

Administration of Arabica Coffee Bean (*Coffea Arabica*) Cream Extract from Wamena Papua Can Reduce MMP-1 And Increase Collagen in Wistar Male Rats (*Rattus Norvegicus*) Exposed to Ultraviolet-B

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ABSTRACT

Introduction: The aim of the study was to determine the effectiveness of Arabica coffee bean extract cream (*Coffea arabica*) from Wamena in reducing MMP-1 levels and increasing collagen density in Wistar rats (*Rattus norvegicus*) exposed to UV-B light.

Methods: This is a post-test only control group design experimental study using male rats as subjects. Each group was exposed to UV light and smeared with coffee bean cream extract from Wamena every day. Then the back skin tissue was taken and the amount of collagen was examined by Picro Sirius Red staining and MMP1 levels were examined by ELISA staining.

Results: The mean MMP-1 levels in groups P1, P2, and P3 respectively 7.57 ± 0.70 , 5.99 ± 0.60 , and 4.57 ± 0.36 . The average percentage of collagen in the P1, P2, and P3 groups was 72.23 ± 4.42 , 77.80 ± 2.73 , and 81.05 ± 2.77 , respectively. The average MMP-1 level decreased with the increasing dose of Wamena arabica coffee bean extract cream. The mean percentage of collagen increased with increasing

doses of Wamena arabica coffee bean extract cream in experimental animals.

Conclusion: Administration of 3% and 6% Wamena Arabica coffee bean extract cream can inhibit the increase in MMP-1 levels and can increase the amount of collagen in male wistar rats (*Rattus norvegicus*) exposed to UV-B light.

Keywords: Arabica coffee bean, MMP-1, Collagen

INTRODUCTION

A decrease in function and the ability to adapt to damage to the body will occur with aging, accompanied by a decrease in the function of various organs of the body and physical changes. The skin is an organ that is in constantly exposed with the environment, including ultraviolet (UV) rays from the sun.[1] The ultraviolet-B (UV-B) radiation is the most dangerous for skin health because of its wavelength can penetrate ozone and cause more frequent sunburn. In addition, UV-B are known to increase collagen degradation by activating MMPs. In addition, ultraviolet B radiation

can damage TGF- and MMP-1 by causing TNF-alpha (tumor necrosis factor-alpha) to be released by fibroblasts and keratinocytes.[2]

Matrix metalloproteinases (MMPs) are a type of endopeptidases that break down structural proteins such as collagen and elastin at intercellular junctions.[3] Exposure to UV light activates the protein kinase pathway resulting in the production of MMP-1, which breaks down collagen.[4] Several studies have used natural coffee ingredients because they contain antioxidant compounds such as chlorogenic acid and flavonoids which can inhibit free radicals, inhibiting the increase in MMP-1.[5] Chlorogenic acid and flavonoids are the most common forms of polyphenols found in Arabica coffee and are the main sources of the highest antioxidant activity.[6]

The aim of the study was to determine the effectiveness of Arabica coffee bean extract cream (*Coffea arabica*) from Wamena in reducing MMP-1 levels and increasing collagen density in Wistar rats (*Rattus norvegicus*) exposed to UV-B light.

METHODS

This study was an experimental post-test only control group design using male rats, aged 10-12 weeks, with body weight of 200-250 grams. The material used in this study was Wamena arabica coffee bean extract with Sirius Red coloring. The sample was divided into 3 groups: treatment group 1 (P1) which received UV light exposure and placebo cream 2x a day, treatment group 2 (P2) which received UV light and 3% Wamena arabica coffee bean extract, and treatment group 3 (P3) exposed to UV light and 6% Wamena arabica coffee bean extract. Each group was exposed to UV light three times a week for four weeks. The

treatment group was smeared with arabica coffee bean extract cream 2x a day. Then the back skin tissue was taken and examined for the amount of collagen by staining Sirius Red and examined for MMP1 levels and collagen density. Data is recorded and analyzed.

