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Anti-aging Properties from Gold Nanoparticles Serum using Fig Leaf Extract (*Ficus carica* L.)

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ABSTRACT

Indonesian women saw premature aging as a serious problem; 60% of female respondents felt less confident due to the symptoms of premature aging they experienced. Fig leaves (*Ficus carica* L.) are a natural ingredient containing flavonoid compounds that have the potential to act as antioxidants and bio-reduction in the biosynthesis of gold nanoparticles that have anti-aging properties. This research aims to determine the antiaging activity of fig leaf serum in inhibiting collagenase enzymes and fibroblast cell proliferation. The research design used a true experimental method by macerating fig leaves. Formulation of 90 µL fig leaf extract gold nanoparticles was carried out in serum preparations varying in the concentration of 5, 10, and 15%. The characteristics of the serum preparation were tested for organoleptic, homogeneity, pH, and viscosity. Antioxidant activity was compared using the DPPH method with Vitamin C. The test for inhibiting skin-degrading enzymes is carried out by inhibiting the collagenase enzyme. Test the cell viability of fig leaf gold nanoparticles against HDFa cells using the MTT assay method. The 15% serum results obtained strong antioxidant activity with an IC_{50} of 21.63 µg/ml, showed good collagenase enzyme inhibition of 88.1%, and could increase cell viability after exposure to H_2O_2 by 93.22%. It can be concluded that gold nanoparticle serum from fig leaf had the potential for antiaging activity and the stability of the new "fig leaf extract-gold nanoparticle serum" formulation for further improvement as a new antiaging cosmetic.
Keywords: Anti-aging; Antioxidants; Fig leaves; Serum

INTRODUCTION

The aging process of the skin can include loss of elasticity, degeneration of elastic fibers, reduction in collagen content and thickness of the epidermis, increased wrinkles, and increasingly dry skin conditions. One skin care method is anti-aging products, which can slow aging (Kusumawulan et al., 2022). Research on anti-aging is currently a topic of interest to humanity. In a survey conducted by JakPat and ERHA Age Corrector in April 2021, 76% of Indonesian women saw premature aging as a serious problem and 60% of female respondents felt less confident because of the symptoms of premature aging they experienced. Aging can be caused by various factors, namely intrinsic factors and extrinsic factors. Intrinsic factors include increasing the activity of certain enzymes involved in skin aging, including elastase, hyaluronidase, collagenase, and tyrosinase (Purwanti et al., 2022).

The collagenase enzyme is a matrix *metalloproteinase* family that breaks down collagen and is said to be a factor causing skin aging. Mechanical tension and pressure are required in the dermal fibroblasts to maintain the balance of collagen synthesis and degradation by enzymes, producing a healthy collagen matrix. In aging skin, fibroblasts will collapse as the accumulation of degraded collagen fibers inhibits the formation of a healthy collagen matrix; as a result, the ratio of collagen synthesis and degradation becomes unbalanced (Yusharyahya, 2021).

Cosmetics are products that are useful in protecting the skin and influencing the biological functions of the skin due to the ingredients contained in the product (Nazliniwaty et al., 2019). One cosmetic preparation that is often used to treat skin problems is serum. The serum is very interesting to apply in cosmetic product as the active substances in the serum are higher So the serum becomes faster and more effective in treating skin problems. They can be packaged in nanoparticle form to increase the effectiveness of delivering active substances to serum.

Nanoparticles are measuring 1-100 nanometers. Gold nanoparticles are one part of nanomaterials that can be applied in pharmaceutical preparations as they have low toxicity, are inert, very stable, can be used as carrier agents to target cells as they have a small size and large surface area, can cross cell membranes, have stability and good biocompatibility (Naveena & Prakash, 2013). Nanogold can interact with the skin membrane and

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increase the skin permeability of active substances with high molecular weight. Nanogold is considered a promising candidate for enhancing skin cell immunity and optimizing the transdermal transport system (Rifada & Lewa, 2020).

