LIGHTFASTNESS OF WATER-BASED YELLOW INKJET IMPRINTS

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This paper aims to examine the lightfastness of yellow water-based ink using a light-accelerated aging chamber. Mondy Maestro Print uncoated offset paper (120 g/m²) was used as printing substrate. The printing was carried out on an inkjet printing machine using water-based inks, and the light exposure was tested within the Solarbox climate chamber. The study was conducted through the analysis of colour differences, as well as changes in chroma and lightness, across light, mid and dark tonal patches, as well as the paper substrate. It is hypothesised that the paper substrate will influence the tonal patches through its changes, and that the colour differences will be greater with higher tonal coverage. Experimental results obtained throught spectrophotometric measurements indicate significant color differences. It was found that the paper substrate, through its alterations, influenced the yellow tonal patches. Furthermore, higher tonal coverage resulted in more pronounced colour changes. An exception was observed in the 70% tonal value (TV), which exhibited greater changes compared to the solid patch. These studies are crucial for better understanding of the application and efficiency of this type of ink in the graphic arts industry.

Keywords: water-based inks, artificial ageing, print quality, color difference, chromaticity, brightness

INTRODUCTION

The digital printing market has rapidly evolved since its inception. One of the most significant advancements has been seen in inkjet printing, a key subset of this technology.[1–5] Inkjet printing systems are increasingly applied in the market due to their low operational costs and versatility in printing on a wide range of products.[6–10]

Paper substrate

In the inkjet printing process, it is essential to choose the appropriate printing substrate. There are no restrictions on the choice of substrate, as it is a contactless technique. However, it is important to emphasise the significance of one of the most commonly used substrates, which is paper.[11,12] Paper is a multifunctional printing substrate primarily made from natural resources (cellulose fibres with added fillers, adhesives, dyes, and other additives important for dimensional stability).[13–17] Depending on the materials used in its production, papers with varying characteristics of durability, permanence, surface treatment, and resistance are produced, with ongoing efforts to diversify products.[18–20] Of the many types, plain paper is most commonly used in inkjet printing, while photo paper is used somewhat less frequently.[21]

For the proper functioning of the printing system and production of high-quality prints, it is crucial to ensure adequate compatibility between the paper and the printing process.[11,14,22] There are specific requirements that paper must meet in order to be used in digital printing systems. First and foremost, it must be free from dust and other paticulate contaminants that could cause contamination. The presence of wavy edges or other forms of curling is also undesirable, as it may result in system blockages or improper paper positioning. The paper must also possess an appropriate moisture content, ideally around 4.5%.[11]

The smoothness of the paper should range from 90 to 150 Sheffield, or 50 to 75 Sheffield for high-quality prints.[11] Smoothness influences the surface tension between the ink and the paper, which, in turn, influences ink adhesion. This factor, combined with print settings and ink viscosity, influences the mechanical dot gain.[23] The paper must also have appropriate resistance to heat and pressure, as these are essential elements of the drying process in digital printing techniques. In addition to this, the quality of paper prints is influenced by parameters such as brightness and whiteness. Whiteness is primarily regulated by the processes of bleaching the cellulose, by adding fluorescent whitening agents (FWA), and is reduced by the remaining lignin, while brightness is most influenced by optical brighteners.[11]

Inkjet inks

Depending on the desired outcome, different types of inkjet inks are used, with water-based inks seeing increasing application.[1,6,24,25] These inks, similarly to others, influence the print quality and the efficiency of the production process through their optimal consumption.[26] It has been estimated that the water-based ink market had an annual growth rate of 5.9% in the previous year, and by 2028, it is expected to further grow at an annual rate of 5.2%, reaching $12.79 billion (comparred to $9.86 billion in 2023 and $10.44 billion in 2024).[27,28]

In addition to their low cost, these inks owe their growing use to their ecological friendliness.[6,11,29,30] This type of ink does not contain volatile organic compounds or solvent residues, tends to form fewer bubbles, reduces the risk of fire, produces less odor, allows for easier printhead cleaning, and reduces nozzle clogging.[29,31–33] However, manufacturers are working to address the drawbacks of these inks, which include slow drying time, high energy consumption, and poor adhesion.[29]

