic acid at 30.969 ppm. Our result showed that robusta coffee extract from Jember could be a candidate for anti-tyrosinase. However, it was lower than kojic acid, one of the standard anti-

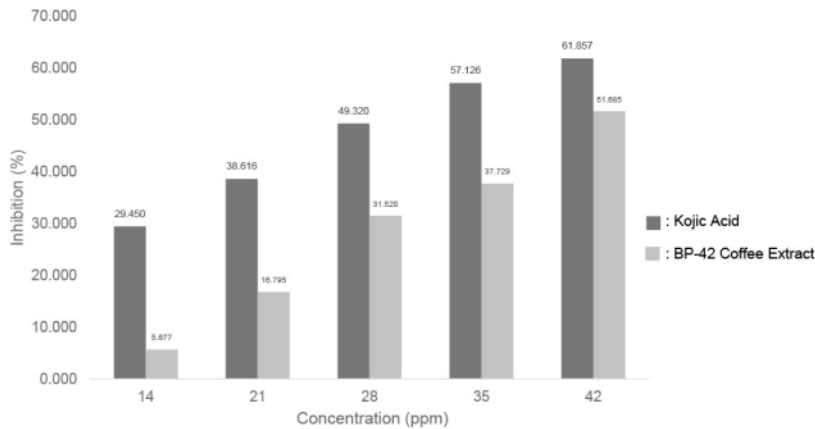


Figure 3. Inhibition rate of tyrosinase activity between Kojic Acid and BP-42 Coffee Extract.

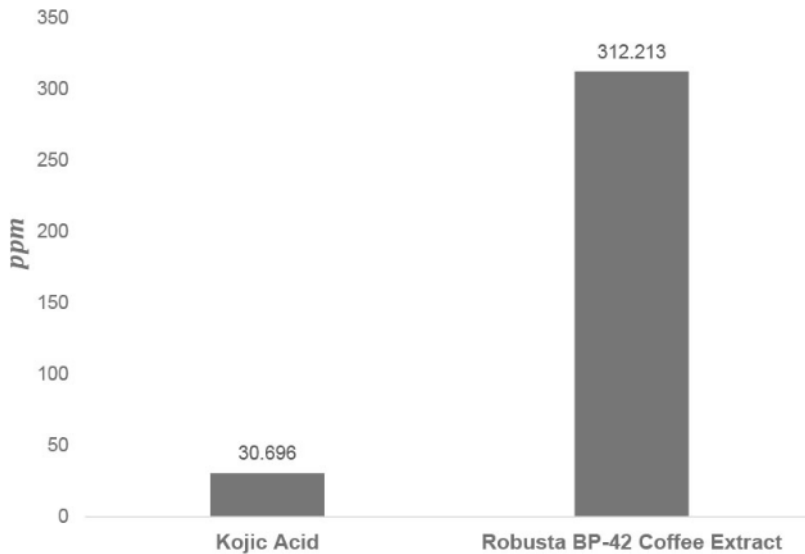


Figure 4. The IC₅₀ value of kojic acid and robusta BP-42 coffee extract.

tyrosinase. This positive result proves that Robusta coffee extract has the potential to continue to be developed as a skin-lightening ingredient. Robusta coffee's anti-inflammatory, antioxidant, and antibacterial abilities make it possible to reduce unwanted effects compared to other anti-tyrosinase standards, such as hydroquinone and kojic acid.^{8,16} Those compounds have side effects that are pretty severe on the skin and can even cause malignancy.²⁸ The tyrosinase activity was reduced by BP-42 coffee extract primarily because of chlorogenic acid. Chlorogenic acid is an essential isomer exhibiting

antioxidant activities and DNA damage protective effects to various extents.^{29,30} But, it has a consideration about the roasting of coffee beans. The highest concentration achieves when coffee isn't roasted. The concentration of chlorogenic acid in coffee beans would decrease if they were roasted at high heat. The longer and higher temperature coffee are roasted, the more the chlorogenic acid will be reduced.^{26,31,32}

In this study, we used a raw extract of BP-42 coffee beans. We didn't use any specific active compound of BP-42 coffee beans. Further research should isolate

every specific active substance of BP-42 coffee beans. Then, compare every pure isolate to see its anti-tyrosinase activities.

CONCLUSION

We conclude that BP-42 coffee bean extract has 12.452 mg/g chlorogenic acid. Our extract can inhibit tyrosinase activity with IC₅₀ at 312.213 ppm. This IC₅₀ result is lower than kojic acid at 30.696 ppm. However, our coffee extract still has an excellent potential to become a candidate for an anti-hyperpigmentation agent because of other benefits that others don't.

