ISSN: 2085-675X (Print)
ISSN: 2354-8770 (Electronic)

Jurnal Kefarmasian Indonesia
Available online at https://jkefarind.com/index.php/jki
Original Research Article
JKI

Feasibility of Corn Silk Eco-Enzyme as Essence in Sheet Mask with Antioxidant Content

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ARTICLE INFO

Article history:
Received 29 April 2024
Revised 27 June 2024
Accepted 03 July 2024
Published online 31 August 2024

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DOI: https://doi.org/10.22435/jki.v14i2.6651

Citation: Nisa ZA, Agustin EW, Kusumastuti A, Achmadi TA. Feasibility of Corn Silk Eco-Enzyme as Essence in Sheet Mask with Antioxidant Content. Jurnal Kefarmasian Indonesia. 2024;14(2):185-193

ABSTRACT

Air pollution level in Indonesia can cause oxidative stress which can impact the antioxidant defenses of the skin so it can trigger premature aging problems. Skin protection should focus on the application of topical antioxidants which include flavonoids as antioxidants. Furthermore, corn silk containing flavonoids has the potential to be used as a topical preparation in the form of a sheet mask as an antioxidant in preventing premature aging. Corn silk which is processed using the fermentation method becomes an eco-enzyme since it can act as a good catalyst and produce antioxidants. The aim of this research is to analyze the feasibility of eco-enzyme as an essence in sheet mask preparations with antioxidant content which meets the preparation evaluation requirements. The method used in this research consisted of making corn silk eco-enzyme which was homogenized with other chemicals to become an essence sheet mask and packaged by using paper sheets in foil bags. The research results show that preparations with eco-enzyme concentrations in each formula, namely 10% (F1), 20% (F2), and 30% (F3), have good physical evaluations and met test standards which included organoleptic, pH, homogeneity, spreadability, adhesion, and stability tests. Moreover, the antioxidant activity test shows the IC_{50} values for each formula are 190.67 µg/mL, 185 µg/mL, and 96.75 µg/mL, respectively. The conclusion is that the F3 with a concentration of 30%, shows the best antioxidant activity, having an IC_{50} value of 96.75 µg/mL, which is classified as strong. In addition, the results of this research prove that the eco-enzyme from corn silk is suitable for use in preparing essence sheet masks with antioxidant content.

***Keywords*:** Antioxidant; Corn silk; Eco-enzyme; Sheet mask

INTRODUCTION

Indonesia is one of the countries with high air pollution levels. Industrial activities, traffic transportation, and indoor household sources can impact the severity of air pollutants. In 2050, the world population can reach 6.3 billion of the total population which lead to increase in air pollution due to increased energy and transportation needs.[1] Continuous exposure to air pollution on the skin can cause oxidative stress which can impact the skin's antioxidant defenses so that it can potentially cause premature aging problems.[2] Premature aging occurs due to excessive oxidative stress so that natural antioxidants in humans are unable to neutralize the effects of free radicals which

ISSN: 2085-675X (Print)
ISSN: 2354-8770 (Electronic)

have an impact on the premature aging process.[3]

Premature aging can be prevented by applying antioxidants to the skin which can inhibit oxidative reactions.[4] Skin protection should focus on the application of topical antioxidants which can be a strategy in order to reduce the harmful effects of exposure to pollutants on the skin. Furthermore, the antioxidant effect formulated in topical preparations can provide an antioxidant effect contained in the active substance which lasts longer when it interacts with facial skin.[5] The application of antioxidants as an effort to prevent premature aging will be more effective if they contain flavonoids derived from phenolic compounds.[6] Flavonoids are biologically active compounds which act as antioxidants.[7] The development of cosmetic trends using natural ingredients can increase the efficiency of cosmetics and reduce the risk of skin irritation, besides, producing natural and environmentally friendly formulations.

The flavonoid content in natural ingredients, one of which is corn hair, has a good antioxidant effect in reducing the generation of free radicals.[8] Corn silk is a major byproduct of the corn processing industry which is usually only disposed of as environmentally friendly agricultural waste. One kilogram of corn kernels produces 35 grams of corn silk waste. One of the active components contained in corn silk as antioxidants is flavonoids. Moreover, the flavonoids contained in corn silk have a percentage of between less than 0.1% to 3%.[8] The antioxidant content in corn silk is stronger than vitamin C as shown in the IC_{50} value or 7.73 ppm.[9] Production of corn silk waste is directly proportional to corn production figures in Indonesia. Therefore, corn silk containing flavonoids has the potential to be used as a topical preparation in the form of a sheet mask as an antioxidant in preventing premature aging.