Water-based inks are thus-named because of the dominant amount of water as a carrier in their composition (50-90%).[25,34] The main coloring agents are pigments or dyes, present in amounts of 1-15%. In addition to these, the ink also contains additives, such as humectants, surfactants and other substances.[25,28] These additives are important for forming adequate interactions between the components (emulsifying, dissolving, wetting, *etc*.).[35,36] Their rheological properties vary, with viscosity ranging between 2-5 cP and surface tension of 30-40 dyne/cm.[6,25,35,37] The drying process typically relies on infrared radiation, with additional drying methods, including hot air, microwaves, and others. Regardless of the drying method, the core process is penetration and absorption, which can often reduce the coloring density and print quality.[29] An adequate ink formulation, including viscosity, temperature, pH value, particle size, *etc*., is crucial for the proper functioning of the printing system and for producing high-quality prints.[31,38]

Pigments are the primary color component of water-based inkjet inks. They are classified into two main categories: organic and inorganic pigments. Organic pigments contain stable chemical bonds based on carbon atoms and other elements, while inorganic pigments are derived from metals, minerals, and oxides. Organic pigments are characterized by their insolubility in water and their tendency to fade or degrade under the influence of light or other factors. However, they also produce a broader spectrum of colors, compared to inorganic pigments.[39,40] Within this classification, there are numerous pigments, but only a select few have been use as colorants in the inkjet industry. This is due to the stringent requirements of the industry, such as cost-effectiveness, particle size and successful formulation. Some of these pigments will be discussed here.[40,41]

When it comes to yellow pigments, one commonly used type is Arylid yellow, more widely known in the market as Hansa. This is an organic pigment with a notable resistance to light, alkalies, and soap. Since its introduction in the early 20th century, it has undergone continuous improvements.[40,42,43] Due to its tendency to bleed, this pigment is most effectively used in water-based inks and systems that cure through air drying. It has relatively low tinting strength (covering ability). In addition to this pigment, diarylide pigments, such as Pigment Yellow 98, 83, 81, 74, 17, 14, 13 and 12, are also commonly used in inkjet inks.[40,44,45]

The significance of testing the lightfastness of yellow pigments is crucial for determining their long-term viability in digital printing. Ensuring that the yellow pigments retain their vibrancy and do not degrade over time when exposed to light is essential, particularly in applications such as art prints, signage, and outdoor advertisements. Therefore, lightfastness testing plays a key role in assessing the durability and quality of yellow inks, enabling manufacturers to select pigments that will maintain their appearance over extended periods, even under direct sunlight or artificial lighting.[40]

Pigments with higher tinctorial strength include diarylide yellow pigments, which are considered the most commonly used yellow pigments due to their ability to meet the requirements of most printing techniques. Additionally, these pigments are characterised by good resistance to light, heat, and soaps, as well as a small particle size that facilitates smoother ink flow through the printing unit.[40]

In addition to the aforementioned organic pigments, there are also inorganic yellow pigments, such as iron oxide, chrome yellow, and cadmium yellow. Iron oxide pigments are known for their high resistance to chemicals and weather conditions, with particularly strong heat resistance. They also have pronounced opacity, which can sometimes cause issues with the dispersion of these colours. Chrome yellow is notable for its ability to produce various shades of opaque yellow, with medium resistance to light, acids, and heat. However, its toxicity and carcinogenic effects have led to a decline in its usage. Cadmium yellow pigments are also highly toxic, and therefore are only used when highly durable reproductions are needed.[40]

Lightfastness

Due to the increasing demand for more durable and higher-quality graphic products, examining the parameter of lightfastness has become essential. Lightfastness is a key research topic in the graphic industry and is defined as the degree of resistance of inks to fading when exposed to light.[46–49] Depending on the ink formulation, lightfastness can vary. The primary cause of colour change is the absorption of light by the pigments and the molecules of the printing substrate, primarily due to the presence of chromophores.

Chromophores are chemical groups within ink compositions that absorb light. When chromophores absorb photons, the chemical bonds within the molecules are broken or altered, leading to the formation of highly reactive and unstable molecules. This can result in changes, such as fading or colour shift, and in extreme cases, complete degradation of the pigments. This process is known as photodegradation.[46,50–52] Research has shown that the ultraviolet portion of the light spectrum has the greatest impact on colour change. Specifically, as the wavelength decreases, the effect on colour increases.[53]

Lightfastness analysis can be performed under natural conditions or using test chambers. The use of test chambers is more common, as natural aging processes are much slower, and test conditions can be controlled.[54–56] Xenon lamps, which emit a spectrum similar to that of sunlight (sometimes with or without UV filters), are commonly used in test chambers to simulate sunlight exposure.[54–56]

