# The Influence of Arbutin 3% and Sesame Oil (3,5,7 % w/w) on SPF Values of Oxybenzon and Padimate O (3:7% w/w) in carbomer Gel Base

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# The Influence of Arbutin 3% and Sesame Oil (3,5,7 % w/w) on SPF Values of Oxybenzon and Padimate O (3:7% w/w) in carbomer Gel Base

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## Abstract

This research was intended to know the influence of addition 3% Arbutin and (3; 5; 7)% w/w sesame oil on SPF value of sunscreen combination Oxybenzone and Padimate – O (3:7 % w/w) was formulated in carbomer gel base. Characteristic test was done in 2nd day after formulated included organoleptic, pH, and spread-ability. The sunscreen effectiveness determination (SPF value) was performed in vitro by measuring the absorbencies of its 10 ppm solutions in isopropanol between 290 – 400 nm. Organoleptic characteristic all formulas were different with the base, so did the pH and spread ability result. From SPF value determination results conclude that addition of arbutin increased SPF value, so did the increased of sesame oil concentration. Formula with the higher concentration of sesame oil had a higher SPF values. From this research, there was suggested to evaluate in vivo acceptability test and affectivity in vivo trial test on human skin.

Key words: Arbutin, Sesame oil, sunscreens, carbomer gel, Oxybenzone, Padimate – O, SPF values

## Introduction

Sunscreens are mostly used to protect the skin from harmful effects of solar radiation. The active ingredients of sunscreens are divided into physical and chemical sunscreen agents. Physical sunscreen agents reflect the UV rays from our skin. It is not transparent and has to be used in a high concentration to be effective, which made them not preferable to some people. The chemical sunscreen agents work by absorbing UV-A radiation like oxybenzone and absorbing UV-B radiation such as Padimate-O (octyldimethyl PABA). To obtain a higher protection and producing a broad spectrum sunscreen, a combination of anti UV-A and anti UV-B sunscreen agents has been used nowadays in many sunscreen product [Widianingsih and Lumintang, 2002].

Normally, our skin has its own protection mechanism against the harmful effect of UV rays such as the thickening of *stratum corneum*, sweat and skin pigmentation. Increasing abnormality of melanin as a result of our skins natural protection can result in a non homogenous skin color which is usually reduce likeliness amongst people. To overcome this problem, whitening agents are used to control the production and metabolism of melanin in the epidermis. One example of a frequently used whitening agent is arbutin, a hydroquinone derivates which inhibits melanin production. Arbutin has lower toxicity than hydroquinone's and its depigmentation effect is higher than kojic acid and vitamin C [Mashhood, 2006]. This substance is used as whitening agent at a various concentration ranging from 0.5-3.0%. It has a low partition coefficient and penetration rate. Therefore, it needs addition of a penetration enhancer [Zulkarnain, 2003; Galilee, 2008; Mitsui, 1998].

One of enhancers that frequently used in cosmetic formula is sesame oil. Sesame oil is a vegetable oil that obtained from pressing Sesamum Indicum seed. Mechanism of sesame enhanced polar pathway in stratum corneum because it contains protein (25%) dan globulin (67,3%) as main substance. Another mechanism is to enhance the oclusiveness (Sarma, K., 1993) to facilitate arbutin penetration. Sesame oil has been widely used in sunscreen and other cosmoceutics preparation for its emollient activity; it is nonirritant, considered as a natural lipid that has the highest compatibility with human skin and has sunburn healing effect [O'Neil, 2006].

Among several variant sunscreen preparations, gel gives us a cool sensation, not sticky, elegant, and smooth and easy to be washed from the skin. A synthetic gelling agent

like *carbomer* 940 usually requires only a small amount of them to produce a gel with good consistency compared to other types of gelling agent.

The aims of this research wants to know whether addition of arbutin 3% w/w and various concentration of sesame oil (3, 5, and 7% w/w) as arbutin's enhancer affect SPF value of sunscreen combination of oxybenzone 3% w/w (as anti UV-A) and Padimate O 7% w/w (as anti UV-B) which is formulated in *carbomer* 940 gel base. SPF values are observed by using a spectrophotometric method.

## Methodology

### Preparation of sunscreen gel containing arbutin and sesame oil

Oxybenzone, Padimate-O and propylene glycol were mixed and put into the good emulsion system contains arbutin, water, BHT, sesame oil, and tween 80 as emulsifying agent. After that it poured into the carbomer gel base and stirred well to form the sunscreen gel. The sunscreen were then kept in a tight container and stored well for further analysis. Preparation of each formula is described as below table.