A sheet mask is a mask in the form of a sheet of cloth in the shape of a face soaked in a solution in the form of serum. Topical preparations in the form of sheet masks are chosen since they are able to overcome the problem of reduced skin elasticity and fine lines which considered as are signs of aging. Sheet masks can revive sagging skin and hydrate the skin, besides, they are able to provide a good lifting effect on facial lines since they consist of laminates and have the ability to stretch the face.[10] Sheet masks are a type of mask which has great demand since they are practical and they can be used without rinsing. In addition, sheet masks which are impregnated with essence are easy to adhere to facial skin.

Therefore, based on the explanation above corn silk was processed using a fermentation method in order to become eco-enzyme to be used as an essence sheet mask preparation. Processing organic waste into facial mask cosmetic products usually uses the extraction method while processing into eco-enzymes has never been conducted. Eco-enzyme is an organic compound from the fermentation of kitchen waste materials. Eco-enzymes can be formed through a fermentation process with brown sugar and water which is conducted for three months. The use of corn silk material highlights the novelty value of utilizing agricultural waste which is often ignored. In addition, the eco-enzyme from the natural fermentation of corn silk is rich in bioactive compounds which can counteract free radicals. Eco-enzymes can produce antioxidants which play a role in slowing cell aging.[11] Therefore, the aim of this research is to analyze the feasibility of eco-enzyme as an essence in sheet mask preparations with antioxidant content which meets the preparation evaluation requirements. Each formula is given the addition of a different concentration of corn silk eco-enzyme. In this research, findings are obtained to determine the potential suitability of corn silk as an antioxidant in facial care cosmetic preparations in the form of sheet masks.

ISSN: 2085-675X (Print)
ISSN: 2354-8770 (Electronic)

METHODS

Making sheet mask preparations from corn silk eco-enzyme was conducted at the Chemistry Laboratory of FMIPA Universitas Negeri Semarang in July-October 2023.

Tools and materials

The tools used in this research were glass jars, beaker glass (Iwaki), glass rod stirrer (Pyrex), pipettes (Pyrex), measuring cups (Pyrex), hand mixer, 60 mesh filter paper, pH meters (Mettler Toledo), and *foil bag*.

The material used in this research were corn silk obtained from the West Ungaran farmer group, Semarang Regency. Meanwhile, other ingredients used include brown sugar, PEG 400 (BASF), tween 80 (Merck), glycerin (Wilmar, 99.8%), butylene glycol (Sigma-Aldrich), xanthan gum (Qindao, 80 mesh), sodium benzoate (EMD Milipore), phenoxyethanol (Innosei, 99.5%), sodium metabisulfite (Merck), sodium EDTA (Merck), citrus oil, rice milk fragrance oil dan distilled water (Smart-lab).

Making corn silk eco-enzyme

In the corn silk process into eco-enzyme, the corn silk that had been collected was then sorted and washed until clean. Next, put the brown sugar in a large-mouthed jar at a rate of 10% of the weight of water. Corn silk was mixed in a container with a ratio of 1 kg of brown sugar, 3 kg of corn silk, and 10 liters of water which was then closed tightly and fermented for 90 days. In addition, eco-enzyme storage could be conducted in a location that was not directly exposed to sunlight, had good air circulation, and was far from rubbish bins and burning waste, and chemicals.

Homogenize the essence sheet mask

Making an essence sheet mask began by making the first mixture, namely Tween 80 and PEG 400 which were dissolved in glycerin. Then, the second mixture was made by using xanthan gum dispersed with butylene glycol. The third mixture was made by mixing sodium benzoate, metabisulfite, sodium EDTA, and phenoxyethanol dissolved in distilled water. The three mixtures were then mixed and added with eco-enzyme according to the concentration of each formula. The mixture was then stirred until homogeneous and rice milk fragrance oil was added as fragrance.

Table 1. Sheet mask preparation formulation

Materials	Concentration (g)		
	F1	F2	F3
Corn Silk Eco-Enzyme	10	20	30
PEG 400	3	3	3
Tween 80	5	5	5
Glycerin	5	5	5
Butylene Glycol	1	1	1
Xanthan Gum	0.2	0.2	0.2
Sodium Benzoate	0.5	0.5	0.5
Phenoxyethanol	0.3	0.3	0.3
Sodium Metabisulfite	0.1	0.1	0.1
Sodium EDTA	0.1	0.1	0.1
Citrus Oil	5 *drop*	5 *drop*	5 *drop*
Rice Milk Fragrance Oil	q.s.	q.s.	q.s.
Distilled Water	ad 100	ad 100	ad 100

