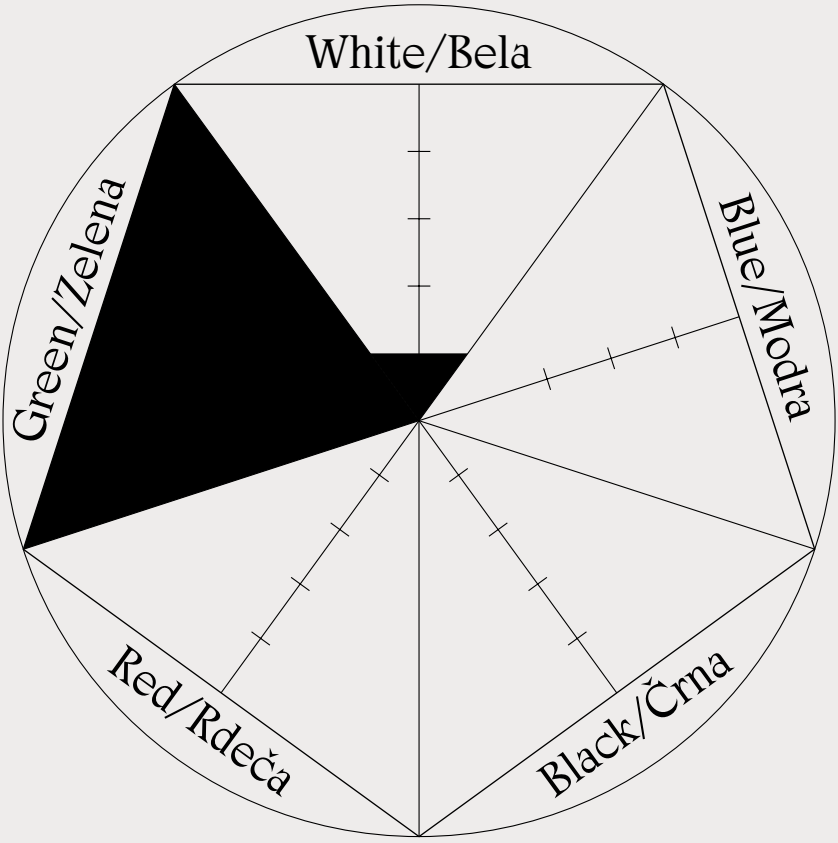
CASE STUDY

5

ŠTUDIJA PRIMERA

Mapping

Mapiranje



WHITE

do-it-yourself

BLUE

BLACK

RED

GREEN

nature as a model, sustainability,
natural order, in tune with nature, wisdom,
tradition, rejection of the artificial

BELA

naredi sam

MODRA

ČRNA

RDEČA

ZELENA

zgledovanje po naravi, trajnost,
naravni red, sonaravno, modrost,
tradicija, zavračanje umetnega

Case Study 5

WHITE BLUE BLACK RED GREEN

DEVELOPMENT OF INKJET PRINTING INKS FROM SUSTAINABLE / NATURAL SOURCES AND THEIR USE IN BOTANICAL PHOTOGRAPHY

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STUDY PROGRAMME AND COURSE	Visual Communication Design, Photography
YEAR	2022

The idea of natural printing inks emerged in response to the question of whether we could derive printing inks from plants and use them to print photographs of plants. The goal of the project was to develop inkjet printing inks from sustainable, natural sources and use them in the exploration of botanical photography.

STARTING POINT

Sources and types of natural dyes

The practice of producing dyes from natural sources is hypothesised to have emerged simultaneously around the world as early as in the Neolithic era, roughly 10,000 BCE. The surviving evidence, found on cave walls, shells, stones, skin and feathers, attests to the use of natural pigments derived from minerals. The lack of written records and the nature of the dyed materials make pinning down the exact age and type of dyes employed very difficult, as they tend to degrade rapidly unless very well protected, as in the case in mummification techniques in ancient tombs. The earliest records attesting to the practice of dyeing date back to 2,600 BCE, with recipes for red, black and yellow dyes found in China (Behan 2018, 10–14).

