JNPDD
Journal of Natural Product for Degenerative Diseases
https://journal.univpancasila.ac.id/index.php/Natural

Formulation and Evaluation of Anti-aging Serum Containing a Combination of Mugwort (*Artemisia capillaris*) Extract and Vitamin C as an Antioxidant

Fit Indri Intan Utami[1*], Rahmatul Qodriah[2], Anarisa Budiati[1], Esti Mumpuni[2]

[1]*Department of Pharmaceutics, Faculty of Pharmacy, Universitas Pancasila, Jakarta, Indonesia.*
[2]*Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Universitas Pancasila, Jakarta, Indonesia.*

*Corresponding Author. E-mail: indryu@gmail.com

Received: 2 September 2023 / Accepted: 7 September 2023

ABSTRACT: Mugwort (genus Artemisia) is a skincare ingredient originating from a South Korean beauty trend having antioxidant properties and is currently popular globally. The aim of this research is to formulate and determine the antioxidant activity of anti-aging serum containing Mugwort (*Artemisia capillaris*) and Vitamin C extract as antioxidants. All formulas were adjusted to a pH range of 5.0 – 5.2. Each formula was characterized based on antioxidant activity using the DPPH method. Serum with mugwort extract (F1) and serum with a combination of mugwort extract and vitamin C (F3) show strong antioxidant activity with an $IC_{50\ of}$ 99.70 and 82.92 ppm, respectively. Anti-aging serum containing mugwort (*Artemisia capillaris*) extract and vitamin C provides strong antioxidant activity with an IC50 of 82.92 ppm (F3).

KEYWORDS: anti-aging serum; antioxidant; artemisia capillaris; Korean beauty trend, mugwort; vitamin C.

1. INTRODUCTION

Skin aging is a process in which skin quality deteriorates, which is shown by creases in the skin, dry skin, and disintegration of the dermis-epidermis junction. The aging process involves many changes that occur due to exogenous factors. The main exogenous factor is oxidative stress, in which molecules are released in the body that are highly unstable and capable of damaging all cellular structures [1]. In this case, numerous studies show that antioxidants play an essential role in reducing oxidative stress. Considering the big role of antioxidants in slowing and preventing skin aging, determining the antioxidant activity of anti-aging serums is important [2].

Meanwhile, in recent years, South Korean skincare has become popular in the global beauty industry [3]. One of the skincare ingredients that comes from this South Korean beauty trend is Mugwort. The global impact of this trend has encouraged the use of mugwort extract in the European, American, and Asian skincare markets, including Indonesia [4]. Mugwort (genus Artemisia) was initially consumed as tea and spice in South Korea [3]. Scientific studies, including antioxidant activity, are currently more common in *Artemisia vulgaris* species [4,6]. However, worthy antioxidant activity has also been confirmed in other Artemisia species such as *Artemisia princeps, Artemisia argyi,* and *Artemisia capillaris* [5-9]. Several studies show the antioxidant activity of *Artemisia capillaris* [7-9]. However, the use of mugwort extract in anti-aging serum requires scientific validation.

Along with that, it is known that the most effective antioxidant comes from the vitamin C group. Vitamin C is also often used in combination with other antioxidants for a higher effect, including artemisia genus [9]. Previous studies showed a synergistic effect on the antioxidant activity by the combination of the artemisia genus with vitamin C. Therefore, The aim of this research was to formulate an anti-aging serum containing Mugwort *(Artemisia capillaris)* extract and vitamin C as an antioxidant. However, vitamin C in the form of Ascorbic Acid is unstable and limited in formulation, so in this formula, a more stable vitamin C derivative was used, namely Ascorbic acid 2-glucoside [10].

How to cite this article: Utami FII, Qadriah R, Budiati A, Mumpuni E. Formulation and Evaluation of Anti-aging Serum Containing a Combination of Mugwort (Artemisia capillaris) Extract and Vitamin C as an Antioxidant. JNPDD. 2023; 1(1): 41-46.

ISSN: 0000-0000
https://doi.org/10.58511/jnpdd.v1i1.5524

2. MATERIALS AND METHODS

2.1. Materials

The samples used in this study were *Artemisia caplillaris* (mugwort) flower extract (Codif Technologie Naturelle, France) and Ascorbic acid 2 -glucoside (Hayashibara Co. LTD., Japan). The materials used are purified water, trehalose (Mibelle Biochemistry, Switzerland), Sidr Extract (Mibelle Biochemistry, Switzerland), saccharide isomerate (DSM-Firemenich, Netherlands), propanediol (Covation Bio PDO, USA), sodium benzoate (IMCD, USA), potassium sorbate (IMCD, USA), glycerine (Ecogreen Oleo, Indonesia), xanthan gum (CP Kelco, USA), citric acid anhydrate (PT. Brataco, Indonesia), trisodium citrate dehydrate (Jungbunzlauer, Switzerland), DPPH (Merck, Germany), and ethanol pro analysis (Mallinckrodt, Ireland).