Sheet mask packaging

Essence sheet masks which had gone through a homogenization process were then packaged to become ready-to-use sheet masks. In this research, the type of sheet mask used was paper sheet. The paper sheet was folded to size, and then put into a foil bag packaging. Next, 20 g of essence was added to the packaging.[12]

Testing

Organoleptic test

Organoleptic tests were conducted by sensory observation using test parameters based on changes in color, texture and aroma.[13]

pH test

The pH test was conducted by using a pH meter. Before use, the pH meter needed to be calibrated with a buffer solution dissolved in 250 ml of distilled water. Then, the pH meter could be used by dipping the electrode into the sample and seeing the pH value which appeared on the screen.[14]

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Homogeneity test

The homogeneity test was conducted by cutting the sheet mask to a diameter of 1 cm and placing it on a glass slide or other transparent material. The preparation could be said to be homogeneous if there were no coarse grains on the glass preparation.[15]

Spreadability test

Tested the spreadability by weighing 0.5 g of the essence sheet mask and placing it in the middle of a round glass plate. Then, a 50 g glass plate was placed on top of the preparation and left to stand for 1 minute. Changes were observed and recorded for the diameter of the spread. Added weight in increments of 50 g until it reached 200 g and measured the diameter of the distribution area.[16]

Adhesion test

The adhesion test was conducted by placing 0.5 g of essence sheet mask on a glass object. Then a load of 250 g was given for 5 minutes. The two object glasses which were attached were then removed and the time recorded until the two glasses were separated from each other.[17]

Stability test

The stability test was conducted by using the cycling test method at temperatures of 4°C and 40°C. Each preparation was stored for 24 hours and tested for six cycles. The parameters tested in this case include organoleptics, homogeneity, and pH.[17]

Antioxidant activity test

The antioxidant activity test used the DPPH method by preparing a stock solution of DPPH (1,1-diphenyl-2-picrylhydrazyl) with concentrations of 20 µg/mL, 40 µg/mL, 60 µg/mL, 80 µg/mL, and 100 µg/mL which was dissolved in ethanol in a volumetric flask, then homogenized. Furthermore, the blank solution was made and a comparison solution of vitamin C which was made with the same concentration as the concentration of the test solution. Then test solution was made with the essence concentration which was homogenized by vortexing and incubated at 37°C for 30 minutes and put into a cuvette and its absorbance was measured by using a UV–Vis spectrophotometer with a wavelength of 517 nm. In addition, the inhibition presentation was calculated to obtain the IC_{50} value from the calculation of the linear regression formula resulting from the percentage of immersion in all solution concentrations.[18]

RESULTS AND DISCUSSION

The corn silk eco-enzyme used to make essence sheet masks used F1, F2, and F3 concentrations of 10%, 20%, and 30% respectively, each of which was packaged in a foil bag sachet with a net weight of 20 grams. The results of the formulation preparation can be seen in **Figure 1.**

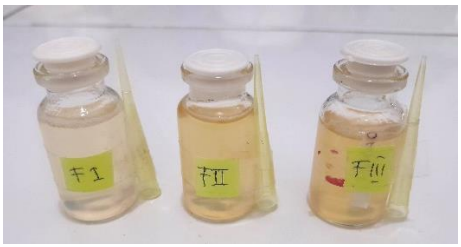

Figure 1. Essence sheet mask preparation results

The results of organoleptic testing based on sensory observations can be seen in Table 2. Meanwhile, testing for pH, homogeneity, spreadability, and adhesion can be seen in Table 3.

In organoleptic testing, storage of the preparations for 28 days shows that F1, F2, and F3 do not show any changes in color, texture, and aroma. The color differences produced in each essence sheet mask formulation result from increasing the concentration of corn silk eco-enzyme added to each formula.

ISSN: 2085-675X (Print)
ISSN: 2354-8770 (Electronic)

Table 2. Organoleptic test

Time	Parameter	F1	F2	F3
Day-0	Color	Clear yellow	Cloudy yellow	Brownish yellow
	Texture	Liquid	Liquid	Liquid
	Aroma	Typical corn	Typical corn	Typical corn
Day-7	Color	Clear yellow	Cloudy yellow	Brownish yellow
	Texture	Liquid	Liquid	Liquid
	Aroma	Typical corn	Typical corn	Typical corn
Day-14	Color	Clear yellow	Cloudy yellow	Brownish yellow
	Texture	Liquid	Liquid	Liquid
	Aroma	Typical corn	Typical corn	Typical corn
Day-28	Color	Clear yellow	Cloudy yellow	Brownish yellow
	Texture	Liquid	Liquid	Liquid
	Aroma	Typical corn	Typical corn	Typical corn