CONFLICT OF INTEREST

The Ethical Committee of Medical Research Faculty of Dentistry, Universitas Jember, Indonesia, approved this study, with reference number 1657/UN25.8/KEPK/DL/2022.

ETHICAL CONSIDERATIONS

The authors declare that there is no conflict of interest.

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AUTHOR CONTRIBUTION

In this article, Ulfa Elfiah acted as the main conceceptor, organized the research method, wrote the main draft and evaluated it. David Sontani Perdanakusuma supported and developed the research methodology. Iswinarno Doso Saputro supported the research method and edited the draft. Misnawi supported the research by giving the BP-42 coffee bean and the method to extract the coffee.

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REFERENCES

- Schlottmann F, Bucan V, Vogt PM, Krezdorn N. A short history of skin grafting in burns: From the gold standard of autologous skin grafting to the possibilities of allogeneic skin grafting with immunomodulatory approaches. *Med.* 2021;57(3):1–15.
- Janowska A, Dini V, Panduri S, Macchia M, Oranges T, Romanelli M. Epidermal skin grafting in vitiligo: a pilot study. *Int Wound J.* 2016;13(S3):47–51.
- Majid I. Grafting in vitiligo: How to get better results and how to avoid complications. *J Cutan Aesthet Surg.* 2013;6(2):83–89.
- Liadaki E, Bergmann PA, Kalousis K, Mailänder P, Siemers F. The central-pedicled intracorial skin-flap technique for reconstruction of the nipple-areola complex (NAC). *Breast.* 2013;22(1):74–77.
- Alsaif A, Karam M, Hayre A, Abul A, Aldubaikhi A, Kahlar N. Full thickness skin graft versus split thickness skin graft in paediatric patients with hand burns: Systematic review and meta-analysis. *Burns.* 2022;S0305-4179(22)00249-2.
- D'Mello SAN, Finlay GJ, Baguley BC, Askarian-Amiri ME. Signaling pathways in melanogenesis. *Int J Mol Sci.* 2016;17(7):1–18.
- Chang TS. Natural melanogenesis inhibitors acting through the down-regulation of tyrosinase activity. *Materials (Basel).* 2012;5(9):1661–1685.
- Qian W, Liu W, Zhu D, Cao Y, Tang A, Gong G, et al. Natural skin-whitening compounds for the treatment of melanogenesis (Review). *Exp Ther Med.* 2020;20(1):173–185.
- Raposo G, Marks MS. Melanosomes—dark organelles enlighten endosomal membrane transport. *Nat Rev Mol Cell Biol.* 2007;8(10):786–797.
- Phasha V, Senabe J, Ndzotoyi P, Okole B, Fouche G, Chuturgoon A. Review on the Use of Kojic Acid—A Skin-Lightening Ingredient. *Cosmetics.* 2022;9(3):1–11.
- Aytemir MD, Karakay G, Ekinici D. Kojic Acid Derivatives. *INTECH.* 2012;(1):1-27.
- Index Mundi. Green Coffee Robusta Production by Country in 1000 60 KG BAGS - Country Rankings [Internet]. 2017. [Cited 5th November 2022] [Available from: <https://www.indexmundi.com/agriculture/?commodity=green-coffee&graph=robusta-production>]
- Purwanto EH, Rubiyo TJ. Karakteristik Mutu dan Citarasa Kopi Robusta Klon BP 42. BP 358 dan BP 308 Asal Bali dan Lampung. *Sirinov. Balai Penelit Tanam Ind dan Penyegar.* 2015;3(2):67–74.
- Fukushima Y, Takahashi Y, Kishimoto Y, Taguchi C, Suzuki N, Yokoyama M, et al. Consumption of polyphenols in coffee and green tea alleviates skin photoaging in healthy Japanese women. *Clin Cosmet Investig Dermatol.* 2020;13(2):165–72.
- Ribeiro HM, Allegro M, Marto J, Pedras B, Oliveira NG, Paiva A, et al. Converting Spent Coffee Grounds into Bioactive Extracts with Potential Skin Antiaging and Lightening Effects. *ACS Sustain Chem Eng.* 2018;6(5):6289–95.
- Aulifa DL, Caroline M, Tristiyanti D, Budiman A. Formulation of the serum gel containing green coffee bean (*Coffea robusta* L) extract as an antioxidant and tyrosinase enzyme inhibitor. *Rasayan J Chem.* 2020;13(4):2346–2351.
- Ky CL, Louarn J, Dussert S, Guyot B, Hamon S, Noirot M. Caffeine, trigonelline, chlorogenic acids and sucrose diversity in wild *Coffea arabica* L. and *C. canephora* P. accessions. *Food Chem.* 2001;75(2):223–230.