RESULTS

The subjects used in this study were 30 male Wistar rats, aged 10-12 weeks, with a body weight of approximately 200-250 grams. The sample was divided into 3 groups, 10 mice each; the control group (P1) which was exposed to UVB light and given placebo, the first treatment group (P2) which was exposed to UVB light and given 3% Wamena coffee bean extract cream, and the group the second treatment (P3) was exposed to UVB light and given 6% Wamena coffee bean extract cream. The variables observed in this study were MMP-1 levels and the percentage of collagen density.

Examination of MMP-1 levels and the percentage of collagen was carried out after treatment on day 14. The results of the descriptive analysis of MMP-1 levels and the percentage of collagen after treatment in each group were shown in Table 1. The mean MMP-1 levels in groups P1, P2, and P3 respectively 7.57 ± 0.70 , 5.99 ± 0.60 , and 4.57 ± 0.36 . The average percentage of collagen in the P1, P2, and P3 groups was 72.23 ± 4.42 , 77.80 ± 2.73 , and 2.77 , respectively. The average MMP-1 level decreased with the increasing dose of Wamena arabica coffee bean extract cream. The mean percentage of collagen increased with increasing doses of Wamena arabica coffee bean extract cream in experimental animals.

Table 1. Descriptive Analysis of MMP-1 Levels and Collagen Percentage

	Placebo (P1)	Cream 3% (P2)	Cream 6% (P3)
MMP-1 levels (ng/ml)			
Total samples	10	10	10
Minimum value	6,44	5,09	3,85
Maximum value	8,68	6,63	5,00
Mean	7,57	5,99	4,57
SD	0,70	0,60	0,36
Std. Error of Mean	0,22	0,19	0,12

Collagen percentage (%)			
Total samples	10	10	10
Minimum value	62,60	73,40	76,70
Maximum value	77,80	81,60	84,50
Mean	72,23	77,80	81,05
SD	4,42	2,73	2,77
Std. Error of Mean	1,40	0,86	0,87

The normality of MMP-1 level data and the percentage of collagen were tested using the Shapiro-Wilk test. The results of the data

normality test are shown in Table 2. The percentage of collagen data was normally distributed with a p-value > 0.05.

Table 2. Descriptive Analysis of MMP-1 Levels and Collagen Percentage

	Placebo (P1)	Cream 3% (P2)	Cream 6% (P3)
MMP-1 Levels			
Total samples	10	10	10
p-value	0,97	0,02*	0,19
Collagen percentage			
Total samples	10	10	10
p-value	0,20	0,64	0,28

Based on the results of the comparative test on MMP-1 levels and the percentage of collagen, a p-value < 0.05 was obtained, so it can be concluded that there was at least a significant difference in the levels of MMP-1 and the percentage of collagen in the two

groups. To find out which pairs of groups had differences, a Post Hoc test was carried out. The results of the comparative test of MMP-1 levels and the percentage of collagen between groups are presented in Table 3.

Table 3. Comparison of MMP-1 Levels and Percentage of Collagen between Groups

	Placebo (P1)	Cream 3% (P2)	Cream 6% (P3)
MMP-1 (<i>Kruskal-Wallis</i>) levels			
Total samples	6	6	6
Mean	7,57	5,99	4,57
SD	0,70	0,60	0,36
p-value	p<0,001		
Collagen percentage (<i>One Way Anova</i>)			
Total samples	6	6	6
Mean	72,23	77,80	81,05
SD	4,42	2,73	2,77
p-value	p<0,001		
Homogenitas (Uji Levene)	p=0,38		

The Bonferroni Post Hoc Test was carried out to determine the comparison of MMP-1 levels between groups and to determine the percentage of collagen between groups was carried out by the LSD (Least Significance

Different) Post Hoc Test. Comparison of MMP-1 levels and the percentage of collagen between groups is presented graphically in Figure 1 and Figure 2.