Accelerated aging conditions, combined with the quantification of stimulus effects on a product's lifespan, provide a clear and objective picture of its lightfastness.[46] Reliable and objective assessment of light-induced changes requires the application of appropriate standards or a combination of them.[57] Standards commonly used for this purpose include: ISO 105-B02, ISO 105-B01-1999, ISO 105-B03-1997, ISO 105-B04-1997, ISO 105-B05-1996, ISO 105-B06-1999, ISO 105-B07:2009, ISO 105-B08:1999, BS ISO 2834-1999, AATCC Test Method, and others.[58–63]

Exposure of samples to light results in varying degrees of change, which can be observed either spectrophotometrically or visually.[64,65] Spectrophotometric analysis involves measuring the CIE L, a, b, C, h components to calculate the difference in colour using specific formulas.[66] Some of these formulas are: CMC (Color Measurement Committee formula) (l:c),[67] BFD (Bradford–Ford–Desaules formula) (l:c),[68] CIE 94,[69] LCD,[70] and CIE $\Delta E00$.[68] Spectrophotometric data are invaluable in detecting colour differences, which helps achieving accurate and reliable results.[47,71]

In addition to exhibiting a lower tendency to change colour, lightfast products offer better protection to the items they cover, especially when their primary purpose is packaging. For example, in the food industry, and the pharmaceutical industry, lightfast packaging can help prevent product degradation. Similarly, lightfast graphics are crucial for instructions and safety labels.[72]

Research on the lightfastness of process colours has shown that magenta and yellow are more prone to colour change compared to cyan and black. This can be attributed to magenta's absorption of the green part of the spectrum, which influences its fading. On the other hand, yellow pigments absorb blue light, leading to pigment loss and visible colour changes.[6,73]

Lightfastness of the paper substrate is often studied alongside the lightfastness of inks, as it impacts the final print quality.[21] The structural components of the paper affect its lightfastness and, consequently, the overall print.[47] For instance, the cellulose content, with its hydrogen bonds, and polymer additives with alkyl groups positively influence light stability. In contrast, polymers containing UV light absorbers can destabilise the substrate and reduce its lightfastness.[74]

The study of lightfastness is essential for ensuring the durability and stability of graphic products, especially when working with new inks, printing machines, and surface treatments. Accordingly, the aim of this study is to examine the lightfastness of newly developed water-based yellow inkjet ink for the market. The lightfastness will be tested spectrophotometrically to ensure objective and reliable results after the exposure of the printed inks in an ageing chamber.

EXPERIMENTAL

In the experimental part of this paper, standard offset paper – Mondi Maestro Print 120 g/m² – was used as the printing substrate. This is an uncoated, wood-free offset paper.[75] It is manufactured using a blend of dried cellulose, carboxymethyl cellulose, starch, and animal-based adhesives. The paper is characterised by a smooth surface, dimensional stability, low CO_2 emissions, and resistance to tearing and dust generation. Its wide range of applications includes office materials, packaging (such as boxes and bags), banners, magazines, and more.[75,76] The material properties are summarised in Table 1.

For printing purposes, a standard Ugra/Fogra Media Wedge v3.0 control strip was used, with control patches measuring 8.5 x 10 mm. A total of 50 samples were produced using the high-speed cutsheet inkjet printer Kyocera TASKalfa Pro 15 000c printing machine, equipped with the RIP Fiery PS-50. The printing unit includes three Kyocera KJ4B-YH piezoelectric printheads for each process colour. The technical specifications of the printing machine are presented in Table 2.

The Kyocera printing machine utilises specially formulated water-based inks. For the purposes of this study, particular emphasis was placed on the application of the yellow process ink (IK7125-Y). The chemical composition of the ink is presented in Table 3.

Table 1
Paper specifications[75]

Characteristic	Standard	Value
Basis weight	ISO 536	120 ± 4.5 g/m^2
Caliper	ISO 534	144 ± 6 µm
Bendtsen roughness	ISO 8791 - 2	225 ± 75 mL/min
Opacity	ISO 2471	96.00 ± 1.6 %
Moisture abs.	ISO 287	6.2 ± 0.7 %
Brightness UV	ISO 2470	135.5 ± 1.5 %
CIE Whiteness	ISO 11 475	145 ± 3.0 %

Table 2
Printing machine specifications[77]

Paper size	98 x 148 mm – 330.2 x 488 mm
Print speed	A4: 150 ppm/150 ppm (75 sheets) A3: 88 ppm/88 ppm (44 sheets) SRA3: 75 ppm/75 ppm (37 sheets) A3W: 74 ppm/74 ppm (37 sheets)
Available thickness printing at rated speed	Up to 360 g/m^2
Print resolution	600 x 600 dpi, 600 x 1200 dpi

Table 3
Chemical composition of the ink [78]