2.2. Equipment

UV-Visible Spectrophotometer UV-1900 (Shimadzu, Japan), Analytical balance (Shimadzu, Japan), Micropipettes 100-1000 µL (Brand, Germany), Micropipettes 50 µL (Nichiryo, Japan), pH meter, magnetic stirrer, and chemical glassware.

2.3. Method

2.3.1. Formulation of anti-aging serum

Three formula series of anti-aging serum and placebo as shown in Table 1. The active substances examined in this research were mugwort (*Artemisia capillaris*) flower extract with the trademark Raykami PDO® (Codif Technologie Naturelle, France) and ascorbic acid 2 -glucoside with the trademark AA2G® (Hayashibara Co. LTD., Japan).

Tabel 1. Anti-aging serum formulation result [11,14].

Ingredient	F0 (%)	F1 (%)	F2 (%)	F3 (%)
Purified water	79,125	78,622	74,225	73,722
Ascorbic acid 2-glucoside	-	-	2	2
Trehalose	1,784	1,784	1,784	1,784
Sidr extract	0,016	0,016	0,016	0,016
Mugwort extract	-	0,006	-	0,006
Saccharide isomerate	5	5	5	5
Propanediol	10	10,497	10	10,497
Sodium benzoate	0,45	0,45	0,45	0,45
Potassium sorbate	0,225	0,225	0,225	0,225
Glycerine	3	3	3	3
Xanthan gum	0,3	0,3	0,3	0,3
Citric acid anhydrate	0,1	0,1	-	-
Trisodium citrate dehydrate	-	-	3	3

(F0) : Plasebo, (F1) : Mugwort, (F2) : Vitamin C, (F3) : Mugwort + Vitamin C

Solution stirring was carried out using a magnetic stirrer. All of the ingredients used are weighed and named. The anti-aging serum formulation begins by first dissolving each of the active ingredients in powder form into purified water until completely dissolved, then the two are mixed and stirred until homogeneous. Other ingredients in liquid form are added to the formula and stirred. after homogeneous, the mixture is added with preservatives and stirred until homogeneous. The next step, in a separate container, xanthan gum is first dispersed in glycerine, then added to the mixture and stirred until fully hydrated and increases in viscosity. 10% citric acid solution or 30% trisodium citrate solution, which had been prepared beforehand, is added to the desired pH value [11].

2.3.2. pH measurement

Acidity measurement is carried out using a pH meter. pH meter was calibrated using pH 4.0 and 7.0 buffers. The measuring electrode is dipped so that the tip of the electrode is completely submerged, and the pH obtained is recorded. The pH of skincare products must match the skin's pH, which is 4.5-6.5 [12].

https://doi.org/10.58511/jnpdd.v1i1.5524
JNPDD 2023; 1(1): 41-46

2.3.3 Antioxidant Determination

A solution of 0.4mM DPPH (BM=394.2) was made by weighing approximately 4 mg DPPH which was then dissolved and added with ethanol until the volumetric flask mark was 25.0 mL. flask protected with aluminum foil and stored in a dark room. Each sample and placebo solution was prepared by weighing 100.0 mg and dissolving it in pro-analysis ethanol up to 10 mL to produce a concentration of 10,000 ppm (stock solution). 50, 100, 150, 200, and 250 µL of stock solution were pipetted into test tubes. In each tube, 1.0 mL of DPPH solution was added, then ethanol was added up to 5.0 mL, and homogenized.

The antioxidant assay was carried out using the DPPH (1,1-diphenyl-2-picryl hydrazyl) method. Each sample solution was made with a concentration of 100-500 ppm, adding 1.0 mL of 0.4 mM DPPH and 5.0 mL of ethanol pro analysis. The sample solution was incubated in the dark for 30 minutes at room temperature. The absorbance of the solution was measured at a wavelength of 517 nm using a UV-Vis Spectrophotometer. The DPPH absorption obtained from the measurement results was calculated as the percent inhibition [5,8]. Formula 0 (F0) is a placebo and is used as a negative control. Antioxidant activity was calculated by determining the decrease in absorption at different concentrations using the equation [5]:

$$\text{Radical scavenging activity (\%)} = \left(\frac{\text{1 - the absorbance of the treated sample}}{\text{the absorbance of control sample}} \right)$$

Antioxidant activity entered into the equation obtained from the linear regression curve to obtain the IC_{50} value. IC_{50} is defined as the "Inhibition Concentration" or efficient antioxidant required to reduce the initial DPPH concentration by 50% [13].