Table 1: Formula used in research

| Composition | Function | Concentration in formula (% w/w) | | | | |
|---|---|---|---|---|---|---|
| | | S | S+A | S+A+O 3% | S+A+O 5% | S+A+O 7% |
| Oxybenzone | Sunscreen agent | 3 | 3 | 3 | 3 | 3 |
| Padimate O | Sunscreen agent | 7 | 7 | 7 | 7 | 7 |
| Arbutin | Whitening agent | 0 | 3 | 3 | 3 | 3 |
| Tween 80 | Emulsifying agent | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Sesame oil | Enhancer | 0 | 0 | 3 | 5 | 7 |
| *Carbomer* | Geling agent | 1 | 1 | 1 | 1 | 1 |
| Distilled water up to | Solvent | 100 | 100 | 100 | 100 | 100 |

* Formula I = S = Sunscreen
Formula II = S+A = Sunscreen + Arbutin
Formula III = S+A+O 3% = Sunscreen + Arbutin + Sesame oil 3%
Formula IV = S+A+O 5% = Sunscreen + Arbutin + Sesame oil 5%
Formula V = S+A+O 7% = Sunscreen + Arbutin + Sesame oil 7%

### Characteristics determination of sunscreens gel

The characteristic of preparation were determined include: organoleptic test visually, while the determination of pH and spread ability are done in 2 days after the formula were made by using a digital pH meter Schott CG 842, and a spread-ability apparatus.

### Determination of SPF value of sunscreens gel

SPF value was determined by Petro's method.

Firstly, 100.0 mg sunscreens were dissolved in 2.0 ml isopropanol, the solution was then centrifuged for 15 minutes at 50 rpm. 1.0 ml of the filtrate is taken and poured into a 5.0 ml metered flask and shake well until its homogenized (10000 ppm). This solution diluted it and then its shaked well until it reached a concentration of 100 ppm (contains 10 ppm sunscreen's active ingredients). An UV spectrum of this solution was measured at 290-400 nm using Double Beam UV-Vis Spectrophotometer (Perkin Elmer Lambda EZ 201) at an interval of 2 nm which has an absorption that is larger than 0.050.

The AUC of each formula from the shortest and longest wavelength are calculated using the following equation:

$$AUC_{\lambda_{p-\alpha}}^{\lambda_p} = \frac{A_{p-\alpha} + A_p}{2} \lambda_p - \lambda_{p-\alpha}$$

Whereas:
AUC = Area under Curve
Ap = Absorbtion on p wavelength
Ap-α = Absorbtion on p-α wavelength

The SPF values of a formula were obtained by converting log SPF calculating from the total AUC into the equation below:

$$Log\ SPF = \frac{Total\ area}{\lambda n - \lambda 1} x\ 2$$

Whereas:
λn= longest wavelength above 290 nm that has an absorption value higher than 0.050
λ1= shortest wavelength 290 nm

**Statistical analysis**

One-way ANOVA were used to assess the significant of differences only for preparation with the same sunscreen category.

## Results and Discussions

The average data of organoleptic observation from all sunscreen formula were shown in table 2. From the data we could see that the addition either of arbutin or sesame oil to the formula affect the color and smell.

Table 2: Organoleptic analysis of the sunscreens formula

| Formula | Colour | Smell | Consistency |
|---|---|---|---|
| Gel base | Transparent | Carbomer like | A bit viscous |
| Sunscreen (S) | Pale Yellow | Padimate-O like | Viscous |
| S+Arbutin (A) | Pale Yellow | Padimate-O like | Viscous |
| S+A+Olive oil (O) 3% | Yellowish | Sesame oil like | Viscous |
| S+A+O 5% | Yellowish | Sesame oil like | Viscous |
| S+A+O 7% | Yellowish | Sesame oil like | Viscous |

Table 3: pH of sunscreen formula

| Formula | pH (average) | % var. coefficient |
|---|---|---|
| Gel base | 6.60 ± 0.07 | 1.05 |
| Sunscreen (S) | 6.31 ± 0.04 | 0.74 |
| S+Arbutin (A) | 6.27 ± 0.05 | 0.70 |
| S+A+Sesame oil (O) 3% | 6.26 ± 0.02 | 0.28 |
| S+A+O 5% | 6.30 ± 0.04 | 0.63 |
| S+A+O 7% | 6.30 ± 0.05 | 0.83 |

* The result were obtained from an average of 3 times replication

One of the important factors that influence sunscreen SPF value is pH, besides extinction coefficient and solvent polarity. Therefore it is important to know the mechanism

of SPF changes in the treatment formula. The pH of sunscreen gels also play a major rule in the sunscreen gels characteristic as the carbomer consistency were heavily affected by its acidity. Acid condition would lower the gels viscosity. From pH data, value of F calculation = 26.083 > F table = 5.42. Tukey HSD test of the pH data has shown decreasing pH by addition of sunscreen ingredient. However, addition of arbutin and/or sesame oil did not affect the pH even though sesame oil concentration increased. Overall, from the pH data we know that all sunscreen formula were in a range of skin pH.

The spread-ability of the formula was measured and the results were shown in table 4: From the data we could see that the spread-ability of the formula increased with the addition of arbutin but decreased with a rise in sesame oil concentration.