Throughout history, the natural dyes and fibres employed have been specific to individual bioregions around the world. The natural resources available helped shape the choice of colours and the methods used to produce the fibres, as well as the tools and methods used to apply the dyes. Some places have an abundance of plants that offer striking colours, such as the bright pinks and reds of Indian redwood (*Biancaea sappani*), the rare tropical indigo dye, the vivid pink colour of the dye extracted from the cochineal insect, *Dactylopius coccus*, of Mexico, and the regal Tyrian purple, produced by the ancient Phoenicians of the western Mediterranean

from the *Murex* sea snail. In Europe, the colour palette tended towards softer shades of pink, yellow, earthy orange, brown and light green (Behan 2018, 10–14).

To this day, natural dyes are produced from plants, minerals and insects, with plants offering the widest colour palette. Any part of the plant can be used—leaves, flowers, stalks, roots, berries, nuts, seeds, wood and bark, as well as fungi and lichens. Mineral dyes include earth and rock pigments, while animal dyes are commonly derived from various insects. Natural dyes can be used to dye textiles, paper, leather, wood or ceramics (Behan 2018, 10–14).

Compared to synthetic dyes, natural dyes cause much less harm to the environment and are also cheaper to produce. Most of the plants suitable for natural dye production are easy to grow in your own garden, field or plantation. Today, the use of natural dyes is limited mainly to domestic and small-scale use by traditional artisans and a handful of commercial companies worldwide (Patra 2016).

CRITICAL EXAMINATION OF THE ISSUE

The harmful impacts of synthetic dyes and the printing industry

Synthetic dyes have many negative impacts on the natural environment and organisms. The greatest risk is to workers in synthetic dye factories, who are directly exposed to various chemicals on a daily basis. Employees suffer from skin diseases, respiratory problems and other types of chronic health problems, even deadly ones. That said, harmful chemical compounds also affect consumers who wear, use or handle the dyed items. Another concern is water consumption in the production of synthetic dyes, and water pollution is an even bigger problem. Wastewater from the textile dyeing industry is one of the most polluted in the world (Patra 2016).

Numerous harmful factors can also be identified in the manufacturing of cartridges and printing inks. The plastic material used to manufacture the cartridges needs 450 to 1,000 years to decompose, and globally, approximately 375 million cartridges are discarded annually, which amounts to about 11 every second (The Recycler 2017). We also throw away a vast number of printed materials in the form of packaging, magazines, books, flyers, etc., printed with chemical printing inks, whose components sooner or later end up in the soil, water and atmosphere (Krosofsky 2021).

Printing inks contain pigments and dyes, as well as additives to improve persistence and binders that bind the components together. The binder can be water, oil or a solvent. Due to better environmental awareness nowadays, there is a resurgence in the use of vegetable oils—the most commonly used are soybean, linseed, and rapeseed oil, with soybean oil yielding the best results (Bambooink 2018).

Consumer-grade printers that use printing inks based on soy oil are already available on the market. These inks contain various pigments, waxes and resins and can produce highly saturated colour images. Waste printed material using this type of ink is also more readily recycled, as soy-based inks are easier to remove from paper pulp (Krosofsky 2021). While soy oil-based printing inks are in fact more ecological, petrochemical additives are still used in their production. These inks are therefore not an ideal solution (The Inktank 2019). It is also important to note that the label "soy oil-based printing ink" does not guarantee that the ink is made exclusively from this ingredient. According to current laws, a product so labelled is only required to contain 6 to 40% of soy. Currently, there are no printing inks on the market that are entirely made from renewable sources or without chemical additives. Algal printing inks on water or soy bases come closest, but these are currently only available in black shades. In addition, these inks are only compatible with specific printing methods (screen printing, flexography and offset printing), which do not include inkjet printing (Ecoenclose 2022).

RESPONSE TO THE IDENTIFIED ISSUES

Producing natural printing inks, choosing the subject and printing

The goal of the assignment was to create inkjet printing inks from entirely natural, easily accessible materials. Mucik set out to develop inks for CMYK printing that could be used with a home printer and then use them to print her own original photographs of flowers.

To make natural cyan ink, Mucik chose blue spirulina, as it yields an intense colour similar to factory-made cyan printing ink. The substance that gives blue spirulina its characteristic blue colour is called phycocyanin. This water-soluble pigment is extracted from green spirulina, an alga that is actually green-blue in colour. Blue spirulina is primarily used in the food and cosmetic industries (Kuddus et al. 2013). Magenta ink was

obtained from beetroot. The pinkish-red shades in beetroot bulbs are due to betanin. For the production of yellow printing ink, she used dry saffron, which gets its yellow shades from a carotenoid pigment. The biggest challenge, Mucik points out, was obtaining black ink, since no black pigment or dye exists in the plant world. After unsuccessful attempts with some other ingredients, the author settled on acorn coffee and iron oxide for black ink.[1] The acorn gets its black shades from tannins, which blacken in reaction with iron oxide.