Due to the increasing effect of skin damage caused by factors that trigger skin aging, it is necessary to design a therapeutic development, one of which is natural ingredients. One of them is using fig plants. *Figs* are plants that can be consumed fresh or dried. Fig (*Ficus carica* L.) belongs to the *Moraceae* family and is known as the fig tree (Badgujar et al., 2014). Fig leaves have pharmacological effects such as antioxidants, anticancer, antidiabetic, antibacterial, antifungal, and antiaging effects (Borase et al., 2013). The flavonoid content of fig leaves is mainly quercetin and luteolin, which provide many health benefits, one of which is as an antioxidant (Badgujar et al., 2014). The antioxidant activity of fig leaves is proven by an IC_{50} value of 13.6 µg/ml in the strong category (Azza M. Abdel-Aty et al., 2019). In addition, the flavonoids contained in fig leaves have the potential to be developed as reducing agents for nanoparticle biosynthesis (Wahab et al., 2018). Using plant extract as a green technique is a safe, straightforward, and cost-effective way to produce gold nanoparticles without chemical reductants or capping agents. The biomolecules may function as ligands and an electron donor system to create stabilized nanoparticles (Shabestarian et al., 2016).

Previous research regarding the formulation of fig leaf serum preparations with varying concentrations of 50, 60, 70, 80, and 90 µl is known to be the best formula, consisting of 90 µl of 10% fig leaf extract as antiaging (Vellayanti, 2020). Previous research has carried out the formulation of cream preparations using fig leaf extract using the DPPH method, which shows that the cream has strong antioxidants with an IC_{50} value of 23.23 ppm (Nurulhuda & Nafi'ah, 2020).

Based on this background, a formulation of gold nanoparticle serum from fig leaf extract was created as antiaging. Fig leaves themselves are known to be rich in antioxidant activity, which is believed to be able to prevent the aging process, so researchers conducted further research to obtain empirical evidence regarding the benefits of fig leaves as anti-aging using the dosage form of gold nanoparticles in increasing fibroblast cell proliferation and inhibiting the collagenase enzyme.

MATERIALS AND METHODS

Material

Research Tools

The tools used in this research were a collection of glassware, analytical scales (Metler Toledo), a magnetic stirrer, a particle size analyzer (PSA) (Horiba Scientific, Nanoparticle Analyzer SZ-100), UV-Vis spectrophotometer (Hitachi), pH meter, Brookfield Viscometer DV-I Prime.

Research Materials

The materials used in this research were fig leaves obtained from Bogor, Indonesia, in June 2023, with determination number 381/Lab.Bio/VIII/2023, pure gold powder (Sigma), 70% alcohol (Brataco), distilled water (Brataco), aqua pro injection (PT. Ikapharmindo Putramas), polyvinyl alcohol/PVA (Merck), Mg metal (Merck), NaOH (Merck), $FeCl_3$ (Merck), HCl (Merck), carbopol (Brataco), triethanolamine (TEA) (Bratako), propylene glycol (Dow Chemical Pacific Singapore Private Limited), propylparaben (UENO Fine Chemical Industry Ltd. Japan), methylparaben (UENO Fine Chemical Industry Ltd. Japan), sodium metabisulfite (Brataco), peptone water (Oxsoid), Plate Count Agar (PCA) media (Oxsoid), Sabouraud Dextrose Agar (SDA) (Oxsoid) media.

Method

Preparation of 10% Fig Leaf Extract

Prepare the fig leaves, then wash and chop them to a uniform size of ±3 cm, then dry them using an oven at 80^0C for 1-2 hours until they are dry enough. It is done to ensure that flavonoids in fig leaves are not damaged. After that, 10 g of dried fig leaves were weighed and extracted using the maceration method using 100 mL of warm Aqua Pro injection (temperature 80^0C, then left to cool) for 24 hours. In this maceration, aqua pro injection at a temperature of 80^0C is used because quercetin is less soluble in water (Abraham & Acree, 2014). Therefore, a temperature of 80^0C is needed to attract the quercetin from fig leaves. Then, let it cool for 24 hours because if it is continuously given 80^0C distilled water, it will damage the quercetin in fig leaves, which cannot tolerate heating (Vellayanti, 2020).

Qualitative Testing of Fig Leaf Extract

Qualitative testing of the fig leaf extract content was done using a tube reagent. The test was carried out by identifying the color changes that occurred in fig leaf extract, which was reacted with Mg, NaOH, $FeCl_3$, and HCl metals (Vellayanti, 2020).