Table 4: Spread-ability of sunscreens formula

| Formula | Average slope (mm/g) | % Var. coefficient |
|---|---|---|
| Gel base | 0.2833 ± - | - |
| Sunscreen (S) | 0.3359 ± 0.004 | 2.26 |
| S+Arbutin (A) | 0.3859 ± 0.004 | 3.09 |
| S+A+Sesame oil (O) 3% | 0.2713 ± 0.002 | 3.47 |
| S+A+O 5% | 0.2474 ± 0.003 | 2.91 |
| S+A+O 7% | 0.2238 ± 0.0007 | 1.25 |

* The result were obtained from an average of 3 times replication

The SPF analysis was done by extracting the sunscreen from its base by using isopropanol. In order to assure that the base gel *carbomer* 940 will not give any absorption in the UV spectrum, it is also extracted using isopropanol and observed at the wavelength of 290-400 nm. From the spectra observed it is known that the gel base did not give any absorption at all, Therefore it is assumed that any change within the observation of SPF value were caused by the active ingredient only.

The SPF value that resulted from the calculation (Table 5) was then categorized based on the American Society of Health System Pharmacist standard in order to classify its protection capability.

Table 6: SPF data from the treatment formula

| Formula | Average SPF** ± SD | % KV | SPF Category (American Society of Health System Pharmacist Standard) | % increasing SPF value compare with control |
|---|---|---|---|---|
| I: S (Sunscreen preparation in gel ) | 6,658 ± 0,15 | 2,21 | Moderate Sun Protection Product | 0 |
| II: S + arbutin | 9,094 ± 0,24 | 2,63 | High Sun Protection Product | 36.58 |
| III: S+A+O 3% | 9,615 ± 0,50 | 5,18 | High Sun Protection Product | 44.42 |
| IV: S+A+O 5% | 11,119 ± 0,34 | 3,08 | High Sun Protection Product | 67.01 |
| V: S+A+O 7% | 16,435 ± 0,61 | 3,72 | Very High Sun Protection Product | 146.84 |

**The data were obtained from an average of 3 different products in 1 formula

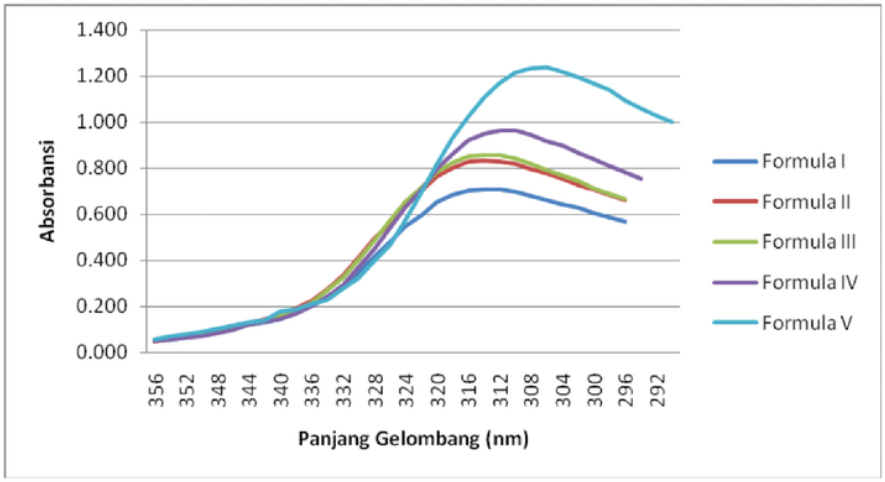


Figure 2: Absorption spectrum of sunscreen

According to category as presented Table 5, we know that arbutin elevated the sunscreen protection category, from "Moderate Sun Protection Product" to "High Sun Protection Product". Increasing sesame oil up to 5% did not alter the category. However addition of 7% sesame provide the maximum protection resulted the sunscreen category enhanced to be "Very High Sun Protection Product"

From the screening spectra profile as shown in Figure 2, it is learned that the addition of arbutin and sesame oil up to 5% did not cause any shiftness on the maximum wavelength. Nevertheless, an increase in the intensity of absorption was observed. Thus it is predicted that an interaction occurred between the molecule of arbutin and sunscreen agent which intensify the effect of aucsochrome group. And it is clear that addition of 7% sesame oil not only increased the absorption intensity but also increased the protection sunscreen, by maximum wavelength shift. This shiftness cause decreasing polarity of sunscreen gels that affect the delocalization of the molecule and resulted in a rise of energy demand needed for excitation to happen and hence, increase the SPF value.

Table 9: HSD test of the sunscreens SPF

**SPF**

Tukey HSD[a]

| Kelompok | N | Subset for alpha = .05 | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| Formula I | 9 | 6.6580 | | | |
| Formula II | 9 | | 9.0936 | | |
| Formula III | 9 | | | 9.6153 | |
| Formula IV | 9 | | | | 11.1192 |
| Sig. | | 1.000 | 1.000 | 1.000 | 1.000 |

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 9.000.

## Conclusion

The addition of arbutin and sesame oil affect the physical appearance (organoleptic and consistency) of sunscreen product as well as its spread ability and significant increase in SPF value of the sunscreen formula combination Oxybenzone and Padimate – O (3:7 % w/w) which was formulated in carbomer gel base.

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