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Enhancement of macro-uniformity of copper(I) oxide printed linen fabrics by addition of *Pinus sylvestris* L. plant extract

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Introduction

Screen printing of textile materials using alginate paste modified with pigments from plants and different types of mordants, while respecting ecological principles, is gaining more and more importance today. Natural colors represent an emerging trend in the textile industry and eco-fashion due to the growing awareness of the concept of sustainability that must be applied to the environment.

But, in textile screen printing, many parameters affect the evenness of the print application and the macro-uniformity of the print surface. Previous research has shown that textile material printed by screen printing has high macro non-uniformity, caused by the texture of the material (Stančić et al., 2016; Vujčić & Ružičić, 2017). In a series of experiments (Fedorovskaya, Blommaert & de Ridder, 1993), (de Ridder, 1996) and (Fedorovskaya, de Ridder & Blommaert, 1997) it was proved that print quality is not only a function of color and color-related features. Surface pattern is a term that refers to optical heterogeneity, non-uniformity of optical density and brightness. It appears on fields of full tonal value and is a non-uniform reflection of light from the print. It usually appears in the form of systematically structured patterns that are easily perceived by the human eye due to its perfect response to pattern detection (Petersson, 2005).

The aim of this paper is to inspect the influence of added metal oxide and plant extract on the print quality of linen based material via surface macro non-uniformity GLCM determination method.

Methods

Alginate paste (CHT-NV) was prepared by adding 92 ml of distilled water at room temperature in 8 g of modified alginate. A homogeneous mixture is obtained by continuous mixing. This paste is used as a base for screen printing. After creating a homogeneous paste 20 ml, 40 ml and then 60 ml of *Pinus sylvestris* L. alcoholic extract was gradually added with mixing. Then, an additional 0.2 g of copper(I) oxide was added individually to each mixture.

A semi-automatic Screenprinter S300 screen printing system was used to print the material. Each sample of linen fabrics previously bleached with hydrogen peroxide (H_2O_2) was printed in two passes at a speed of 0.08 m/s on a 15 threads/cm screen.

The fabrics are cut to a size of 50 x 50 cm, and a 40 x 30 cm patch was printed on each sample. After drying, the samples were scanned with a Mustek 1200 ub plus flatbed scanner. The resolution used is 1200 spi, and image was generated using the Adobe Photoshop software. When scanning, all options for automatic image adjustment are turned off. The scan setup is the same for all samples. The GLCM image processing method was applied to scanned printed samples using MATLAB software and a plugin proposed by Uppuluri (2008).

Results

The results are shown in next figures.

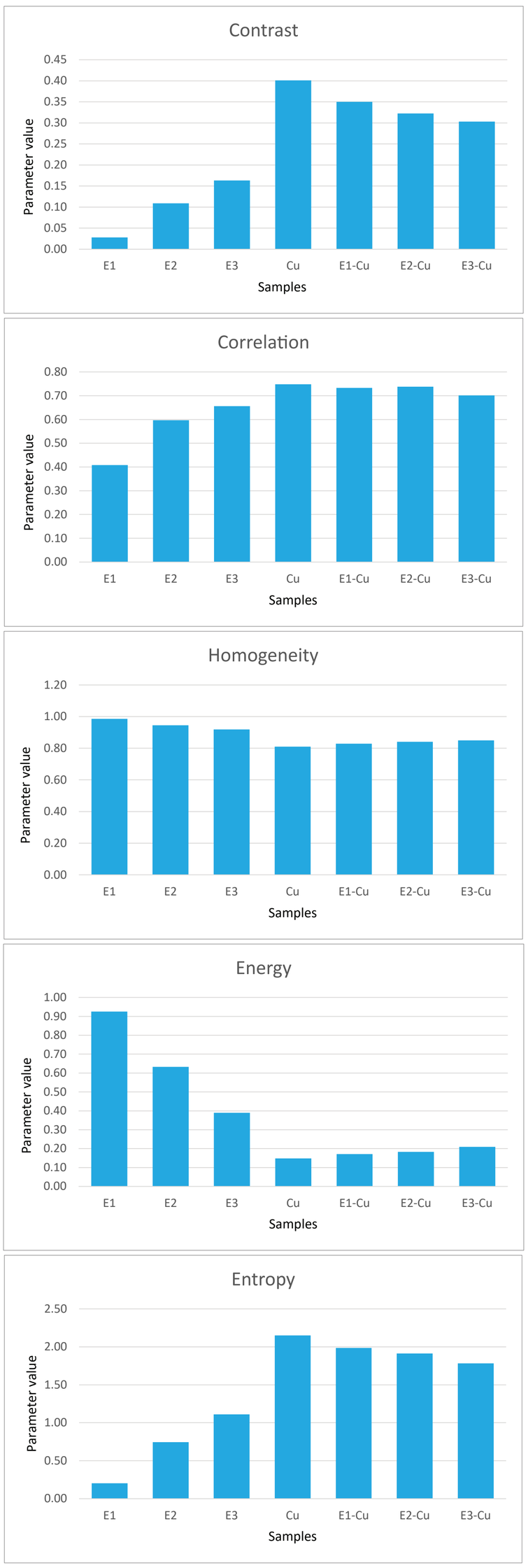

Figure 1

Macro non-uniformity parameters values

Discussion / Conclusion

Observing all parameters of surface non-uniformity, it can be concluded that the sample E1 has the most favorable parameters and the highest uniformity during printing, and this uniformity is decreased by increasing the concentration of the extract. This could be caused by the accumulation of extract in the weaves of the fabric, which becomes more pronounced as the concentration of the extract increases. This can also be attributed to the structure of the linen fabric by looking at the entropy parameter that best correlates with the human perception of texture. We see that, where the entropy value is high, a certain texture becomes more visible and noticeable. On samples with added copper(I) oxide (sample Cu) it can be concluded that Cu_2O significantly disrupt the uniformity of the printed surface, however, by adding the extract, particles of copper ions penetrate deeper into the yarn and the macro non-uniformity decreases.

The addition of Cu_2O to the printing ink has an effect on the macrouniformity of the printed fabric, which is confirmed by all parameters of surface non-uniformity. It has been shown that the samples with added copper(I) oxide significantly impair the uniformity of the printed surface, however, by adding the extract, the copper ion particles penetrate deeper into the yarn and macro non-uniformity is reduced.

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