Preparation of Fig Leaf Gold Nanoparticle

Preparation of 0.5 mM $HAuCl_4$ Gold Solution

$HAuCl_4$ 0.5 mM gold solution was made by dissolving 0.019 g of gold powder in 100 mL Aqua Pro Injection, homogenized, and stored in a dark container. Next, the $HAuCl_4$ gold solution was shaken and could be used directly (Vellayanti, 2020).

Making 0.5% Polyvinyl Alcohol (PVA) Solution

The PVA solution was made by dissolving 0.5 g of PVA in 100 mL distilled water, heated to 60^0C. During the heating process, the mixture was stirred using a magnetic stirrer for 24 hours at a speed of 176 rpm. Then, the solution was filtered using a 0.45 µL microsyringe (Vellayanti, 2020).

High-energy biosynthesis of gold nanoparticles process using of 10% fig leaf extract, 0.5 mM $HAuCl_4$, and 0.5% PVA

Prepare 10% fig leaf extract, then put it in a test tube. The $HAuCl_4$ gold solution was taken with a micropipette with a volume of 1,400 µL then put into a test tube containing 10% leaf extract according to the specified formulation. A 0.5% PVA solution with a volume of 50 µL was added to the reaction tube (Dzimitrowicz et al., 2019). Then, ultrasonics were carried out at a temperature of 30^0C with a pulser of 20 for approximately 2 minutes.

Characterization of Gold Nanoparticles

Visual Observation of Color Changes

Visual color changes were observed at 0, 15 minutes, 30 minutes, 1 hour, 3 hours, 6 hours, and 24 hours.

Observation of UV-Vis Absorption Wavelength

Observations of the absorption wavelength of gold nanoparticles were measured when the nanoparticles were formed in the absorption wavelength range between 400 and 600 nm using a UV-Vis spectrophotometer.

Particle Size Reading using Particle Size Analyzer (PSA)

Particle size readings were carried out using a particle size analyzer (Horiba Scientific, Nanoparticle Analyzer SZ-100). A sample of 1 mL was taken, put into a cuvette, and then put into the cuvette holder for particle measurements. This particle size test was carried out by measuring the particle size of fig leaf extract with a concentration of 10% and 0.5 mM chloroauric acid. Particle measurement analysis was carried out when gold nanoparticles were formed. Particle size calculations were carried out to determine the difference in particle size formed from the two solutions.

Preparation of Fig Leaf Gold Nanoparticle Serum

The fig leaf gold nanoparticle serum preparations were manufactured using a serum base (Table II). Weigh mixture A, which consists of carbopol, dissolve it in distilled water, and leave it for 24 hours until it swells. After swelling, mixture A is added with TEA. We weighed mixture B, methyl, and propylparaben, then dissolved it in propylene glycol. Mix mixture A and mixture B until homogeneous. Then add sodium metabisulfite and stir until homogeneous. After the serum base is ready, add fig leaf gold nanoparticles into the serum base and stir until homogeneous (Vellayanti, 2020).

Antioxidant Activity Test of Gold Nanoparticle Serum Preparation from Fig Leaves

Determination of the maximum wavelength of 1,1 diphenyl-2-picrylhirazil (DPPH). 3 mL of 96% ethanol was pipetted, after which 1 mL of 0.2 mM DPPH solution was added. Then, put it in a cuvette and look for λmax for use in the next stage. Measurement of antioxidant activity by dissolving the sample in 96% ethanol solvent with varying concentrations of 1, 2, 3, 4, and 5 ppm. Pipette 3 mL of extract from each concentration and add 1 mL of 0.2 mM DPPH solution. This treatment was repeated three times. Next, it was incubated at 37^0C for 30 minutes, and then the absorbance was measured using a UV-Vis spectrophotometer at the λmax obtained. The control was 1 mL of 0.2 mM DPPH solution in 3 mL of 96% ethanol. The ascorbic acid comparator was used as a sample. The IC_{50} value is calculated in the equation y = ax+b, obtained from the linear regression curve of the relationship between percent antioxidant activity and antioxidant fraction extract concentration. IC_{50} is calculated by entering the 50% value into the standard curve equation as the y-axis and calculating the x value as the IC_{50} concentration (Winanta et al., 2021).