Table 3. pH, homogeneity, spreadability, and adhesion test

Parameter	F1	F2	F3
pH	5.46 ± 0.02	5.16 ± 0.02	4.96 ± 0.02
Homogeneity	Homogeneous	Homogeneous	Homogeneous
Spreadability	6 ± 0.04	5.4 ± 0.04	5.2 ± 0.04
Adhesion	5.56 ± 0.03	5.45 ± 0.03	5.57 ± 0.04

In organoleptic testing, storage of the preparations for 28 days shows that F1, F2 and F3 do not show any changes in color, texture and aroma. The color differences produced in each essence sheet mask formulation result from increasing the concentration of corn silk eco-enzyme added to each formula.

pH testing was conducted to determine the acidity level of the product in order to ensure safety when using sheet mask preparations on facial skin. In this research, pH testing was conducted by using a pH meter. All sheet mask preparations show a pH indicator value which meets the requirements for a pH value which is safe for the skin with a standard pH value in the range of 4.5-6.5, where a pH value that is too high can result in dry skin, while the pH value too low can result in skin irritation.[12] Moreover, based on the results of pH testing conducted by using a pH meter, the essence sheet mask preparations F1, F2, and F3 have pH values of 5.46 ± 0.02, 5.16 ± 0.02, dan 4.96 ± 0.02 respectively, where the decrease in pH indicates that the greater the concentration of eco-enzyme corn silk, the smaller the resulting pH value (Oneway Anova; $p<0.05$). In addition, the pH values produce in the three formulas meet the requirements of SNI No. 06-2588-1992 so that it is safe to use and does not have the potential to irritate facial skin.

The results of the homogeneity test on the essence sheet mask preparation which was smeared on a transparent glass plate and visual observations were conducted show that the entire formula have homogeneous characteristics as indicated by the absence of coarse particles, lumps and no separation between the essence sheet mask base ingredient and corn silk eco-enzyme. Storing the preparations for 28 days showed that the preparations, whether F1, F2 and F3, did not show any changes so that they can be considered as homogeneous preparations. The homogeneity test was conducted in order to determine the homogeneity of the

ISSN: 2085-675X (Print)
ISSN: 2354-8770 (Electronic)

essence sheet mask preparation which had been formulated between the essence sheet mask base ingredient and corn silk eco-enzyme. Moreover, homogeneity testing is used in order to see changes which may occur during storage. The criteria for good homogeneity in the preparation can be seen by the absence of coarse and separated particles in the preparation.[19] In addition, the homogeneity test influences the effectiveness of therapy since it is related to the same level of active substance with each use. If a preparation is homogeneous, then when used the levels of the active substance are also homogeneous.[12] Referring to research which had been conducted by Lestari et al., homogeneity testing can ensure that the active substance can be completely dissolved in the base formula so that it can provide maximum effect when applied to facial skin.[20] A homogeneous essence sheet mask preparation will be able to spread evenly on facial skin which leads to the release of active compounds by the base in order to provide optimal results.

The spreadability test was used in order to determine the speed of distribution of the preparation on the skin. Good spreadability is an indicator that the preparation is easy to apply to the skin.[21] The easier it is to spread, the more optimal the absorption capacity of the active substance in the skin will be.[19] All formulas show spreadability results which meet the criteria for good spreadability in topical preparations, namely in the range of 5-7 cm. Based on the data from the three formulations analyzed by using Oneway ANOVA, it shows P>0.05, which indicates that in the spreadability measurement there is no significant difference between the formulas. Furthermore, the results of observing the spreadability of the essence sheet mask preparation have the quality of spreading easily when applied to the skin. Testing the spreadability of essence sheet mask preparations in three formulas shows different values. It is caused by contact between the active ingredient of corn silk eco-enzyme and the essence sheet mask base formula. The addition of eco-enzyme causes the preparation to become thicker so that it can increase the spreadability of the preparation.

Adhesion testing was used in order to determine the ability of essence sheet mask preparations to adhere optimally to the skin surface.[20] The longer the essence sheet mask preparation takes to adhere, the better the chance of the active substance being absorbed. All formulas show adhesion results which meet good adhesion standards, namely less than 4 seconds.[17] Based on the data from the three formulations analyzed using Oneway ANOVA, it shows P>0.05, which indicates that in the adhesion measurement there is no significant difference between the formulas, so that increasing the concentration variation of corn silk eco-enzyme does not affect the adhesion power. Furthermore, the results of observations of the adhesive power of the essence sheet mask preparation have good adhering qualities to the skin surface.

