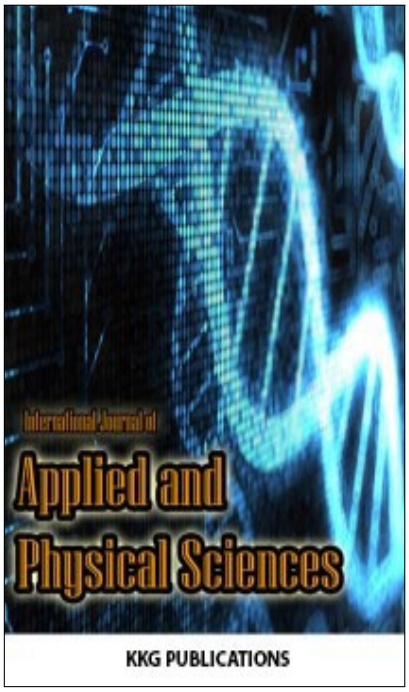

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ABSORBANCE VALUE OF TOBACCO (NICOTIANA TABACUM) ESSENTIAL OIL TO ULTRAVIOLET RADIATION IN THE WAY TO INVESTIGATE THE POTENTIAL OF TOBACCO LEAF FOR SUNSCREEN SUBSTANCE

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Abstract. The high intensity of ultraviolet radiation is one of the environmental problems to be solved, especially in a tropical country with a long duration of sun exposure like Indonesia. Esthetically, it causes wrinkles, hyperpigmentation, skin sagging, sunburn, etc. Medically, it causes genetic mutation at the cellular scale and skin cancer at a higher scale. Besides, it causes other health problems such as immune system disorder and cataracts. Sunscreen is needed to protect the skin from ultraviolet damage since it is the first gate of radiation to enter the whole body. Tobacco (Nicotiana tabacum) leaf is a potential herb to be used for radiation protection. It contains various antioxidants, including aromatic substances. Generally, the tobacco commodity is only used for the cigarette industry, and as we know, there are many environmental and health problems caused by its smoke. The problem is, we cannot stop the cigarette industry without giving solutions to the tobacco farmers. The only way to keep tobacco farming alive is by finding tobaccos other potentials. In this case, we are about to check the potential of tobacco leaves for radiation protection by seeing the absorbance value of essential tobacco oil to ultraviolet radiation. In this experiment, essential tobacco oil was gained by distillation methods using a water distillatory tube. The tobacco leaves were supplied by Tobacco Information Center (TIC) Jember, East Java. Tobacco essential oil from the distillation process has a density of 0.976 g/ml and has a strong scent. Absorption ability was checked by using Spectrophotometer Ultraviolet Visible. In this process, the essential oil was diluted with isopropyl alcohol in the concentration of 0.125%, 0.25%, 0.5%, 1%, 1.5%, 2%, 2.5% and 3%. In that variety of concentration, the absorbance value was investigated in the range of erythema and pigmentation wavelength (290-375 nm). Erythemal transmission value is 0.41%, 0.44%, 0.49%, 0.57%, 0.68%, 0.85%, 0.92% and 0.98% and the pigmentation transmission value is 0.55%, 0.58%, 0.63%, 0.71%, 0.80%, 0.91%, 0.96% and 0.99%. Those numbers represent the percentage of ultraviolet energy transmitted by the essential oil. It means the active compound of tobacco oil absorbed the rest. The category of total sunblock requires erythemal and pigmentation transmission value under 1%. The minimum concentration of the solution when it can still absorb the ultraviolet radiation based on the graphic is 0.0047%. The results showed that essential tobacco oil is a kind of total sunblock and is effective to use for sunscreen substance.

INTRODUCTION

Ultraviolet is one kind of natural radiation emitted by the sun, beside X ray, ray, infra red, neutrino visible light, etc. It has a shorter wavelength compared to visible light, but longer than X ray and ray. Containing lower energy than X ray and ray, does not mean that ultraviolet radiation is not dangerous. Ultraviolet radiation, however is needed. World Health Organization (WHO) [1],[2] stated that for human body, ultraviolet stimulates the production of vitamin D. But it can be fulfilled with only 5 minutes of sun bathing. Being exposed continuously to the sun in high dose and long duration could cause many side effects.

