Study of Fastness, UV Protection, Deodorization and Antimicrobial Properties of Silk Fabrics Dyed with the Liquids Extracted from the Gallnuts, Areca Nuts, and Pomegranate Peels

Nabil Ben Muhammad, Nurfa Dewiza Luzik[a], Suci Ramadhani[b], Nanda Husnul Khotimah[c], Siska Alicia Farma, S.Pd., M.Biomed[d], Arizona[e*]
[a,b,c,d,]Department of Chemistry , Faculty of Math and Science, Universitas Negeri Padang, Air Tawar Barat Padang Utara West Sumatera, Indonesia, 25171 Indonesia
[e]Magister Programme of Educational Chemistry , Faculty of Math and Science, Universitas Negeri Padang, Air Tawar Barat Padang Utara West Sumatera, Indonesia, 25171 Indonesia

*Coresponding *E-mail: nurfaluzik12@gmail.com*

ABSTRACT

The purpose of this research is to study the fastness, UV-protection, deodorization, and antimicrobial properties of silk fabrics dyed with liquids extracted from the gallnuts, areca nuts, and pomegranate peels. Among dyeing fastness of dyed silk fabrics, light and dry cleaning fastness wass 3-5 grade. The dyed silk fabrics in wavelenght range of 290-400 appeared UV protection. Deodorization activity of dyed silk fabrics appeared over 99%. The dyed silk fabrics showed high antibacterial activity of 99.9% agains Staphylococcus aerus and Klebsiella pneumoniae.

Keywords: deodorization, UV-protection, gallnuts, areca nuts, and pomegranate peels

1. INTRODUCTION

In textile industry, to synthetic dyestuffs and pigments are widely used because of their various range of colours, better colour fastness properties and low prices. However, synthetic dyestuffs and pigments are ruled out by many producers because of their toxicity and carcinogenic effect, being not bio-degradable as well ecological. Recently, the textile finishing industry tends to restrict the use of such synthetic dyestuffs and pigments in order for human health and environmental purposes. As a result, the use of natural dye has begun to increase for their better properties as being bio- degradable, non-toxic, origination no problem to human health and waste water contaminant. Natural dyes are environmental friendly, low toxic and less allergenic. Due to these advantages, over the last decade the use of natural dyes has gained momentum in food, pharmaceutical, cosmetic and textile dyeing industry. For many years, scientists have investigated the deodorizing/aroma, insect-repellent, flame retardant, protection against to UV rays of plants dyeing and usability in the textile industry. Unlike the synthetic dyes, colorants derived from the nature are thought to be safe because of their non-toxic, non-carcinogenic and biodegradable nature. Natural dyes mainly consist of phenolic compounds which play an important role in plant growth and reproducibility. Many of

them have antioxidant activity and are also considered as antibacterial and anti-inflammatory compounds. They have been widely used as herbal medicines as well as natural dyeing agents. Phenolic compounds based on their different chemical structure, are divided to groups corresponding to flavonoids, quinones, curcuminoids and tannins.

The purpose of this research is to study the fastness, UV-protection, deodorization, and antimicrobial properties of silk fabrics dyed with the liquids extracted from the gallnuts, areca nuts, and pomegranate peels contained tannins. The light, dry cleaning, rub, and perspiration fastness of the dyed silk fabrics was evaluated. The UV protection factor of the dyed silks with SPF calculated in wavelength range of 290-400 nm range. The deodorization activity was made from concentration of residual ammonia gas in a container. The antimicrobial activity of the dyed silks was measured against *Staphylococcus aureus* and *Klebsiella pneumoniae*.

2. LITERATURE REVIEW

Gallnut

Gallnuts are outgrowths of plant tissues produced when irritants are released by the larvae of gall insects such as those of the Cynipidae family, the gall wasps. This extract contains the highest naturally occurring levels of tannin (gallotannin, 50-75%), as well as smaller molecules such as gallic acid and ellagic acid. Additionally, this extract is known to possess pharmaceutical properties, including anti-inflammatory, antibacterial, and detoxifying properties. Figure 1 showed the chemical structure of tannin(Gallnut tannin) contained in gallnut and image of gallnut dried.