In stability testing, the parameters observed using the cycling test method were organoleptic, homogeneity and pH. The three formulas show no changes after conducting stability tests (6 cycles) both in terms of organoleptics and homogeneity, namely the colors f1, f2, and f3 are clear yellow, cloudy yellow, and brownish yellow, respectively. In addition, the texture is liquid, has a distinctive corn aroma, and is homogeneous and does not separate from the preparation. Tests on pH parameters are shown in Figure 2.

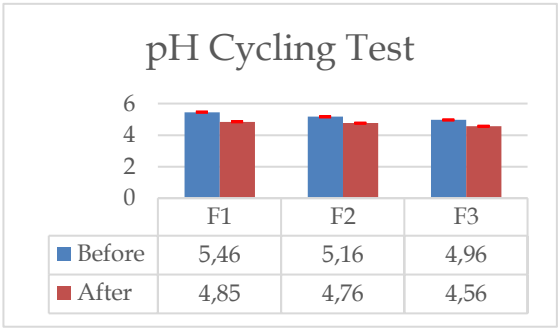

Figure 2. pH test results after the cycling test

In the pH parameter, there is an increase and decrease in pH because of the

ISSN: 2085-675X (Print)
ISSN: 2354-8770 (Electronic)

influence of temperature. However, all the pH in each formula shows that it is still in the pH range that is safe for the skin, namely 4.85 ± 0.02, 4.76 ± 0.01, and 4.56 ± 0.02.

Antioxidant activity testing was conducted by using the DPPH method which is seen through changes in the purple color intensity of DPPH in proportion to the concentration of the DPPH solution which occurred due to the immersion of free radicals from the reaction of DPPH molecules with hydrogen atoms, causing a color change from purple to yellow. The color change which occurs after being measured using a UV-Vis spectrophotometer will result in a free radical scavenging activity value with an IC_{50} value.[22]

The results of the antioxidant activity test for the essence sheet mask are shown in Table 4.

Table 4. Antioxidant activity test results

Sample	IC_{50} Value	Category
F1	190.67	Moderate
F2	185	Moderate
F3	96.75	Strong

Referring to research which had been conducted by Chandra, Asra, and Mevia, quantitatively testing antioxidants is said to be very strong if the IC_{50} value is less than 50 µg/mL, it is considered as strong if the IC_{50} value is 50-100 µg/mL, it is considered as moderate if the IC_{50} value is 101-250 µg/mL, and it is considered as weak if the IC_{50} value 250-500 µg/mL.[23] Testing of the IC_{50} value of vitamin C showed it to be 6.25 µg/mL, which is classified as very strong. The IC_{50} value of vitamin C is lower than the IC_{50} values of the three formulas, indicating that the antioxidant activity of vitamin C is stronger than that of the samples from the three formulas. However, the IC_{50} values obtained from the samples of the three formulas still indicate the presence of antioxidants, with different IC_{50} values for each formula.

Testing the antioxidant activity of the essence sheet mask preparation in F1 with an eco-enzyme concentration of 10% shows that antioxidant activity is considered in the moderate category as indicated by the IC_{50} value of 185 µg/mL. In F2 the antioxidant activity of the essence sheet mask preparation with an eco-enzyme concentration of 20% shows antioxidant activity with the moderate category as indicated by the IC_{50} value of 190.67 µg/mL. Testing the antioxidant activity of essence sheet mask preparations on F3 with an eco-enzyme concentration of 30% shows that antioxidant activity is categorized as strong as indicated by the IC_{50} value of 96.75 µg/mL. In addition, the difference in the IC_{50} value as antioxidant activity in each essence sheet mask preparation formula is influenced by the addition of the active substance, namely eco-enzyme from corn silk. The higher the concentration of corn silk eco-enzyme in the formula, the greater the antioxidant activity produced.

CONCLUSION

Based on research which had been conducted, corn silk eco-enzyme can be formulated into sheet mask preparations with concentrations of 10%, 20%, and 30% so that the formula results have characteristics that meet the requirements of good parameters. The results of testing antioxidant activity when adding corn silk eco-enzyme with the highest concentration of 30% show the best antioxidant activity. In addition, the results of this research prove that the eco-enzyme from corn silk is suitable for use in preparing essence sheet masks with antioxidant content.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

ISSN: 2085-675X (Print)
ISSN: 2354-8770 (Electronic)

Acknowledgments

The author would like to thank to Universitas Negeri Semarang and lecturer in the consortium research who has facilitated the conduct of this research with funding sources from DIPA LPPM UNNES. In addition, the author would like to thank to all parties who have contributed to the research.

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