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- RESEARCH ARTICLE-

Antibacterial Activity of Cotton, Wool and Silk Fabrics Dyed with Daphne sericea Vahl Collected from Antalya

Menekşe Suzan Teker*

Akdeniz University, Faculty of Fine Arts, Department of Fashion and Textile Design, Antalya, Turkey

Abstract

Antalya is very important in the rich vegetation of the Mediterranean region. This richness of plants is an important source for dyes as well as the medicine, cosmetics and food industry. In this article, *Daphne sericea* Vahl is used as a source of dyestuff, locally called "ezentere" in Döşemealtı. Daphne (Thymealaceae) species have been widely used in traditional Anatolian medicine, but *Daphne sericea* Vahl is evaluated as a dyestuff in this study. A natural dye has been extracted from *Daphne sericea* Vahl and its antibacterial activity on cotton, wool and silk fabrics has been studied. According to results of against antimicrobial activity of dyed fabrics; Non mordant and alum mordant dyeing was seen to provide effective protection for all bacteria species (2 gram negative and 2 gram positive) and also all fabric samples (silk satin, silk mongol, cotton, gabardine), iron mordant dyeing was effective against to just gram negative bacteria except gabardine fabric. Potassium mordant dyeing was not providing any protection to bacteria species.

Keywords:
Natural dyeing, Antibacterial, *Daphne sericea*
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Introduction

Natural dyes have been used in textiles for thousands of years. They have lost their importance after the discovery of synthetic dyes. However, after the negative effects of synthetic dyes on environmental pollution (wastewater) and human health, natural dyes became important again. At this point, it is aimed not only to reuse natural dyes but also to gain importance with correct and sustainable studies.

* *Corresponding author, Menekşe Suzan Teker, E-mail: mesinal@hotmail.com*

Plants are the main source of natural dyestuff sources. It is possible to mention hundreds of plants used in natural dyeing in Turkey (Doğan et al., 2003; Karadağ, 2007; Enez, 1987). The Mediterranean region is also included in this rich resource. In addition to coloring, natural dye plants give many features such as antibacterial (Ren et al., 2017), antifungal (Shadid et al., 2012a; Shadid et al., 2012b), antifeedant (Kato et al., 2004), UV protection (Grifoni et al., 2011; Čuk, & Gorjanc, 2017) and antioxidant (Toussirot et al. 2014).

Including annual species, which spread in the world's tropical and temperate regions, one of the members of the Thymelaeaceae family, belonging to the genus Daphne, 7 species are known to grow in the Flora of Turkey (Borris, 1988). Tosun (2006) gave brief information about chemical constituents and biological activities of daphne L. species on her article. The aerial parts of Daphne sericea yielded two new flavonoids, luteolin 7-methyl ether 5-β-d-glucoside and luteolin 7,3′-dimethyl ether 5-β-d-glucoside, as well as luteolin 7-methyl ether, isovitexin, apigenin and its 7-β-d-glucoside.the following (Ulubelen, 1982).

Bacteria need basic requirements such as oxygen, moisture, nutrients, temperature to grow and multiply. Protein, cellulose etc., in the structure of natural fibers are very suitable for them. This environment, which is found in textile products, generally causes objectionable odor, dermal infection, product degradation, allergic reactions and other related diseases (Singh et al., 2005; Thiry, 2001).

The regional temperature changes in the body during active activity are the triggers of the growth of these bacteria. The presence of food sources (various food impurities, fat, protein, sugar and skin residues) on textile products is another factor that accelerates microbial growth on textile materials.

Textile products which are given antimicrobial properties help to reduce and eliminate the negative effects caused by microorganisms. These product groups are used to prevent infection of micro-organisms, to control infections, to prevent odor and staining and color change caused by micro-organisms and to prevent loss of quality. In recent years, interest in these products has increased due to their antibacterial effects.

Many test methods are being developed to determine the effectiveness of antimicrobial textiles. These methods generally fall into two categories: quantitative (AATCC100) and qualitative (AATCC 147) analysis. These are called agar diffusion test and suspension test respectively. In Table 1, some test standards are given under quantitative and qualitative analysis methods (Palamutçu, 2008).

Table 1. Antimicrobial activity test methods (Palamutçu, 2008).