One special character of ultraviolet is a weak penetration. At the cell scale, maximum ultraviolet absorption happens in nucleic acid. The main destruction mechanism by ultraviolet happens in ribosome so then it causes mutation and cell death. Radiation absorption makes a chemical modification from nucleoprotein and makes a cross-section of timin molecules. It causes misreading of genetic codes and weakening of the vital function of organism. At the scale of organism, ultraviolet radiation could cause the medical long term effects like another strong electromagnetic wave. High dose of ultraviolet radiation causes tumor, benign cancer, malignant cancer, melanoma, carcinoma, from the low stadium to lethal stadium [2].

Beside medical effect, ultraviolet also has esthetical problems which some people are worried about. UV-A, specially can cause wrinkles, hyperpigmentation and skin sagging. UV-A has the longest wavelength and its penetration is the biggest, while UV-B with its greater energy can cause sunburn, black spot and erythema. WHO again stated that ultraviolet radiation is not only dangerous for skin, but high dose of ultraviolet exposure can cause cataract and decrease in immune system [1].

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Indonesia is one of the countries in the equatorial area on earth. It is exposed to the sun light along the year for longer durations than the countries in the Polar Regions. It means Indonesian people are exposed to the ultraviolet radiations with the higher intensity. Thus, they need protection more than the others.

The second background problem of the experiment is tobacco. Tobacco commodity is one of the never ending controversial issues. People stand between the economics and healthy point of view. More than 5.2 billion kg of tobacco are produced every year in over 70 countries in the world. Indonesia Tobacco Community Alliance (AMTI) mentions tobacco land area in Indonesia reached 202.453 hectares. About 200 million kg of tobacco are produced each year in Indonesia. The tobacco farms are centered in Central Java, East Java, West Nusa Tenggara and some other areas [3],[4].

Tobacco is the main ingredient of cigarette manufactures. Indonesia is a country with the third largest number of smokers in the world after China and India. National Health Research Board (RISKESNAS) states that the number of Indonesian passive smokers in 2013 was 96.9519 million and two thirds of them were women and children. On the other hand, tobacco became one of the ten largest industrial sectors in Indonesia. In 2010, the tobacco sector's contribution to country's revenues reached 64 trillion rupiahs. It represents 8.6% of the annual tax. More than 6 million workers are dependent on the tobacco sectors from the farmers to the retailers of cigarettes [3], [13]. Stopping the tobacco circular commodity without providing a solution to the tobacco farmers is an impossibility. Seeking its potential to be used as a more useful product is one way to open another production of tobacco that could reduce the production and economic dependence of cigarette companies. Those two main root reasons motivated the writers to solve the problems of ultraviolet radiation and tobacco sectors by investigating the potential tobacco to be a radiation protection.

LITERATURE REVIEW

Tobacco is a source of antioxidants. It contains antioxidant complex, including vitamin C [5]. Like other green plants, tobacco also contains chlorophyll which can be used for a variety of health products [6]. Tobacco can also be used as a vaccine of Ebola virus and anti-cancer [7]. In addition, the Tobacco Information Center (TIC) Jember has also done a research in Bali publications that tobacco can be utilized as an anti-rabies medicine [8].

Sunblock or sunscreen is a medical material used to protect the skin from ultraviolet radiation by chemical or physical mechanism. Based on the mechanism of protection, sunscreen is divided into three types, namely sunblock, sunscreen and suntan [9]. Sunblock is a kind of sunscreen that naturally reflects ultraviolet radiation. Commonly contains chemical compounds like zinc oxide (ZnO) or titanium dioxide (TiO2). Sunscreens that absorb ultraviolet are classified into sunscreen, generally contain octinoxate (absorbs UV-A) and avobenzone (absorbs UV-B). Absorption of TiO2 by the skin will pass through the blood vessels and then enter the blood circulation and has an effect on the liver and nervous system disorders. ZnO nanoparticles have carcinogenic effects on mammalian cells [2].

The third classification of the sunscreen is suntan. It is the sunscreen that accelerates the production of melanin and accelerates the flow of blood to the skin to darken or start browning (tanning) so that the skin can be naturally protected from ultraviolet radiation. This latter material does not have a direct contribution in protecting the skin from ultraviolet radiation.

