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Dyeing and antibacterial properties of aqueous extracts from quince (*Cydonia oblonga*) leaves☆

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ABSTRACT

In this study was reported a novel application of using vegetable waste such as fall quince leaves for wool fibers dyeing. Natural dye obtained by aqueous extraction of quince leaves (*Cydonia oblonga*) was applied to a wool fibers by an exhaustion dyeing process. Effect of extraction temperature on UV–vis absorbance of the extracted liquor was studied. Zinc chloride and silver nitrate were used as mordants. The dyeing process was conducted with and without metallic salts, using post-mordanting method. The fastness properties and color parameters of the dyed wool samples were determined. The antimicrobial activity of dyed and post-mordanting wool fibers was also evaluated. Dyeings with aqueous extracts of fall quince leaves have moderate to very good fastness properties. Mordanting with silver nitrate result in significant improvement in light fastness. The best results were achieved when dyeing was conducted with quince leave extracted at 100 °C. Wool fibers dyed with mordant had a darker reddish-brown shades than those dyed without mordant. However, darker shade was obtained with silver nitrate mordant. Dyed and post-mordanting samples with silver nitrate have a good antibacterial activity against Gram-negative and Gram-positive bacteria. It was found from the study that the dye extracts from fall quince leaves can be successfully used for dyeing of wool materials to obtain a wide range of shades from light beige to reddish-brown. "Green waste" obtained from forest and garden residues could be used as valuable resource of natural dyes and bioactive compounds.

1. Introduction

In the recent years eco-friendly products are regaining popularity in different spheres of our lives (Shahid et al., 2013). There was a growing interest in the application of natural dyes, due to the increasing worldwide environmental consciousness (Rungruangkitkrai and Mongkholrattanasit, 2014). Natural dyes are emerging globally because they are environment-friendly and thus the application of natural dyes should be considered as a better alternative that provide many advantages over synthetic dyes, such as a higher bio-degradability, reduced pollution and reduced toxicity (Nasirizadeh et al., 2012). Natural dyes show a wide range of colors and can be extracted from different parts of plants: roots, rhizomes, seeds, bark, leaves, flowers or fruits (Rungruangkitkrai and Mongkholrattanasit, 2014). Eco-friendly processing of textile materials adds value to resulting products. From natural fibers, wool is among the earliest natural fibers used for textiles (Shen et al., 2014). Textile materials represent a favorable environment for the growth and development of microorganisms. Microbial growth on textile materials can generate foul odors, allergic reactions, textile degradation or discoloration. According to the data from the literature, the antimicrobial effect of natural dyes is given by tannins, flavonoids, curcuminoids, alkaloids and quinones contained in their extracts (Shahid et al., 2013; Mongkholrattanasit

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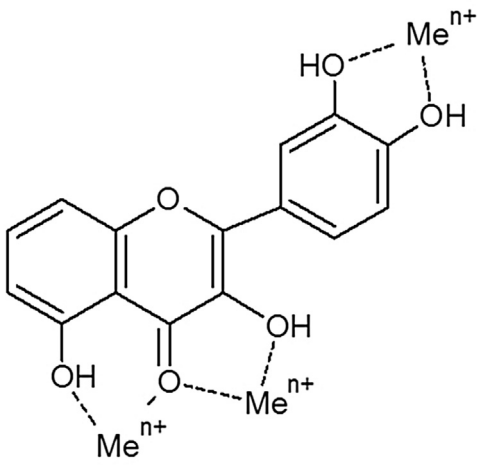

Fig. 1. Flavonoid-metal complex.

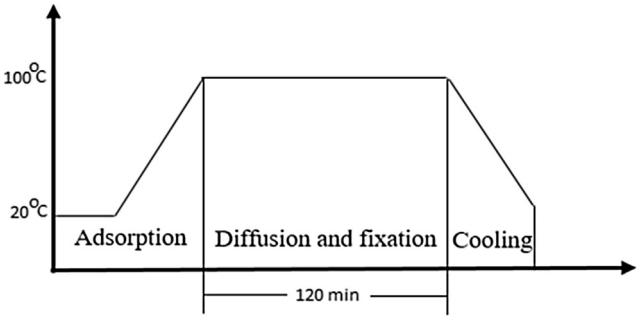

Fig. 2. Exhaust dyeing line diagram.