- Awwad S, Issa R, Alnsour L, Albals D, Al-Momani I. Quantification of Caffeine and Chlorogenic Acid in Green and Roasted Coffee Samples Using HPLC-DAD and Evaluation of the Effect of Degree of Roasting on Their Levels. *Molecules.* 2021;26(24):7502.
- Kath J, Byrareddy VM, Craparo A, Nguyen-Huy T, Mushtaq S, Cao L, et al. Not so robust: Robusta coffee production is highly sensitive to temperature. *Glob Chang Biol.* 2020;26(6):3677–3788.
- Verbist B, Putra AED, Budidarsono S. Factors driving land use change: Effects on watershed functions in a coffee agroforestry system in Lampung, Sumatra. *Agric Syst.* 2005;85(3):254–270.
- Wang N, Jassogne L, van Asten PJA, Mukasa D, Wanyama I, Kagezi G, et al. Evaluating coffee yield gaps and important biotic, abiotic, and management factors limiting coffee production in Uganda. *Eur J Agron.* 2015;63(2):1–11.
- Jember BK. The Amount of Rainfall (mm) By Subdistricts. Gauging Stations and Months. 2020. [Cited 16th November 2022] [Available from: <https://jemberkab.bps.go.id/statictable/2015/03/12/40/banyaknya-curah-hujan-mm-menurut-kecamatan-stasiun-pengukur-dan-bulan-2013.html>]
- Jember P. Geografis dan Topografi – Pemerintah Kabupaten Jember. 2019. [Cited 16th November 2022] [Available from: <https://www.jemberkab.go.id/selayang-pandang/geografis-dan-topografi/>].
- Yudantara IMA, Cahyani NKN, Saputra MAW, Dewi NKDP. Chlorogenic acid and kojic acid as anti-hyperpigmentation: in silico study. *Pharm Reports.* 2022;1(2):1–6.
- Kusumawati LAI, Dewi ENA, Xenograf OC, Rifrianasari K, Hidayat MA. Tyrosinase inhibition assay and skin whitening cream formulation of edamame extract (Glycine Max). *Int J Pharmacogn Phytochem Res.* 2015;7(6):1167–1171.
- Kiattisin K, Nantarat T, Leelapornpisid P. Evaluation of antioxidant and anti-tyrosinase activities as well as stability of green and roasted coffee bean extracts from *Coffea arabica* and *Coffea canephora* grown in Thailand. *J Pharmacogn Phyther.* 2016;8(10):182–192.
- Makurina ON, Zaitsev V, Kolesnikov A, Sokol O, Sadykhova A. Aging changes' inhibition of hemostasis and blood rheological features on the background of antioxidant liposomal preparation "Lipovitam-Beta" application. *Bali Medical Journal.* 2018;7(1):114–119.
- Carvalho Neto DPD, Gonot-Schoupinsky XP, Gonot-Schoupinsky FN. Coffee as a Naturally Beneficial and Sustainable Ingredient in Personal Care Products: A Systematic Scoping Review of the Evidence. *Front Sustain.* 2021;2:1–22.
- Xu JG, Hu QP, Liu Y. Antioxidant and DNA-Protective Activities of Chlorogenic Acid Isomers. *J Agric Food Chem.* 2012;60(46):11625–11630.
- Mulyani WRW, Sanjiwani MID, Sandra, Prabawa IPY, Lestari AAW, Wihandani DM, Suastika K, Saraswati MR, Bhargah A, Manuaba IBAP. Chaperone-Based Therapeutic Target Innovation: Heat Shock Protein 70 (HSP70) for Type 2 Diabetes Mellitus. *Diabetes Metab Syndr Obes.* 2020;13:559–568.
- Fuller M, Rao NZ. The Effect of Time, Roasting Temperature, and Grind Size on Caffeine and Chlorogenic Acid Concentrations in Cold Brew Coffee. *Sci Rep.* 2017;7(1):1–9.
- Moon JK, Hyui-Yoo SUN, Shibamoto T. Role of roasting conditions in the level of chlorogenic acid content in coffee beans: Correlation with coffee acidity. *J Agric Food Chem.* 2009;57(12):5365–5369.



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Degeneration", Journal of Agricultural and Food Chemistry, 2013

Publication

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V. Lecoultre, G. Carrel, L. Egli, C. Binnert, A. Boss, E. L. MacMillan, R. Kreis, C. Boesch, C. Darimont, L. Tappy. "Coffee consumption attenuates short-term fructose-induced liver insulin resistance in healthy men", American Journal of Clinical Nutrition, 2013

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