Standart no	**Name of Standard (Orijinal İngilizce)**	**Method**
SN 195920-1992	Textile fabrics: Determination of the antibacterial activity: Agar diffusion plate test	DIFFUSION AGAR METHOD, (semi-quantitative method)
SN 195921-1992	Textile fabrics: Determination of the antimycoticactivity: Agar diffusion plate test	
AATCC 30-1993	Antifungal activity, assessment of textile materials: Mildew and rot resistance of textile materials	
AATCC 147-1993	Antibacterial assessment of textile materials: Paralel streak methods	
AATCC 90-1982	Antibacterial activity of fabrics, detection of: Agar plate method	

AATCC 174-1993	Antimicrobial activity assessment of carpets	
JIS L 1902-1998	Testing method for antibacterial of textiles	
AATCC 100-1993	Antibacterial finishes on textile materials: assessment of textile materials: parallel streak method	Quantitative method- (Challenge test)
SN 195924-1983	Textile fabrics: Determination of the antibacterial activity: Germ count method	
XP G39-010-2000	Properties of textiles-Textiles and polymeric surfaces having antibacterial properties. Characterization and measurement of antibacterial activity	
JIS Z 2911-1992	Methods of test for fungus resistance	Distortion test, (burying test)
ISO 846-1997	Plastics –Evaluation of the action of microorganisms	
ISO 11721-1-2001	Textiles –Determination of resistance of cellulose containing	
ASTM E2149-01	Standard Test Method for Determining the Antimicrobial Activity of Immobilized Antimicrobial Agents Under Dynamic Contact Conditions	
ISO 20743	“Textiles –Determination of the antibacterial activity of Antibacterial Finished products	

The aim of this study, determination of antibacterial activity of cotton, wool and silk fabrics dyed with *D. sericea* commonly can be collected in Antalya.

Material and Methods

Pure silk fabric with different woven structure weighing 64 g/m^2 (satin) and 80 g/m^2 (mongol), wool (gabardine) weighing 245 g/m^2 and pure cotton (voile) weighing 72 g/m^2 (bought from Erol Kumaşçılık, Antalya) were used.

Daphne sericea Vahl. plant were collected from Ağırtaş, Döşemealtı, Antalya which coordinates are N 37°13ˈ0,091" E 30°40ˈ13,66" and N 37°12ˈ57,754" E 30°40ˈ11,883". Plants dried in the shade and in an open airy place. Above ground part of the plant was used in dyeing process. For dyeing process, plants were used as a 100% proportion of the quantity of the textile. Dried plants were put in a kettle with the ratio of 1:40. Boiled for an hour and let in the kettle for 24 hours then filtered.

Alum [$KAl(SO_4)_2.12H_2O$] and ferrous sulphate heptahydrate [$FeSO_4•7H_2O$] from Merck and potassium dichromate [$K_2Cr_2O_7$] from Zag were used. Also potassium bitartrate [$KC_4H_5O_6$] was used as an auxiliary substance in alum mordanting. Pre-mordanting method was applied.

Determination of Antibacterial Activity of Dyed Fabrics

AATCC-100 and AATCC-147 Test Method was used to determine the antimicrobial activity. Antibacterial activity test was performed against both gram positive (+), (*Staphylococus aureus, Listeria Monocytogenes*) and gram negative (-); (*Aeromonas hydrophila, Pseudomonas aureginosa*).

In the AATCC 147 agar diffusion test method, pre-prepared bacterial concentrations are poured into the medium and then 25 mm diameter sample fabrics are placed. After the sample fabrics were stored at 37 ° C for 24 hours, the efficiency of the sample fabric was determined in mm by measuring the diameter around the fabric (inhibition zone diameter) (Figure 1A).

The AATCC 100 test method is used to quantitatively determine the degree of activity of the antibacterial agent present in textile samples. Quantitative evaluation provides important information about whether antibacterial agent used in textile products is effective on bacteria. The fabric samples prepared in the same dimensions are sterilized by standing at 121 ° C and 1.5 atm pressure for 15 minutes. The untreated sample and a control sample whose antimicrobial activity is assured should be combined with the test sample. Sowing samples are stored at 37 °C for 48 hours. The sample is wetted with 1 ml solution containing microorganism at a density of 105/ml. The soaked sample is then poured into the neutralization solution, mixed well. The neutralization solution is diluted to certain dilutions and sown on the solid medium. The aim of this process is to reduce the number of bacteria to a countable level. All the sown oil is kept in the oven at 37 ° C for 48 hours. After 48 hours, the count is made and evaluated. The reproduction amounts at the respective dilutions were obtained by multiplying the number of colonies by the dilution rate. The following formula is used to calculate the activity value of the antimicrobial agent of interest (Figure 1B).