Effectively, sunscreen ingredients which are necessary for mankind are that it is aesthetically invisible, odorless and pungent, have minimum effect on health, and the most important is optimum in absorbing or reflecting ultraviolet waves. Ultraviolet radiation interaction with the biological medium can also activate the free radicals. Thus in the manufactures of sunscreen, scientists also pay attention to the antioxidant content of the materials used. This is the way to neutralize free radicals caused by ultraviolet radiation as well as to reduce the signs of aging. Herbs that have been used for ultraviolet protection are the pomegranate seed oil, wheat germ, grape seeds, sesame seeds, carrot root, raspberry seeds, bran and combinations of one or more of these oils [10].

METHODS

The experiment consisted of two major phases, direct water distillation to obtain essential oil of tobacco leaf, and spectrophotometry using Ultraviolet Visible (UV-Vis) Spectrophotometer equipment (brand Shimadzu). Tobacco leaves as the main material used in this study were supplied by Tobacco Information Center (TIC) Jember, East Java. Tobacco leaves used are the leaves that have been dried by the wind.

Distillation or refining is a chemical separation method based on the speed and ease of evaporation materials. The process is, mixing the plant material with water and boiling until evaporated. The steam will be cooled and becomes a liquid that will be separated between water and oil. The oil component is what is called essential oil [5].

The second main process to determine the absorbance value of tobacco to ultraviolet radiation is the UV-Vis spectrophotometry in the measurement of the wavelength from 290 nm to 375 nm with each range of 1 nm. Spectrophotometer UV-Vis is one of the spectrophotometers that uses electromagnetic

radiation sources of ultraviolet (190-380 nm) and visible light (380-780 nm) [11]. UV-Vis light absorption results into electron transitions at electron scale, when the electrons in the ground state are excited to the orbit with higher energy. Molecules that require more energy to raise the electron will absorb light with shorter wavelengths. Molecules that absorb less energy will absorb light at longer wavelengths.

The output of this spectrophotometer is the absorption values at 290-375 nm of wavelength in every concentration of the sample. Absorption value will be transformed to the transmission based on this formula:

$A = -LogT$

The summation of transmission values in every concentration of solution will be processed as Erythema Transmission (ET) and Pigmentation Transmission (PT) in order to investigate the sunscreen's categories of the sample. Erythema Transmission is the percentage of the radiation transmitted through the sample in the range of erythema wavelength (290-320 nm) which causes erythema on the skin. Pigmentation Transmission is also the percentage of transmitted radiation through the sample in the pigmentation wavelength (320-375 nm) and it can cause pigmentation on the skin [12]. Both erythema and pigmentation transmission can be amounted as the equation below:

$ET = T \times Fe$

$\%ET = \frac{\sum(T \times Fe)}{\sum Fe}$

$PT = T \times Fp$

$\%PT = \frac{\sum(T \times Fp)}{\sum Fp}$

Where,

Fe = Erythema factor

Fp = Pigmentation factor

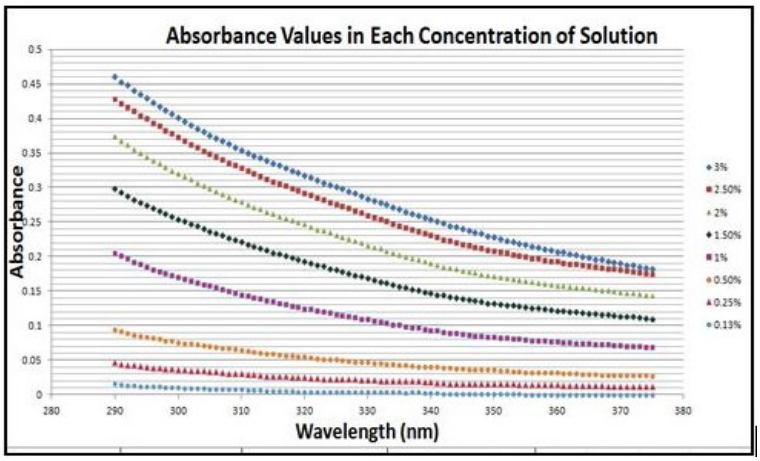
Erythema and pigmentation transmission can be used to categorize the essential oil solution based on this table [9]:

Category	Percent Transmission	
	%Erythema	%Pigmentation
Total Sunblock	<1	3-40
Extra Protection	1-6	42-86
Suntan	6-12	45-86
Fast Tanning	10-18	45-86

RESULTS

The result of water distillation process was the pure tobacco essential oil. It had a light orange color with density value of 0.976 g/ml. It had a strong scent.