Collagenase Enzyme Activity Inhibition Test

Twenty-five µL of test sample solutions from various concentration series were taken and then put into a 96-well plate as test sample solutions and blank samples. Take 25 µL of assay buffer solution as enzyme control and 25 µL of control inhibitor solution as control inhibitor and then put it into 96 wells. Added 50 µL of inhibition reaction mix (Neutrophil Collagenase Enzyme) to the sample solution, enzyme control solution, and control inhibitor solution (blank sample without

enzyme added). Add 50 µL of assay buffer solution to the blank sample solution. Take 25 µL of enzymatic reaction mix (Substrate) into each well. It was incubated for 30 minutes at 37^0C, and the absorbance was measured at a wavelength of 405 nm using an Elisa reader, which was observed for 10 minutes at intervals of every 1 minute.

Proliferation Test using the MTT Assay Method

HDFa fibroblast cells were put into a 96-well microplate, 100 µL/well each, 1 x 104. The cells were incubated for 24 hours in a starvation state. They were treated with each combination concentration and then incubated again for 24 hours and 48 hours. The wells were supplemented with 100 µL of fresh medium and 10 µL of MTT reagent (10 µL/100 µL per well), then incubated for 4-6 hours in a CO_2 incubator at 37°C. Each well was supplemented with 100 µL of 10% sodium dodecyl sulfate (SDS) in 0.01% HCl. Incubate at room temperature for 12 hours or overnight. The microculture wells were then read for absorbance using an ELISA reader at a wavelength of 595 nm. The Proliferation effect of the sample compared with commercial serum. Calculation of proliferation by calculating cell viability, namely the percentage of cell viability = (Treatment Absorbance – Media Absorbance) / (Control cell Absorbance – Media Absorbance) x 100% (Nur et al., 2017).

Evaluation of Fig Leaf Gold Nanoparticle Serum Preparations

Organoleptic and Homogeneity Tests

Organoleptic tests included shape, color, and odor and were carried out visually on the fig leaf gold nanoparticle serum preparations. Meanwhile, the homogeneity test is carried out by smearing a serum sample on a piece of glass or other suitable transparent material (Vellayanti, 2020).

pH Test

The pH test is carried out using a pH meter calibrated using a neutral pH standard buffer solution (pH 7.01) and an acidic pH buffer solution (pH 4.01). Wash the electrode using distilled water, then dry it using a tissue. Dip the electrode into the sample until the instrument shows a constant pH. The constant number shown by the pH meter is the pH value of the preparation (Vellayanti, 2020).

Viscosity Test

The viscosity test is carried out by inserting 100 mL of the preparation into a tube-shaped container and installing the appropriate spindle. The spindle must be submerged in the test preparation. Turn on the viscometer and adjust the viscometer speed. The constant number shown by the viscometer is the viscosity value of the preparation (Vellayanti, 2020).

RESULTS

Extraction and Maceration

Fig leaf extract is obtained from the maceration process of 10 g of fig leaf powder, which is dissolved with 100 mL Aqua Pro Injection at a temperature of 80^0C and then left for 24 hours to produce a dark green liquid extract.

Qualitative Analysis of Fig Leaf Extract

The results obtained from qualitative analysis of fig leaf extract using a tube reagent showed a color change as in (Table III).

The color change that occurs indicates the presence of flavonoid content in fig leaf extract. The sample of fig leaf extract, which was reacted with Mg and HCl, showed a color change to orange. Concentrated HCl was added to hydrolyze flavonoid glycosides into aglycon flavonoids by hydrolyzing the O-glycosyl group. H+ will replace Glycosyl from the acid because of its electrophilic nature. Flavonoids that are reduced with Mg and concentrated HCl can produce complex compounds that are red, yellow, or orange. This colored complex compound indicates the presence of flavonoids (quercetin-3-O-β-D-glucuronide) (Vijayalakshmi & Madhira, 2014). The color change to blackish green indicates that the fig leaf extract positively contains flavonoids (luteolin-7-Oβ-glucopyranoside) (Vijayalakshmi & Madhira, 2014). Meanwhile, the fig leaf extract sample reacted with $FeCl_3$ and showed a color change to blackish green. The sample of fig leaf extract that was reacted with NaOH showed a change in color to yellow. The color change to yellow indicates that the fig leaf extract is positive for containing flavonoids (quercetin-3-O-β-D-glucuronide).