et al., 2011a). Flavonoids (e.g. catechins, quercetin, rutin, anthocyanidins) and tannins are two of the most interesting natural phenolic compounds and are considered very useful during the dyeing process because of their ability to fix dyes within fabrics (Krizova and Wiener, 2013; Mongkholrattanasit and Punrattanasin, 2012). The tannins from plants have shown potential antibacterial, antiviral, and antiparasitic effects (Doss et al., 2009). It is shown antibacterial activity against certain microorganisms such as *Staphylococcus aureus*, *Escherichia coli* and *Staphylococcus epidermids*, by precipitating microbial protein and making nutritional proteins unavailable for them (Cowan, 1999; Sajid et al., 2015; Shobowale et al., 2013; Spencer et al., 1988). A good and low-cost natural source of polyphenols is the quince tree (*Cydonia Oblonga*) and among its tissues, the leaves is the poorly studied one (Costa et al., 2009; Oliveira et al., 2012; Siqueira et al., 2012). Several studies have showed that total concentration of phenolic compounds in quince leaves is higher than in other parts of the plant, and tannins from the quince leaves reach up to 17.31% from the total content of chemical compounds (Krstic-Pavlovic et al., 1983; Oliveira et al., 2008). Besides being recognized as a good and cheap source of natural dyes, the quince leaves are also used in folk medicine because they constitute an inexpensive source of bioactive compounds with sedative, antioxidant (free radical scavengers) and antipyretic properties. Due to bioactive principles, the quince leaves extracts are also used for the treatment of various skin diseases (Krstic-Pavlovic et al., 1983; Oliveira et al., 2012; Sajid et al., 2015). Although many studies were conducted on textiles dyeing with natural dyes (Carvalhoa and Santos, 2015), forest and garden wastes have not been much explored as a source of natural dyes. The major polyphenolic constituents of forestry wastes include flavonoids and tannins, and can be used as source of natural dyes (Kuppusamy et al., 2015). The purpose of the present study was the valorization of vegetable waste for wool fibers dyeing. As far as we know, there is no information in literature on fall Quince leaves (*Cydonia Oblonga*) extract interaction with textiles. So, this study considers the application of quince leaves extract to textiles. Therefore, the present study was conducted to investigate the influence of the flavonoids and tannins, extracted from quince leaves, on the color parameters of dyed wool fibers. Besides, the experimental conditions such as extraction temperature and time, salts addition, the overall fastness properties, effect of metallic salts on dyeing quality and antibacterial effect were also investigated.

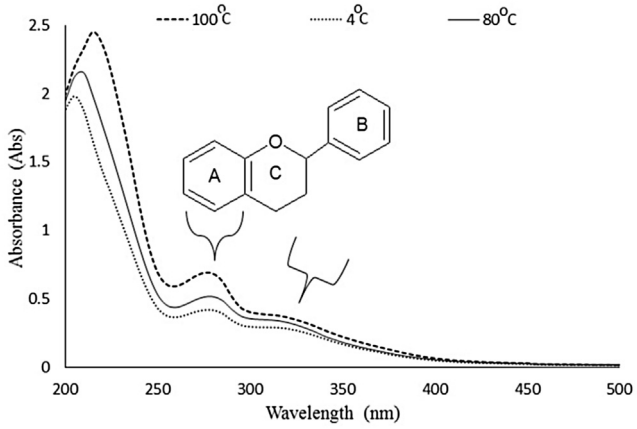

Fig. 3. UV–vis absorbance curves of quince leave extracts.

2. Materials and methods

2.1. Materials

Waste vegetal material consisting of quince leaves (*Cydonia oblonga*) was collected from the same location in the Northeast of Romania between September 2015 and October 2015. The samples were collected in polyethylene bags and kept at room temperature in the laboratory. Before using, quince leaves were washed to remove the dust and other impurities and wiped dry at room temperature using filter paper. The moisture content of dried quince leaves was found to be 10.02%.

For experiment, 23 μm diameter woolen fibers were used. The fibers were scoured with a solution of 5 g/L non-ionic surfactant and 5 g/L Na_2CO_3 at 50 °C for 10 min, rinsed with distilled water and dried. Metallic salts (silver nitrate and zinc chloride), aluminium chloride, rutin, catechin, sodium acetate, ethyl alcohol, vanillin and hydrochloric acid used in the study were of laboratory grade.

2.2. Extraction of polyphenols from the quince leaves

Extraction of polyphenols from the quince leaves was carried out according to the simple aqueous methods. In this method, the dried quince leaves are first broken into small pieces to improve extraction efficiency. The vegetable material to liquor ratio (M:L) was 1:12.5. The extractions were carried out at different liquor temperatures (4 °C, 80 °C and 100 °C) and for different time durations (60, 120, 180 and 240 min). The degree of vegetable product exhaustion was visually assessed by discoloration of the extracted solution (concentration of vegetable extract – 2% (w/v)).

2.3. UV–vis absorption spectra

The UV–vis spectra of the quince leaves aqueous extracts at different extract temperatures were recorded using a Single Beam