Areca nut

Areca nut (Areca catechu L.), belonging to the family Palmae(or Arecaceae), native to Malaysia, widely cultivated in Indonesia, Sri Lanka, Hainan province, Guangdong province, Yunnan province and other places in Southeast Asia, is one of th most widely used South- China medicine resources. Areca nut is popular chewable items used in traditional herbal medicine. Areca nut exhibits multiple therapeutic properties like, aphrodisiac, antihypertensive, wound healing, hypoglycemic, and antidepressant. It is one of the most commonly used drugs in the world, containing alkaloids, tannins, polyphenols, sugars, and lipids that have anthelmintic, antifungal, antibacterial, anti-inflammatory, and antioxidant activities.

Pomegranate

Pomegranate (*Punica granatum* L.) belongs to the Punicacea family. The cultivation of pomegranate is native to the Middle East and was later known in the Mediterranean. Pomegranate peels are rich in tannins. They have been used traditionally for their medicinal properties as anticancer, anti-inflammatory, antioxidant and antithelminthic and for other purposes such as tanning, dyeing and heavy metal removal. Pomegranate peels are characterized by an interior network of membranes comprising almost 26-30% of total fruit weight and are characterized by substantial amounts of phenolic compounds, including flavonoids (anthocyanins, catechins and other complex flavonoids) and hydrolysable tannins (punicalin, pedunculagin, punicalagin, gallic and ellagic acid). Gallic acid, ellagic acid and punicalagin, in addition to their free radical-scavenging properties, also possess antibacterial activites against intestinal flora, particularly enteric pathogens, i.e., Escherichia coli, Salmonella spp. Shigella spp., as

well as Vibrio cholera. Figure 3 showed the chemical structure of pomegranate tannin(Ellagic tannin) contained in pomegranate peels and image of pomegranate peels dried.

Experimental methods

UV-Vis/NIR Spectra: 1g dried gallnuts, areca nuts and pomegranate peels was added to 100 ฦ ethanol respectively, and they were extracted at room temperature for 24 hours, and filtered. The filtered extracts respectively were used as samples for UV-Vis analysis. The measurement of the UV-absorption characteristics was conducted in the range of 190-800 nm by using anultraviolet-Visible/Near Infrared spectrophotometer (Varian Cary 5000).

FT-IR Spectra: The dried and grinded powers of gallnuts, areca nuts and pomegranate peels were analyzed with Fourier Transform Infrared Spectrometer (Bruker TENSOR27). Each samples were scanned registering the spectrum with 32 scans with a resolution 0f 4 cm^{-1} in the wave number range between 4000 and 600 cm^{-1}.

The extraction treatment of gallnut, areca nut and pomegranate peel: Gallnuts, areca nuts and pomegranate peels were extracted in liquor ratio of 1:20 at the boiling temperature for 20minutes. Each solutions were filtered with filter paper. The process was repeated 2 times. The liquid extraction combined first and second extract liquid was used as solution for dyeing.

Mordanting: Silk fabrics were mordanted by post-mordanting method using ferric mordant (0.2%), andliquor ratio for mordanting was kept at 1:30. Before the application of mordants, silk fabrics were soaked in distilled water. Water soaked silk fabrics were immersed in mordants solutions, and mordanted at 40 ℃ for 30minutes with constant stirring. Mordanted silk fabrics were rinsed with distilled water to remove superfluous mordants.

3. EXPERIMENTAL

Table 1. Wavelength and absorption of gallnuts, areca nuts andpomegranate peels

Samples	Wavelength(nm)	Absorption
Gallnut	217	1.813
	279	0.771
Areca nut	224	4.001
	280	0.856
Pomegranate peel	258	6.654
	368	1.366

DOI: https://doi.org/10.54482/GENETIKA/

Table 2. Deodorization activity of silk fabric dyed

		Deodorization Activity (%)
Untreated Silk		
Silk Fabric Dyed	30min.	over 99%
	60min.	over 99%
	90min.	over 99%
	120min.	over 99%

Figure 1. UV-VIS Spectra of ethanol extraction solution of gallnuts(A), areca nuts(B) and pomegranate peels(C)