Characterization of Gold Nanoparticles

Observation of UV-Vis Absorption Wavelength

Observations of the absorption wavelength of gold nanoparticles (Table I) were measured when the nanoparticles were formed in the absorption wavelength range between 400 nm to 600 nm using a UV-Vis spectrophotometer.

From the results of observations using a UV-Vis spectrophotometer (Table IV), it can be concluded that the results obtained are good for formulation C and formulation D. This is because the values obtained for formulation C and formulation D fall within the range, both for wavelength and absorbance of fig leaf gold

Table I. Formulation of Gold Nanoparticles from Fig Leaf Extract

Formulas	Fig Leaf Extract (µL)	Gold Solution $HAuCl_4$ (µL)	PVA Solution (µL)
A	60	1,400	50
B	70	1,400	50
C	80	1,400	50
D	90	1,400	50

Table II. Formulation of Fig Leaf Gold Nanoparticle Serum Preparation

Material	Base	Formula 1	Formula 2	Formula 3
Gold nanoparticle (%)	-	5	10	15
Carbopol (%)	0.45	0.45	0.45	0.45
TEA (%)	0.2	0.2	0.2	0.2
Propilen glikol (%)	10	10	10	10
Methyl paraben (%)	0.18	0.18	0.18	0.18
Propil paraben (%)	0.02	0.02	0.02	0.02
Sodium metabisulfite (%)	0.075	0.075	0.075	0.075
Destilled water (%)	Add 100	Add 100	Add 100	Add 100

Table III. Qualitative Test Results of Fig Leaf Extract

Reagent	Result	Interpretation
Mg Metal + HCl	Orange	+ (Flavonoid)
$FeCl_3$	Blackish Green	+ (Flavonoid)
NaOH	Yellow	+ (Flavonoid)

nanoparticles. The expected absorbance of gold nanoparticle samples is 0.2–1.2 (Narayana et al. 2005). The SPR band can be read in the wavelength range of 520–570 nm.

Particle Size Reading using Particle Size Analyzer (PSA)

This particle size test was carried out by measuring the particle size of fig leaf extract with a concentration of 10% and 0.5 mM chloroauric acid. Particle measurement analysis was carried out when gold nanoparticles were formed. Particle size calculations were carried out to determine the difference in particle size formed from the two solutions (Table V).

Of the 4-fig leaf gold nanoparticle formulations that were formed, all 4 formulations showed good results because they fell into the size range of gold nanoparticle sizes, namely 1-100 nm (Huang & El-Sayed, 2010; Khezri et al., 2018). In formula D, the particle size value shows the smallest size compared to other formulas, namely 76.3±1.36, while the polydispersion index value for formula D is 0.27±0.27, which is monodisperse. The polydispersion index value describes the level of uniformity of size distribution in a nanoparticle system, where the smaller the polydispersity index value, the better and more uniform the particle size in a component is (Luo et al., 2017). The range of good polydisperse index values is 0–1. If the polydisperse index value is <0.7, then the nanoparticle system is monodispersed, while the nanoparticle system is polydisperse if the polydisperse index value is >0.7 (Nidhin et al., 2008). A good polydispersion index value indicates the long-term stability of a good component (Rodriguez Amado et al., 2017).

The results obtained can be concluded from the serum pH test of fig leaf gold nanoparticles with a variety of active substances of 5%, 10%, and 15%, which is good because it falls within the skin's pH range, so the preparation will be safe if applied to the skin. It is because the 3 formulations fall within the skin pH range, namely in the range of 4.5-6.5 (Ojha et al., 2019; Thakre, 2017). Meanwhile, the viscosity measurement of fig leaf gold nanoparticle serum preparations was carried out on day 1 using a viscometer with an S63 spindle at a speed of 20 rpm. The results obtained were quite good because gel-based serum preparations' viscosity was 800–3,000 cP (Kamishita et al., 1992; Septiyanti et al., 2019).