3. RESULTS AND DISCUSSION

3.1. Result of Anti-aging Serum Formulation

Raykami PDO® contains 0.6% mugwort (artemisia capillaris) flower extract, 49.7% propanediol, and 49.7% water [14]. The recommended usage amount for Raykami was 1% which is equivalent to 0.006% mugwort extract. The use of mugwort extract in this formula has little impact on the differences in the amount of total propanediol in the formulas as shown in Table 1.

Each anti-aging serum formula contains enhancers, viscosity modifiers, pH regulators, and preservative systems as required by facial serum formulas in general. All active ingredients used in these anti-aging serum formulas are selected based on general rules for aging skin care, such as mugwort extract and sidr extract [11].

Mugwort (*Artemisia capillaris*) extract contains polyphenols such as chlorogenic acid that exhibit antioxidant properties [15]. Numerous studies show that antioxidants play an essential role in the ability to prevent skin aging [16]. Thus, this is what underlies the addition of this ingredient in the formula.

Vitamin C group still one of the most effective antioxidants. However, vitamin C in the form of ascorbic acid in the presence of water is unstable so that limited in liquid formulation. Therefore, ascorbic acid 2-glucoside, a natural vitamin C stabilized with glucose, was used to replace ascorbic acid [8]. Previous studies showed a synergistic effect on the antioxidant activity by the combination of the artemisia genus with vitamin C [9]. That data was the background for adding a variety of formulas with this ingredient.

Ingredient such as sidr (*Ziziphus spina-christi)* leaf extract was used in this formula because of their properties in preventing glycation, wrinkles, as well as collagen fragmentation. This extract contains polyphenol and dammarane-type saponins that were the key bioactive[16,17].

Apart from those ingredients, the anti-aging serum formula is loaded with humectants and moisturizers such as glycerine, propanediol, trehalose, and saccharide isomerate. As previously explained dry skin is one of the problems caused by skin aging, these ingredients are intended to give hydration and moisturize the skin so that it can provide comfort when used and prevent worse damage caused by dry skin [18].

3.2. Result of pH Measurement

The pH of the three series of anti-aging serum formulas and placebo before and after pH adjustment can be seen in Table 2. Initial pH measurements need to be carried out to find out what pH adjuster is added to the formula and predict the quantity added. The pH of the anti-aging serum must match the pH of the skin

(4.5 – 6.5) to prevent irritation [12]. The pH should be effective for the preservation system, a pH that is too high or too low can reduce the effectiveness of the preservative. The preservatives used in this formula are sodium benzoate and potassium sorbate which is optimum at a less acidic solution, which is pH 4.5 - 5.5 [19]. Therefore, the pH range for this formula was adjusted to be 5.0 – 5.2.

Ascorbic acid 2-glucoside is an acidic active ingredient, so the formula had a low pH and added by ingredient that can increase the pH, such as sodium citrate to reach pH 5.0 – 5.2. Otherwise, other formulas tend to need a decrease in pH by adding citric acid [19].

Table 2. Result of pH measurement

	F0	F1	F2	F3
Before pH adjusting	5.64	5.56	3.12	3.18
After pH adjusting	5.01	5.06	5.08	5.20

3.3. Antioxidant Activity

DPPH absorbance from the sample and placebo was measured using UV-Vis Spectrophotometer at a wavelength of 517 nm [5,8]. The wavelength used is the wavelength for DPPH. The DPPH absorption obtained from the measurement results was calculated as the percent inhibition as shown in Table 3.

Table 3. Percent inhibition of anti-aging serum

Concentration (ppm)	% Inhibition			
	F0	F1	F2	F3
100	0.252825	0.197967	0.266557	0.294385
200	0.270989	0.243524	0.335607	0.367432
300	0.326191	0.273285	0.372542	0.418753
400	0.383872	0.331538	0.414437	0.463942
500	0.413372	0.381952	0.442450	0.526175

The antioxidant activity, IC_{50} of 3 anti-aging serum series and placebo have been determined using the DPPH (diphenylpicrylhydrazil) method. Shown in Table 3, the average IC_{50} value of placebo (F0) was 124.5 ppm, serum with mugwort extract (F1) was 99.7, serum with vitamin C derivatives (F2) was 124.47, and serum with the combination mugwort extract and vitamin C derivatives (F3) was 82.92.