4. RESULTS AND DISCUSSION

Spectroscopic analysis by UVöVis/NIR spectra

Figure 4 shows the UV-Vis/NIR spectra of the ethanolic extraction solution of gallnuts, areca nuts and pomegranate peels in the range of 190-800 nm. As shown by Figure 4 and Table 2, two absorption bands are easily seen in the ranges from 190 to 250 nm, and from 250 to 300 nm, and another broad absorption band appears around 300-400 nm. Gallnuts presented two characteristic absorption maximum, λmax_1 around 217 nm and λmax_2 at 279 nm. Spectra of areca nuts classified as condensed tannin, presented two characteristic absorption maximum, λmax1 around 224 nm and λmax2 at 280 nm. Pomegranate peels absorbed with two λmax at 250 and 368 nm.

Fastness properties

Fastness properties of silk fabrics dyed were given in Table 3. The samples showed mostly good light and dry cleaning fastness with 4 grade. Wet rub fastness was found to be relatively better than dry rub fastness. Perspiration fastness was all excellent grades 4~5 except for the 3~4 grades from discoloration by acidity and alkalinity.

UV Protection Rate

UV protection rate of dyed silk fabrics was shown in Table 4. UV-A protection rate of the samples in wavelength range of 290-400 nm showed 98.3%, and UV-B protection rate of the samples in wavelength range protection rate.

***of 290□315 nm showed 98.4%. As described above, the samples appeared very good UV* Deodorization activity of silk fabric dyed**

Table showed deodorization activity of dyed silk fabrics. As outlined in Table 5, the samples appearedexcellent deodorization activity over 99% even after 120min test.
Antimicrobial ativity of silk fabric dyed. The antimicrobial activity of dyed silk fabrics against *Staphylococcus aureus* and *Klebsiella pneumoniae* was assessed. Table 6 showed the antiimicrobial activity of dyed silk fabrics. The samples appeared high antiimicrobial activity activity of 99.9% against *Staphylococcus aureus* and *Klebsiella pneumoniae*.

5. CONCLUSION

Among dyeing fastness of dyed silk fabrics, light and dry cleaning fastness wass 3-5 grade. The dyed silk fabrics in wavelenght range of 290-400 appeared UV protection. Deodorization activity of dyed silk fabrics appeared over 99%. The dyed silk fabrics showed high antibacterial activity of 99.9% agains Staphylococcus aerus and Klebsiella pneumoniae.

ACKNOWLEDGEMENTS

We would like to thank all those who have contributed to the writing of this paper which we have no mentioned one by one, hopefully this paper will be useful. Thank you.

REFERENCES

[1] Zainul, R. (2015). Design of photovoltaic cell with copper oxide electrode by using indoor lights. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, *6*(4), 353-361. http://repository.unp.ac.id/id/eprint/602

[2] Zainul, R., Abd Azis, N., Md Isa, I., Hashim, N., Ahmad, M. S., Saidin, M. I., & Mukdasai, S. (2019). Zinc/aluminium–quinclorac layered nanocomposite modified multi-walled carbon nanotube paste electrode for electrochemical determination of bisphenol A. *Sensors*, *19*(4), 941.Zainul, R., Abd Azis, N., Md Isa, I., Hashim, N., Ahmad, M. S., Saidin, M. I., & Mukdasai, S. (2019). Zinc/aluminium–quinclorac layered nanocomposite modified multi-walled carbon nanotube paste electrode for electrochemical determination of bisphenol A. *Sensors*, *19*(4), 941. https://doi.org/10.3390/s19040941

[3] Zainul, R. (2015). Photoelectrosplitting water for hydrogen production using illumination of indoor lights. *Journal of Chemical and Pharmaceutical Research*, *11*(7), 57-67. http://repository.unp.ac.id/id/eprint/598

[4] Zainul, R., Effendi, J., & Mashuri, M. (2019). Phototransformation of Linear Alkylbenzene Sulphonate (LAS) Surfactant Using ZnO-CuO Composite Photocatalyst. *KnE Engineering*, 235-247. https://doi.org/10.18502/keg.v1i2.4448

[5] Sharif, S. N. M., Hashim, N., Isa, I. M., Bakar, S. A., Saidin, M. I., Ahmad, M. S., ... & Zainul, R. (2021). Polymeric Nanocomposite-Based Herbicide of Carboxymethyl Cellulose Coated-Zinc/Aluminium Layered Double Hydroxide-Quinclorac: A Controlled Release Purpose for Agrochemicals. *Journal of Polymers and the Environment*, *29*(6), 1817-1834. https://link.springer.com/article/10.1007/s10924-020-01997-0