Antioxidant Activity Test of Gold Nanoparticle Serum Preparation from Fig Leaves

The result of antioxidant activity using the DPPH method on serum obtained strong acitivity with IC_{50} value <50 µg/mL. It can be seen in the Table VII.

Table IV. Maximum Wavelength Observation Results

Formula (F)	Volume of Fig Leaf Extract (µL)	Volume of $HauCl_4$ (µL)	Volume of PVA (µL)	Wavelenght (nm)	Absorbance
A	60	1,400	50	535	0.082
B	70	1,400	50	536	0.0203
C	80	1,400	50	535.5	0.308
D	90	1,400	50	535	0.331

Table V. Results of Particle Size Measurements (n=3)

Formula (F)	Volume of Ekstract 10% (µL)	Volume of $HauCl_4$ 0,5 mM (µL)	Volume of PVA (µL)	Particle Size (nm)	Polydispersion Index (Đ)
A	60	1,400	50	86.9±1.79	0.27±0.35
B	70	1,400	50	78.4±0.91	0.35±0.12
C	80	1,400	50	82.7±0.19	0.44±0.25
D	90	1,400	50	76.3±1.36	0.27±0.27

Table VI. Evaluation of Fig Leaf Gold Nanoparticle Serum Preparations (n=3)

Formula	Gold Nanoparticle Concentration (%)	pH Value	Viscosity Value (cP)
F1	5	5.91 ± 0.02	912.0
F2	10	5.93 ± 0.02	918.0
F3	15	5.96 ± 0.005	936.0

Table VII. Antioxidant Activity Test of Gold Nanoparticle Serum Preparations from Fig Leaves

Formula	Serum Concentration (%)	IC_{50} (µg/mL)
F1	5	26.43±6,44
F2	10	22.85±0.64
F3	15	21.63±0.31
F4	Vitamin C	4.28±0.01

Proliferation Test using the MTT Assay Method

The results of measuring the viability of fibroblast cells in various antiaging serum treatments at various concentrations showed good results. It can be seen in the Figure 1.

Collagenase Enzyme Inhibition Test

The results of collagenase in the variations in formulas 1, 2, and 3 showed good results because they were close to 100%. It can be seen in the Figure 2.

DISCUSSION

The results of the antioxidant activity test obtained good results, where the IC_{50} value was included in the very strong antioxidant category, namely <50 µg/mL. It states that forming gold nanoparticles using fig leaves increased antioxidant activity. The presence of flavonoid compounds can inhibit the activity of free radicals or ROS, which cause oxidative stress in the body through oxidation reactions by radical compounds to produce more stable compounds. Flavonoids can convert free radicals into inactive ones due to the high reactivity of the hydroxyl groups in flavonoids (Panche et al., 2016).

The viability of fibroblast cells in various antiaging serum treatments (Figure 1) at concentrations of 5, 10, and 15% showed good results because they were close to 100%. It is better than the value produced by commercial serum, namely 78.40%. There was an increase in the percentage of HDFa cell viability in the group exposed to and without exposure to H_2O_2, indicating that the serum has the potential as an antiaging agent with a mechanism to protect the FGF-2 content contained in human skin so that it can prevent the aging process. FGF-2 (Fibroblast Growth Factors-2) can reduce signs of aging by repairing damaged tissue (de Araújo et al., 2019; Rival et al., 2009). Previous research on the anti-aging properties of gold nanoparticles has been carried out on fibroblast cells and human skin explants, which were proven to provide cell protection from cell aging due to UVA radiation by reducing intracellular ROS production (Jundkk., 2020).