Viable colonies of bacteria on the agar plate were counted and the percentage of reduction in the number of bacteria was calculated using Eq.(1) as follows:

$$R (\%) = A-B/A \times 100 \quad (1)$$

Where R is the percentage reduction of bacteria, A represents the number of bacteria colonies in the control (the untreated fabric), and B represents the number of bacteria colonies in the treated fabrics (Palamutçu, 2009).

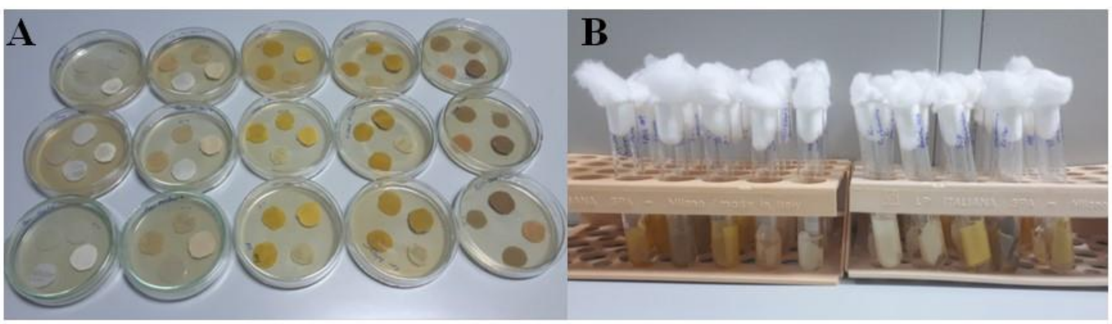

Figure 1. A) AATCC 147 agar diffusion test method B) AATCC 100 test method.

Results

Totally 16 fabrics (4 different fabrics for 4 different mordants) were dyed with *Daphne sericea* Vahl. Antibacterial activity was analyzed of the naturally dyed fabrics. All results are reported (Table 2).

Table 2. Value of against antimicrobial activity of dyed fabrics.

No	Fabric	Mordant	Gram positive		Gram negative	
			S. aureus	*L. monoctogenes*	*A. hydrophila*	*P. aureginosa*
1	Silk Satin	Non mordant	**99,87**	**99,83**	**99,70**	**99,75**
2		Alum	**99,87**	**99,83**	**99,75**	**99,80**
3		Iron II	-	-	**99,65**	**99,75**
4		Potassium dichromate	-	-	-	-

5	Silk mongol	Non mordant	**99,80**	**99,75**	**99,75**	**99,80**
6		Alum	**99,99**	**99,75**	**99,70**	**99,80**
7		Iron II	-	-	**99,80**	**99,80**
8		Potassium dichromate	-	-	-	-
9	Cotton voile	Non mordant	**99,99**	**99,75**	**99,75**	**99,85**
10		Alum	**99,99**	**99,58**	**99,70**	**99,90**
11		Iron II	-	-	**99,80**	**99,85**
12		Potassium dichromate	-	-	-	-
13	Gabardine	Non mordant	**99,87**	**99,66**	**99,70**	**99,80**
14		Alum	**99,80**	**99,66**	**99,65**	**99,70**
15		Iron II	-	-	-	-
16		Potassium dichromate	-	-	-	-

Discussion

According to results of against antimicrobial activity of dyed fabrics in the Table 2; Non mordant and Alum mordant dyeing was seen to provide effective protection for all bacteria species [against gram positive (+) (*Staphylococus aureus*, *Listeria Monocytogenes*) and gram negative (-) (*Aeromonas hydrophila, Pseudomonas aureginosa*)].

Iron mordant dyeing was effective against to just gram negative bacteria except gabardine fabric. Potasium mordant dyeing was not providing any protection to bacteria species.

We think that the use of alum mordant or non mordant dyeing will provide a better antibacterial effect in natural dyeing with daphne species.

The use of naturally dyed textile products can be increased by solving one of the most important problem which the lack of dyestuff. The other advantage of using pulp of plant is decreasing dyestuff cost.

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Conflict of Interest: The authors declare that they have no conflict of interest.

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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