[6] Putri, G. E., Gusti, F. R., Sary, A. N., & Zainul, R. (2019, October). Synthesis of silver nanoparticles used chemical reduction method by glucose as reducing agent. In *Journal of Physics: Conference Series* (Vol. 1317, No. 1, p. 012027). IOP Publishing. https://iopscience.iop.org/article/10.1088/1742-6596/1317/1/012027/meta

[7] Putri, G. E., Arief, S., Jamarun, N., Gusti, F. R., & Zainul, R. (2019). Microstructural analysis and optical properties of nanocrystalline cerium oxides synthesized by precipitation method. *Rasayan J. Chem*, *12*(1), 85-90. http://rasayanjournal.co.in/admin/php/upload/555_pdf.pdf

[8] MadJin, H. M., Hashim, N., Isa, I. M., Hussein, M. Z., Bakar, S. A., Mamat, M., ... & Zainul, R. (2020). Synthesis and characterisation of zinc hydroxides nitrates–sodium dodecyl sulphate fluazinam nano hosts for release properties. *Journal of Porous Materials*, *27*(5), 1467-1479. https://link.springer.com/article/10.1007/s10934-020-00925-w

[9] Mohd Sharif, S. N., Hashim, N., Md Isa, I., Abu Bakar, S., Idris Saidin, M., Syahrizal Ahmad, M., ... & Zainul, R. (2021). Carboxymethyl Cellulose Hydrogel Based Formulations of Zinc Hydroxide Nitrate-Sodium Dodecylsulphate-Bispyribac Nanocomposite: Advancements in Controlled Release Formulation of Herbicide. *Journal of nanoscience and nanotechnology*, *21*(12), 5867-5880. https://doi.org/10.1166/jnn.2021.19499

[10] Djasli, Y. A., Purnamasari, D., & Zainul, R. (2020, March). Study of dynamically catalytic system on humic acid phototranformator. In *Journal of Physics: Conference Series* (Vol. 1481, No. 1, p. 012037). IOP Publishing. https://iopscience.iop.org/article/10.1088/1742-6596/1481/1/012037/meta

[11] Jung, J. S. (2016). Study of fastness, UV protection, deodorization and antimicrobial properties of silk fabrics dyed with the liquids extracted from the gallnuts, areca nuts, and pomegranate peels. In *MATEC Web of Conferences* (Vol. 49, p. 03001). EDP Sciences. https://doi.org/10.1051/matecconf/20164903001

[12] Brown, B. A., Cloix, C., Jiang, G. H., Kaiserli, E., Herzyk, P., Kliebenstein, D. J., & Jenkins, G. I. (2005). A UV-B-specific signaling component orchestrates plant UV protection. *Proceedings of the National Academy of Sciences*, *102*(50), 18225-18230. https://doi.org/10.1073/pnas.0507187102

[13] Hoffmann, K., Laperre, J., Avermaete, A., Altmeyer, P., & Gambichler, T. (2001). Defined UV protection by apparel textiles. *Archives of Dermatology*, *137*(8), 1089-1094. https://jamanetwork.com/journals/jamadermatology/article-abstract/478464

[14] Kathirvelu, S., D'souza, L., & Dhurai, B. (2009). UV protection finishing of textiles using ZnO nanoparticles. http://hdl.handle.net/123456789/6078

[15] Egambaram, O. P., Kesavan Pillai, S., & Ray, S. S. (2020). Materials science challenges in skin UV protection: A review. *Photochemistry and Photobiology*, *96*(4), 779-797. https://doi.org/10.1111/php.13208

[16] Hoang-Minh, T., Le, T. L., Kasbohm, J., & Gieré, R. (2010). UV-protection characteristics of some clays. *Applied Clay Science*, *48*(3), 349-357. https://doi.org/10.1016/j.clay.2010.01.005