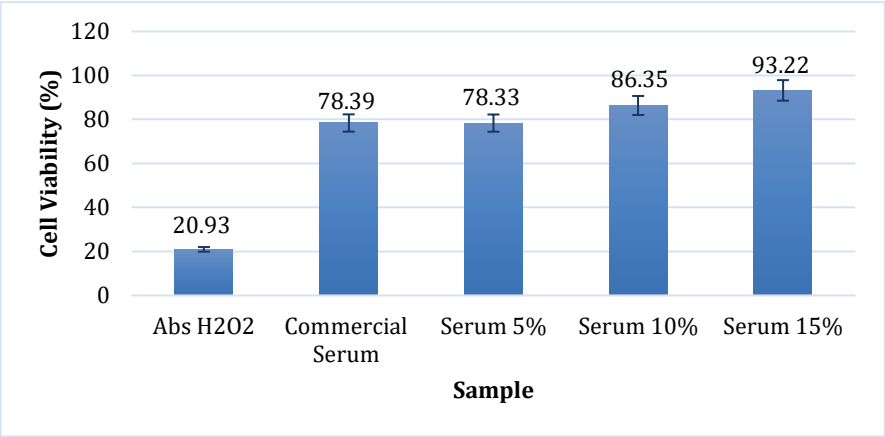

Figure 1. Results of proliferation tests on fibroblast cells when administered with fig leaf gold nanoparticle serum using the MTT Assay Method (mean±SD, n=3)

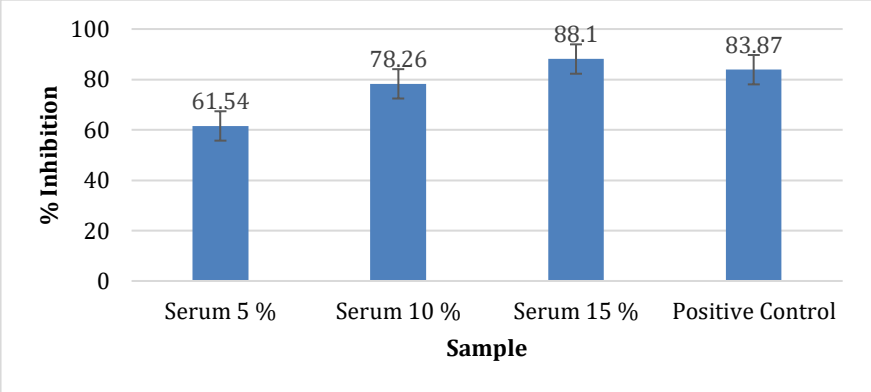

Figure 2. Collagenase Enzyme Inhibition Test Results (mean±SD, n=3)

The results of inhibition measurements in the treatment of anti-aging serum variations in formulas 1, 2, and 3 (Figure 2) showed good results because they were close to 100%. At a serum concentration of 15%, it has a better value than the value produced by the positive control (10-Phenanthroline), and this proves that the inhibitory ability of a serum concentration of 15% is more effective in inhibiting the collagenase enzyme so that it can prevent collagen degradation. Free radicals cause collagen degradation through a chain molecular reaction that increases the formation of AP-1, which stimulates the transcription process of the matrix metalloproteinase (MMP) enzyme, which plays a role in collagen degradation. The high antioxidant activity of fig leaf extract gold nanoparticle serum can inhibit free radicals, which activate collagenase so that antioxidant compounds can act as inhibitors of the collagenase enzyme (Sutjiatmo et al., 2020). In addition, the correlation between antioxidant activity and enzyme inhibitory activity by gold nanoparticles can be caused by the presence of compounds belonging to the antioxidant group contained in fig leaves, which can influence the inhibitory activity of the collagenase enzyme (Chatatikun & Chiabchalard, 2017). This study is limited to the addition of tin leaf extract in its ability to form gold nanoparticles, and it will then examine its activity in inhibiting collagenase enzyme and fibroblast proliferation. Future research is recommended to look at the antioxidant capacity of the extract in forming a stable gold nanoparticle serum.

CONCLUSION

Anti-aging serum, fig leaf extract nanoparticles produced strong antioxidant activity and had activity in increasing fibroblast cell proliferation after exposure to H_2O_2 with the highest value of 93.22%. The 90 µL serum preparation formulation was good because it was in the size range of gold nanoparticles, namely 73.6 nm. The collagenase enzyme inhibition test showed good results because, at a concentration of 15%, it showed enzyme inhibition of 88.1%, which was greater than the positive control used. So, the fig leaf extract gold nanoparticle serum has the

potential for antiaging activity and the stability of the new "fig leaf extract-gold nanoparticle serum" formulation for further improvement as a new antiaging cosmetic.

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