In spectrophotometry process, the essential oil was diluted with isopropyl alcohol in the concentrations of 0.125%, 0.25%, 0.5%, 1%, 1.5%, 2%, 2.5% and 3%. In that variety of concentration, it had been tested for each absorbance value in the range of 290-375 nm in every 1 nm. Here is the graphic:



For higher concentration of the solution, it results in lower transmission of the radiation. In other words, for the higher concentration of the solution, the more molecules of substance absorbed the radiation.

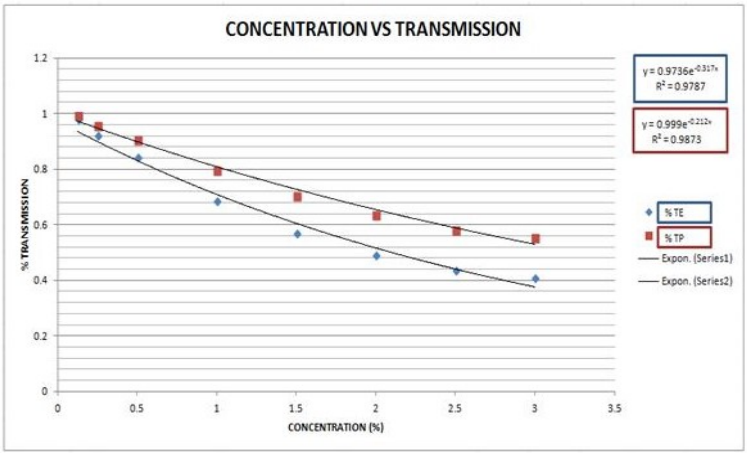
After plotting the wavelength against the absorbance values in every concentration of the solution, it obtained the

transmission values of whole exposure.

All the absorbance values showed that tobacco essential oil had a potential to absorb effectively. To ensure in what category this substance is classified, it had to quantify the erythema transmission and pigmentation transmission as represented by the table below:

C (%)	% ET	% PT	CATEGORY
0.125	0.98	0.99	Total Sunblock
0.25	0.92	0.96	Total Sunblock
0.5	0.84	0.91	Total Sunblock
1	0.68	0.80	Total Sunblock
1.5	0.57	0.71	Total Sunblock
2	0.49	0.64	Total Sunblock
2.5	0.44	0.58	Total Sunblock
3	0.41	0.55	Total Sunblock

All results of erythema and pigmentation transmission in the table show the percentage under 1%, even in the lowest concentration of this experiment. Predicting the minimum concentration where the essential oil can still absorb ultraviolet radiation in that range of wavelength, it needs analysis of the relation between concentration and the transmission value as shown in the graph below:



The graphic shows that the relation between concentration and percent transmission is exponential line in form of:
$(\%T) = ae^{-bC}$
In $(\%T) = Inae^{-bC}$
In $(\%T) = Ina - bC$

Thus, to find the minimum concentration is about finding the concentration value where the transmission is under 1%. From the equation above, the minimum concentration formula is:
$C = \frac{In(\%T) - Ina}{-b}$

T	Equation	Minimum Concentration
ET	(%T)=0.9736 e^{-317C}	0.0047
PT	(%T)=0.999 e^{-212C}	0.0844

DISCUSSION AND CONCLUSION

Based on this study result, tobacco essential oil is very effective to absorb ultraviolet radiation. In 1% of concentration, it only transmitted 0.68% radiation in the erythema wavelength and 0.80% radiation in pigmentation wavelength. It means, this essential oil absorbs more than 99% of the radiation. It had

also been proven that tobacco essential oil has a high ability to absorb ultraviolet radiation. In concentration of 0.125% based on experiment, and 0.0047% based on the graphic calculation, it is counted as a total sunblock.

In summary, tobacco essential oil is a potential material of radiation protection. The way to investigate another beneficial advantage of tobacco leaf can solve many problems. It can reduce cigarette and its smoke. Automatically, it solves environmental and health problems to economic problems.

In the end, there must be a following experiment to test the tobacco toxicity for human skin. There must be an in vivo test to make sure which compound in tobacco leaf is potential and safe for this case.

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