[17] Hou, X., Chen, X., Cheng, Y., Xu, H., Chen, L., & Yang, Y. (2013). Dyeing and UV-protection properties of water extracts from orange peel. *Journal of cleaner production*, *52*, 410-419. https://doi.org/10.1016/j.jclepro.2013.03.004

[18] Alebeid, O. K., & Zhao, T. (2017). Review on: developing UV protection for cotton fabric. *The Journal of the Textile Institute*, *108*(12), 2027-2039. https://doi.org/10.1080/00405000.2017.1311201

[19] Bilger, W., Johnsen, T., & Schreiber, U. (2001). UV-excited chlorophyll fluorescence as a tool for the assessment of UV-protection by the epidermis of plants. *Journal of Experimental Botany*, *52*(363), 2007-2014. https://doi.org/10.1093/jexbot/52.363.2007

[20] Grifoni, D., Bacci, L., Zipoli, G., Albanese, L., & Sabatini, F. (2011). The role of natural dyes in the UV protection of fabrics made of vegetable fibres. *Dyes and Pigments*, *91*(3), 279-285. https://doi.org/10.1016/j.dyepig.2011.04.006

[21] Lee, S. R., Lee, Y. H., Kim, I. H., & Nam, S. W. (1995). A Study on the Antibacterial and Deodorization of Silk Fabrics Dyed with Natural Dye (II)—Sappan Wood—. *Textile Coloration and Finishing*, *7*(4), 74-86. https://www.koreascience.or.kr/article/JAKO199511920176591.page

[22] Nadiger, V. G., & Shukla, S. R. (2016). Antibacterial properties of silk fabric treated with silver nanoparticles. *The Journal of the Textile Institute*, *107*(12), 1543-1553. https://doi.org/10.1080/00405000.2015.1129756

[23] Lee, Y. H., Hwang, E. K., Baek, Y. M., & Kim, H. D. (2015). Deodorizing function and antibacterial activity of fabrics dyed with gallnut (Galla Chinensis) extract. *Textile Research Journal*, *85*(10), 1045-1054. https://doi.org/10.1177%2F0040517514559580

[24] Lee, Y. H., Hwang, E. K., Baek, Y. M., Lee, M. S., Lee, D. J., Jung, Y. J., & Kim, H. D. (2013). Deodorizing and antibacterial performance of cotton, silk and wool fabrics dyed with Punica granatum L. extracts. *Fibers and Polymers*, *14*(9), 1445-1453. https://link.springer.com/article/10.1007/s12221-013-1445-0

[25] El-Molla, M. M., El-Khatib, E. M., El-Gammal, M. S., & Abdel-Fattah, S. H. (2011). Nanotechnology to improve coloration and antimicrobial properties of silk fabrics. http://hdl.handle.net/123456789/12650

[26] Lee, Y. H., Lee, S. G., Hwang, E. K., Baek, Y. M., Cho, S., & Kim, H. D. (2017). Dyeing properties and deodorizing/antibacterial performance of cotton/silk/wool fabrics dyed with myrrh (Commiphora myrrha) extract. *Textile Research Journal*, *87*(8), 973-983. https://doi.org/10.1177%2F0040517516646055

[27] Hwang, E. K., Lee, Y. H., & Kim, H. D. (2008). Dyeing, fastness, and deodorizing properties of cotton, silk, and wool fabrics dyed with gardenia, coffee sludge, Cassia tora. L., and pomegranate extracts. *Fibers and Polymers*, *9*(3), 334-340. https://link.springer.com/article/10.1007/s12221-008-0054-9

[28] Mongkholrattanasit, R. (2013). The evaluation of eucalyptus leaf extract for dyeing and its antibacterial properties on silk and wool fabrics. *Current Applied Science and Technology*, *13*(2), 76-81.

[29] Zhou, Y., & Tang, R. C. (2016). Modification of curcumin with a reactive UV absorber and its dyeing and functional properties for silk. *Dyes and Pigments*, *134*, 203-211. https://doi.org/10.1016/j.dyepig.2016.07.016

[30] Kim, M. S., Shin, Y. J., & Jang, J. (2013). Antimicrobial Finish of Cotton and Silk Fabrics Dyed with Schizandra Chinensis Fruit Extract. *Textile Science and Engineering*, *50*(3), 167-173. https://www.koreascience.or.kr/article/JAKO201328053103148.page