Chemical name	Identifier	Percentage
Water	7732-18-5	40-60%
Polyhydric alcohol	Confidential	20-30%
Triethylene glycol monobutyl	143-22-6	5-10%
Organic pigment	Confidential	5-10%
Glycerol	56-81-5	5-10%
1,2-benzisothiazol-3(2H)-one	2635-33-5	<0.05%
2-methyl-2H-isothiazol-3-one	268-20-4	<0.05%

Table 4
Calibration results

Parameter	Reference value for A grade	Obtained value
ΔE_{00} average value of all samples	2.5	1.9
ΔE_{00} maximum value of all samples	6.5	5.7
ΔE_{00} maximum value of paper whiteness	2.5	1.3
ΔH maximum value of CMYKRGB sample	5.0	4.0
ΔCh average value of CMYK samples	2.5	1.8

Based on the chemical composition of ink IK7125-Y, it is likely that the yellow pigment belongs to the diarylide pigment, most probably Pigment Yellow 12 or Pigment Yellow 13. These pigments, derived from 3,3'-dichlorobenzidine, are commonly used in water-based inks due to their chemical stability, non-toxicity, and high compatibility with modern printing processes. Both are classified as non-hazardous under the Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures, matching the absence of hazardous substances in the MSDS (Material Safety Data Sheet). Pigment Yellow 12 is particularly common in printing and packaging applications due to its strong colouring strength and good transparency, whereas Pigment Yellow 13 offers better lightfastness. Given its wide industrial use and favourable properties, Pigment Yellow 12 is considered the most probable choice. However, further testing, such as lightfastness evaluation and spectral analysis, is recommended to confirm the pigment's identity.[79–83]

Before the printing process, the printing machine was calibrated according to the Fogra 52 standard for uncoated paper (PSO Uncoated v3). This standard ensures colour accuracy, as well as consistency and uniformity in printing. The average colour difference values (ΔE00) were measured for all samples, along with the maximum colour difference values for both, all samples and the paper. Additionally, the maximum CMYRGB tone values (ΔH), and the average ΔCh value for CMYK were measured, as these are important parameters for characterising and comparing neutral tones near the grey axis ($\Delta C < 7$), which cannot be described through ΔH. The average values of these parameters were rated as grade A, ensuring compliance with the standard. The results are presented in Table 4.

Spectrophotometric measurements were carried out using an X-Rite Exact Advance spectrophotometer. The *CIE L**, *a** and *b** values of the paper, as well as the tonal values of yellow (10%, 20%, 40%, 70%, and 100% tonal value (TV)), were measured with the following parameters: 2.5 mm measuring aperture, M0 measuring mode, 2˚ standard observer, and a D50 standard illuminant. After the initial measurement, the prints were placed in the Solarbox 1500e xenon light ageing chamber, where they were exposed to 550 W/m² lamp power, a temperature of 50 °C, and no UV filter, for a period of 18 months. Every 91 days (*i.e.* every 3 months), samples were removed from the chamber and their *CIE L**, *a**, and *b** values were measured. One hour of exposure in this chamber corresponds to approximately one day of exposure to real-world weather conditions.

RESULTS AND DISCUSSION

In this section, the results obtained through instrumental measurements are presented. The results are divided according to the type of difference. First, the obtained values of colour difference are shown. The difference between the colours was calculated according to the *CIE* ΔE_{00} formula (ISO 11664-6:2014). To describe the aforementioned difference in more detail, or to uncover the more precise cause of the change, the deviations in tone chromaticity (ΔC) as well as the deviations in brightness (ΔL) are presented afterwards.

Colour difference

The resulting colour difference is presented in the diagrams in Figures 1 and 2. Figure 1 presents the colour change diagram for light and mid-tone areas, while Figure 2 presents the colour change diagram for dark-tone areas.

First, it is essential to explain the changes that have occurred in the printing substrate, as these directly influence the color changes observed in the yellow patches. The printing substrate, *i.e.* the paper, undergoes a color change of $\Delta E = 6.7$ after three months. With continued aging, this value increases to $\Delta E = 7.99$ after six months, while the average color difference in the period from 6 to 18 months is $\Delta E_{6\text{–}18m} = 7.95$. This value indicates a visible change in colour. According to the Blue Wool scale, these patches are classified as having very good lightfastness, with the exception of the ΔE value after 18 months, where a value of $\Delta E_{18m} = 8.18$ causes the imprint to fall into the category of fair (impermanent) lightfastness.

When it comes to light yellow tones, the 10% TV tonal patch exhibits the greatest colour change after three months, with a value of $\Delta E_{3m} = 4.13$.