In the course of her research, Mucik found that successful printing with plant-derived inks crucially depends on the particle size and viscosity of the ink. The latter is important because the printhead comes from the factory adapted for the use of inks of a certain density. If the ink is thicker or thinner than the factory ink, problems can arise in the density of the layer it applies and in the spreading of the ink dot. Through laboratory testing, the author determined that the viscosity of the natural inks obtained in the research is sufficiently close to that of factory inks. The filtration of natural inks posed more challenges. If the particles in the inks are too large, they clog the nozzles on the printheads, which causes them to stop printing or white lines to appear in prints. Mucik achieved the appropriate particle size by using several different types of filtration in sequence. For the first filtration, she used a kitchen strainer, then a coffee filter, followed by filtering through a 50-micron mesh sieve, and finally gradual filtration using 12-micron filters and 2-micron with the help of a homemade vacuum pump (Junkyard – Origin of Creativity 2016). **FIG. 16**

The selection of photographic subjects for printing with natural printing inks focused on plants with flowers in basic CMYK colours or that most closely approximate those. Echoing her experience in the preparation of natural ink for printing, Mucik had the most difficulty in finding a black flower, as black flowers do not exist in nature. There are varieties with dark red or dark violet flowers that appear partially black. The flower that comes closest to black is the petunia (*Petunia*), as its flowers have a velvety surface that does not reflect much light.

For the initial printing experiments, Mucik chose wide shots of plants in basic colours and printed them in ten layers. She used basic printing settings. To prevent wrinkling due to the numerous layers of ink, the author used thicker 240-gram paper. **FIG. 17–18**

① This was extracted from white vinegar in which rusty objects had been soaked for several days.

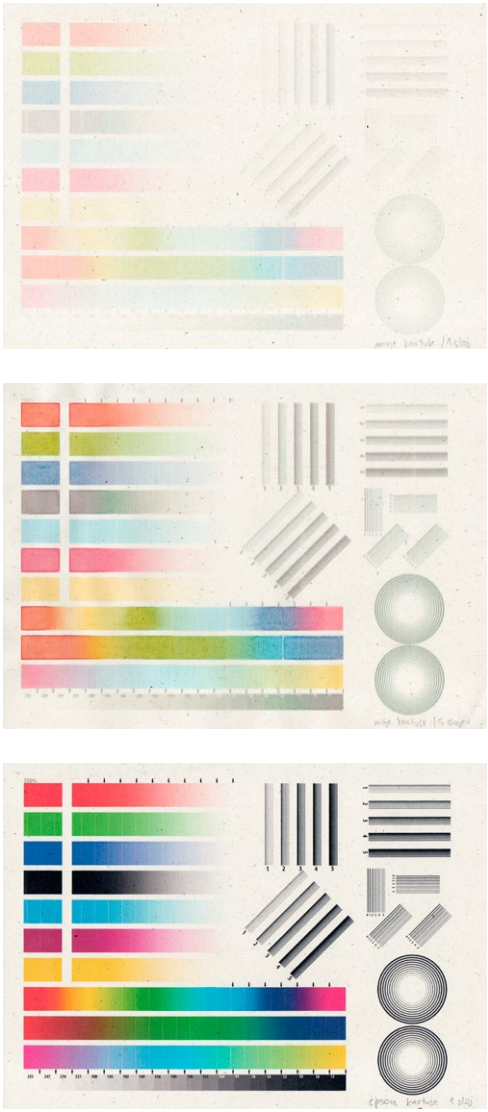

FIG. 16

Tilyen Mucik, from top to bottom—1 application of plant-derived printing inks, 10 applications of plant-derived printing inks, and 1 application of original Epson printing inks. An older generation Epson printer was used for printing, which, due to its lower resolution, allows for the printing of larger particles and has printing inks stored in pouches, 2022, author's archive.

Tilyen Mucik, od zgoraj navzdol – 1 nanos rastlinskih tiskarskih barv, 10 nanosov rastlinskih tiskarskih barv in 1 nanos originalnih tiskarskih barv Epson. Za tisk je bil uporabljen tiskalnik Epson starejše generacije, ki zaradi slabše resolucije omogoča tiskanje večjih delcev in ima tiskarske barve shranjene v vrečkah, 2022, arhiv avtorice.