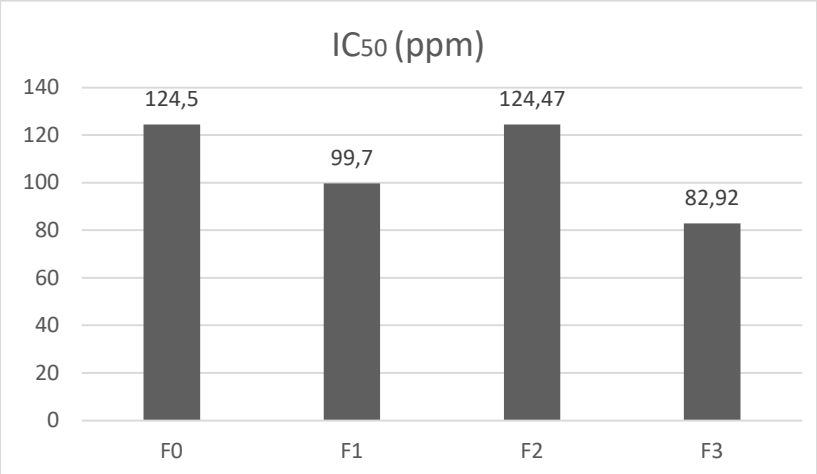

Figure 1. Value of antioxidant activity (IC_{50}) of anti-aging serum

The antioxidant activity of the placebo was in the "moderate" category. The presence of this antioxidant activity is caused by other ingredients in the formula which may contribute to providing antioxidant activity. The antioxidant activity of serum with mugwort extract (F1) belongs to the "strong" antioxidant category, which means that adding mugwort extract to the formula could improve the antioxidant performance of anti-aging serum [20].

Serum with vitamin C derivatives (F2) has antioxidant activity in the "moderate" category which is similar to placebo values. These data show that there is no detectable improvement in antioxidant activity when vitamin C derivative was added to the formula. This could be because ascorbic acid 2-glucoside is an

inactive pro-vitamin C that requires activation by enzymes in the skin to be metabolized into vitamin C to bring antioxidant properties [21].

The antioxidant activity of serum with a combination of mugwort extract and vitamin C derivatives was classified as the "strong" category and is stronger than serum with mugwort extract alone [20]. It is suspected that causes stronger antioxidant activity at F3 could come from pH. As shown in Table 2, The pH at F3 is 5.20, slightly higher than the other 3 samples, hence, the optimum pH for mugwort extract to provide antioxidant activity needs to be carried out further [20]. The aim of an anti-aging serum containing mugwort extract that is combined with Ascorbic acid 2-glucoside is to obtain an antioxidant synergistic effect as well as stability improvement. However, this synergistic action as an antioxidant needs further examination using proper and precise methods.

4. CONCLUSION

Anti-aging serum containing a combination of mugwort extract *(Artemisia capillaris)* and vitamin C provides strong antioxidant activities with an IC_{50} of 82.92 ppm (F3). The optimum pH for mugwort extract to provide antioxidant activity needs to be carried out further. To examine the antioxidant synergistic action of mugwort extract and ascorbic acid 2-glucoside, a more precise test method is needed.

Acknowledgments: The authors are grateful to Sendy Y.S. Dachi S.T, Director of PT Zahara Natural Indonesia, for the provision of funds and materials.

Author contributions: Concept – F.I.I.U., E.M.; Resources – F.I.I.U.; Materials – F.I.I.U., RH.; Data Processing – F.I.I.U., R.H.; Analysis and/or Interpretation – F.I.I.U., R.H.; Critical Reviews – F.I.I.U., A.B.

Conflict of interest statement: The authors declared no conflict of interest

REFERENCES

[1] Chaudhary M, Khan A, Gupta M. Skin Ageing: Pathophysiology and Current Market Treatment Approaches. Curr Aging Sci. 2020;13(1):22-30.

[2] Munteanu IG, Apetrei C. Analytical Methods Used in Determining Antioxidant Activity: A Review. Int J Mol Sci. 2021;22(7):3380.

[3] Guyen JK, Masub N, Jagdeo J. Bioactive ingredients in Korean cosmeceuticals: Trends and research evidence. J Cosmet Dermatol. 2020;19(7):1555-1569.

[4] Ekiert H, Pajor J, Klin P, Rzepiela A, Ślesak H, Szopa A. Significance of *Artemisia Vulgaris* L. (Common Mugwort) in the History of Medicine and Its Possible Contemporary Applications Substantiated by Phytochemical and Pharmacological Studies. Molecules. 2020;25(19):4415.