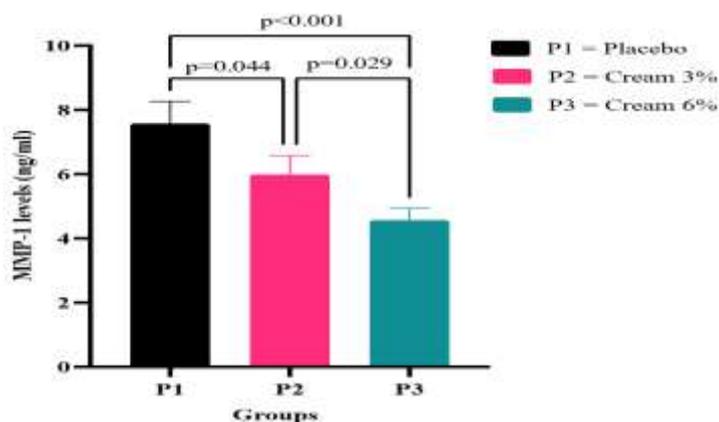


Figure 1. Graph of Comparison of MMP-1 Levels between Groups

Comparison of MMP-1 levels between groups showed that all groups had significant differences ($p < 0.05$). The

average MMP-1 level decreased with increasing doses of Wamena arabica coffee bean extract given to experimental animals.

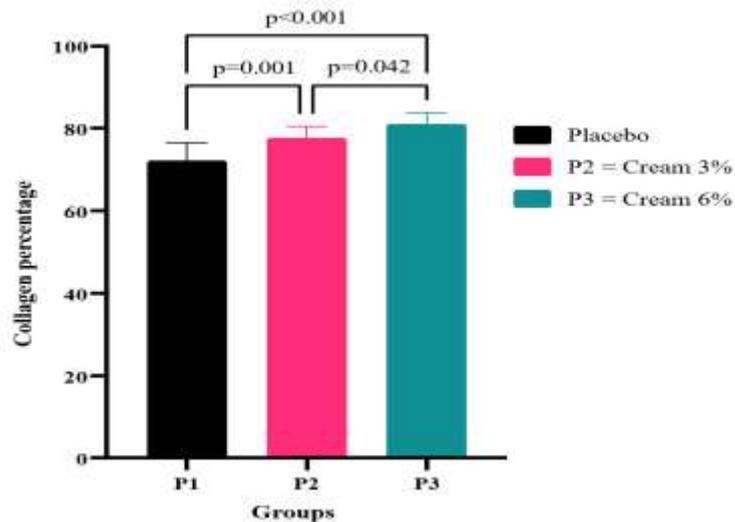


Figure 2. Graph of Collagen Percentage Comparison between Groups

Comparison of the percentage of collagen between groups showed that all groups had significant differences ($p < 0.05$). The increase in the concentration of Wamena arabica coffee extract in the cream is directly proportional to the increase in the

percentage of collagen. The results of this study showed a decrease in MMP-1 levels along with an increase in the percentage of collagen in the administration of Wamena coffee bean cream to experimental animals.