FIG. 17

Tilyen Mucik, each flower in the basic CMYK colours, printed in their own channel, 2022, author's archive.

FIG. 17

Tilyen Mucik, vsak od cvetov v osnovnih barvah cmyk,
tiskan v svojem kanalu, 2022, arhiv avtorice.

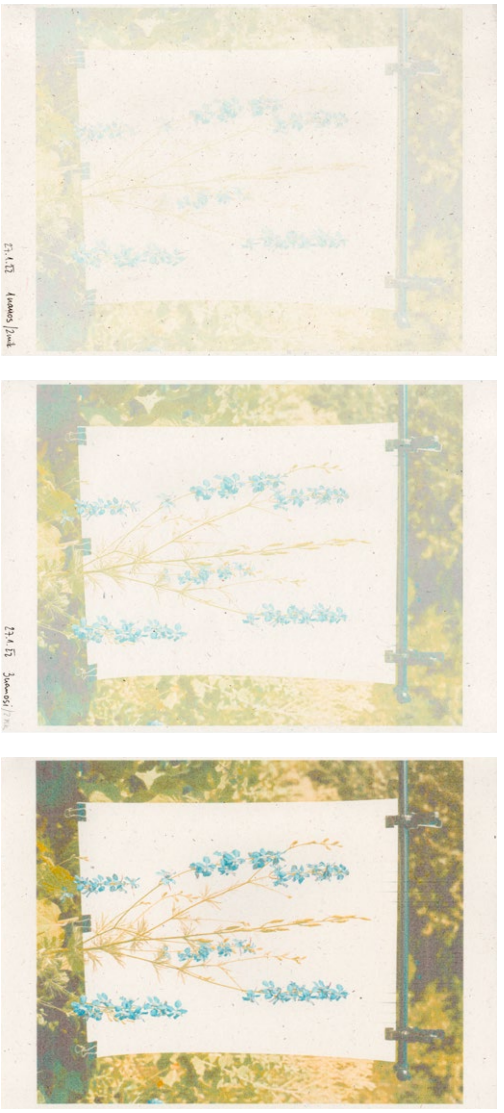

FIG. 18

Tilyen Mucik, From top to bottom—1 application, 3 applications and 10 applications of the plant-derived printing inks, 2022, author's archive.

Tilyen Mucik, od zgoraj navzdol – 1 nanos, 3 nanosi in 10 nanosov rastlinskih tiskarskih barv, 2022, arhiv avtorice.

One of the main motivations for this research was to critically examine the ecological aspect of printing. After conducting the tests, however, the author concluded that at the moment, this cannot be considered an ecological solution. The main shortcoming of plant-derived printing inks, according to Mucik, is their rapid deterioration. She found through numerous tests that the printer could only print smoothly for up to 48 hours after the introduction of the inks into the cartridges. The problem is that cleaning the nozzles on the printheads and the tubes through which the ink flows in an inkjet printer is extremely difficult and time-consuming. As a result of the damage caused by the use of natural printing inks, more than one printer would be used and discarded for just one completed printed image. Moreover, each new print job would require a brand-new printer, as it turned out that purging inks from used devices is practically impossible due to the factory protections. To print with home-made inks from natural ingredients, the printer would need to be modified or alternatively manufactured in such a way that even prolonged use of such inks would not damage it.

As an additional challenge from an ecological standpoint, Mucik highlights the persistence of the printed images. Due to the organic origin of the dyes, their qualities change rapidly over time. Plant dyes are more sensitive to external factors and fade much faster than chemical ones. To protect the prints, the author had to use a large number of plastic sleeves during the project's development.

But just as the images created in the course of the project are "alive", so is the process itself. Mucik points out that humans often perceive nature as unpredictable, incomprehensible and independent. Throughout the development of the project, the behaviour of natural materials, specifically plant dyes and pigments, always presented an unknown to the author. Likewise, the author could not foresee how long the project would take; some natural processes simply cannot be accelerated, she says, adding that creating and using natural ingredients forces the creator to avoid rushing the process and to adjust their clock to "natural time". The natural material, Mucik argues, operates "according to its own laws", which can be extremely frustrating for creators if they do not reconcile with the idea that it is the very unpredictability of such creation that gives it meaning. Mucik is convinced that the fact that not everything goes according to plan makes the works unique, irreplaceable and perfect in their imperfection.

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