[5] Kim JK, Shin EC, Lim HJ, Choi SJ, Kim CR, Suh SH, Kim CJ, Park GG, Park CS, Kim HK, Choi JH, Song SW, Shin DH. Characterization of Nutritional Composition, Antioxidative Capacity, and Sensory Attributes of Seomae Mugwort, a Native Korean Variety of Artemisia argyi H. Lév. & Vaniot. J Anal Methods Chem. 2015;2015:916346.

[6] Ji Young Choi · In Hee Cho · Young-Suk Kim · Hyong Joo Lee. Aroma-Active Compounds of Korean Mugwort (Artemisia princeps orientalis). J Korean Soc Appl Biol Chem. 2014;57(3):323−329.

[7] Kim, Jong-Myeung & Shin, Yong-Kyu & Kim, Byung-Oh & Kim, Jong-Kuk & Lee, Sang-Han & Kim, Young-Sup. (2012). Effect of Artemisia capillaris Extracts on Antioxidant Activity and Allergic Dermatitis. Journal of Life Science. 2012;22(7):958-963.

[8] Ahn EY, Lee YJ, Park J, Chun P, Park Y. Antioxidant Potential of Artemisia capillaris, Portulaca oleracea, and Prunella vulgaris Extracts for Biofabrication of Gold Nanoparticles and Cytotoxicity Assessment. Nanoscale Res Lett. 2018;13(1):348.

[9] Ko-Eun Hwang, Hyun-Wook Kim, Dong-Heon Song, Yong-Jae Kim, Youn-Kyung Ham, Yun-Sang Choi1, Mi-Ai Lee2 , and Cheon-Jei Kim. Enhanced Antioxidant Activity of Mugwort Herb and Vitamin C in Combination on Shelf-life of Chicken Nuggets. Korean J. Food Sci. An. 2014;34(5): 582-590.

[10] Maeda J, Allum AJ, Mussallem JT, Froning CE, Haskins AH, Buckner MA, Miller CD, Kato TA. Ascorbic Acid 2-Glucoside Pretreatment Protects Cells from Ionizing Radiation, UVC, and Short Wavelength of UVB. Genes (Basel). 2020;11(3):238.

[11] Protap Pengolahan Batch Honey Squad Serum Barrier Protecting and Revitalizing. Zahara Natural, Depok. 2023.

[12] Tranggono, Latifah F. Buku Pegangan Ilmu Pengetahuan Kosmetik. PT Gramedia Pustaka Utama, Jakarta. 2007.

[13] Kedare SB, Singh RP. Genesis and development of DPPH method of antioxidant assay. J Food Sci Technol. 2011;48(4):412-22.

[14] Raw Material Identification: Raykami PDO-ALG422. Codif Technologie Naturelle, France. 2018.

[15] Hsueh TP, Lin WL, Dalley JW, Tsai TH. The Pharmacological Effects and Pharmacokinetics of Active Compounds of *Artemisia capillaris*. Biomedicines. 2021;9(10):1412.

[16] Bozicevic, A, Mieri MD, Benedetto AD, Gafner F, Hamburger M. Dammarane-type saponins from leaves of Ziziphus spina-christi, Phytochemistry (2017):1-11.

[17] Wandrey F, Schmid D, Zülli F. Fighting Glycation for Rejuvenated Skin. Personal Care. 2021;1-4.

[18] Voegeli R, Rawlings AV. Moisturizing at a Molecular Level – The Basis of Corneocare. IFSCC Magazine. 2021;24(4):187-202.

[19] Guynot ME, Ramos AJ, Sanchis V, Marín S. Study of benzoate, propionate, and sorbate salts as mould spoilage inhibitors on intermediate moisture bakery products of low pH (4.5-5.5). Int J Food Microbiol. 2005;101(2):161-8.

[20] Giuliana FE, Ardana M, Rusli R, Pengaruh pH Terhadap Aktivitas Antioksidan Ekstrak Daun Miana (*Coleus atropurpureus* L. Benth). Prosiding Seminar Nasional Kefarmasian Ke-1. Samarinda, 2015, pp.242-251

[21] Jacques C, Genies C, Bacqueville D, Tourette A, Borotra N, Chaves F, Sanches F, Gaudry AL, Bessou-Touya S, Duplan H. Ascorbic acid 2-glucoside: An ascorbic acid pro-drug with longer-term antioxidant efficacy in skin. Int J Cosmet Sci. 2021;43(6):691-702.