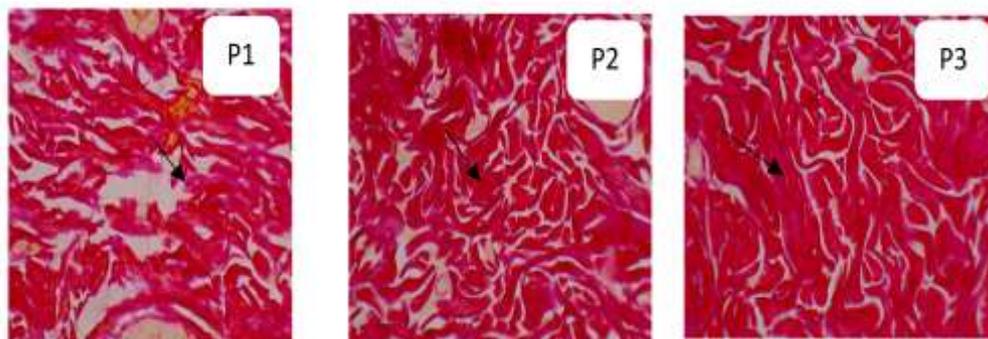


Figure 3. Amount of Collagen in Rats Tissue with Picro-Sirius Red Staining

DISCUSSION

Damage to collagen due to exposure to UVB light is known through the mechanism of activation of matrix metalloproteinase (MMP) enzymes, especially MMP-1. The increase in MMP-1 expression was caused by an increase in ROS production due to exposure to UVB. Apart from this mechanism, the direct structural change in collagen through the process of oxidation by

ROS is known to play a role in collagen damage due to exposure to UVB. Phytochemical compounds contained in natural ingredients, both of which have a direct or indirect effect on the MMP-1 enzyme, will affect the degradation of collagen in the skin. Phytochemical screening and antioxidant tests showed that roasted arabica coffee bean extract (*Coffea arabica*) from Wamena had active

compounds of alkaloids, flavonoids, terpenoids, saponins, polyphenols and tannins with an antioxidant IC₅₀ of 107.97. Various types of these active compounds are known to have antioxidant activity as well as anti-inflammatory activity which plays a role in suppressing the inflammatory process due to UVB exposure which will later have an effect on MMP-1 levels and collagen degradation.[7]

Several mechanisms are known to play a role in reducing MMP-1 levels by the active compounds contained in Arabica coffee. The first mechanism is active compounds that have antioxidant activity to reduce ROS production.[8] Wamena arabica coffee extract contains antioxidant compounds such as chlorogenic, caffeine, flavonoids, and ferulic acid which can neutralize ROS, inhibiting excessive ROS production will reduce the activation of the MMP-1 enzyme which in turn protects collagen from damage due to exposure to UVB rays.[9]

Another mechanism is by directly inhibiting MMP-1 enzyme activity, suppressing the inflammatory process, and suppressing the expression of MMP-1 transcription factors, such as AP-1 and NF- κ B. AP-1 via the mitogen activated protein kinase (MAPK) pathway which is a transcription factor of MMP-1.[10]

Application of roasted arabica coffee bean (*Coffea arabica*) cream from Wamena Papua has been shown to have an effect on increasing collagen density in the skin of Wistar rats exposed to UVB light in this study. The percentage of collagen density in this study is directly proportional to the dose of Arabica coffee bean cream given to experimental animals, where the percentage of collagen density will be higher with increasing doses of 3% and 6% Wamena arabica coffee bean extract.

Damage to collagen in the skin caused by UVB exposure can be prevented by various active compounds found in Arabica coffee beans through various mechanisms. The known mechanism is through the inhibition of collagen-breaking enzymes, especially

MMP-1 which plays a role in the breakdown of collagen types I and III in the skin.[10]

The antioxidant activity of the active compounds found in Wamena Arabica coffee such as chlorogenic acid, caffeine, flavonoids, and ferulic acid have a broad protective effect against collagen damage due to exposure to UVB rays. Antioxidant activity in protecting collagen can be through the inhibition of MMP-1 gene expression through the MAPK pathway. In addition, antioxidants can also inhibit the expression of AP-1 which is a protein that can inhibit procollagen production. Antioxidants such as flavonoids interfere with the function of MMP-1 to bind to collagen. Antioxidants occupy the active sites needed by MMP-1 to bind to collagen so that the process of collagen degradation can be prevented. Antioxidants are also known to have anti-inflammatory effects where by reducing the inflammatory process, they can reduce the activity of the MMP-1 enzyme through inflammatory pathways. In addition, antioxidants also provide direct protection by binding to ROS which can oxidize collagen and cause direct damage to the collagen structure.[11]

CONCLUSION

Administration of 3% and 6% Wamena Arabica coffee bean extract cream can inhibit the increase in MMP-1 levels and can increase the amount of collagen in male wistar rats (*Rattus norvegicus*) exposed to UV-B light.

Declaration by Authors

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