This is the only point of this tone that exceeds a value of 4 on the diagram. Specifically, this is the case where the 10% TV patch is rated as having very good lightfastness. As the ageing process continues, the colour difference decreases after 6 months (ΔE_{6m}= 0.71), and then shows a slight increase after 9 months (ΔE_{9m} = 2.26). After this period, the colour difference stabilises and remains approximately the same until the end of the experiment. The average colour difference over the period from 3 to 18 months is $\Delta E_{3\text{-}18m}$ = 2.47. Taking this value into account, the yellow patch with 10% tonal coverage demonstrates excellent lightfastness, and the cause of variations in the results is the colour change of the paper substrate, namely the fading of optical brightening agents (OBA). The fading of optical brightening agents occurs as a result of exposure to UV light. The fundamental reaction involves the degradation of the OBA molecules, which leads to the loss of their characteristic bluish undertone.

The 20% TV patch is characterised by a steady increase in colour difference until the ninth month. At this point, the imprint is rated as having fair lightfastness, with a colour difference of ΔE_{9m} = 9.40. After that, the changes stabilise until the end of the experiment, with the colour difference values remaining within the range of fair lightfastness. The average colour difference for the period from 9 to 18 months is $\Delta E_{9\text{-}18m}$ = 10.25.

The 40% TV patch shows almost no colour change during the first three months. After that, a nearly linear increase is observed up to the twelfth month, with the colour difference reaching ΔE_{6m} = 8.86 (fair lightfastness) after six months, ΔE_{9m} = 16.51 (poor lightfastness), after nine months, and ΔE_{12m} = 20.39 after twelve months. Following the twelve months, colour changes stabilise, and the average value for the period from 12 to 18 months is $\Delta E_{12\text{-}18m}$ = 20.69 (poor lightfastness).

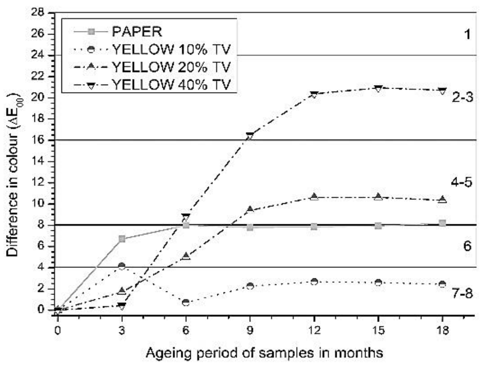

Figure 1: Colour difference diagram of light and mid-tones

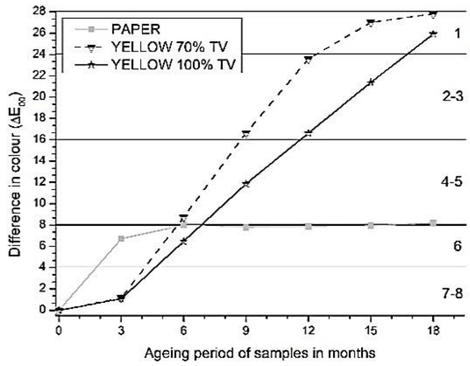

Figure 2: Colour difference diagram of dark tones

The colour difference of the 70% TV patch increases almost linearly from the third month until the end of the experiment. The most pronounced linearity is observed between the third and twelfth month. After six months of ageing, the colour difference is ΔE_{6m} = 8.73, placing the imprint in the range of fair lightfastness. After nine months, the imprint shifts into the category of poor lightfastness with ΔE_{9m} = 16.63, and ΔE_{12m} = 23.58. After fifteen months, the imprints are in the category of very poor lightfastness (ΔE_{15m} = 27.01). The colour difference after eighteen months is ΔE_{18m} = 27.81. This is also the highest recorded colour difference in this experiment. As the value exceeds 24, the print is considered unstable.

For solid patch, the trend is almost identical, with even more pronounced linearity. A clearly linear progression in colour change is observed from the third month, starting with a recorded value of ΔE_{3m} = 1.08. The colour difference after six month is ΔE_{6m} = 6.47, with an average increase of 4.86 every three months. The final colour difference after eighteen months is ΔE_{18m} = 25.92. This consistent linearity results in a gradual decline in lightfastness rating – from excellent to very good, fair, poor, and eventually very poor. It is assumed that with continued ageing, the colour difference would continue to increase.

Changes in chromaticity

Chromatic changes become particularly relevant when a more detailed analysis of colour changes is required. Figure 3 illustrates the deviations in the chromaticity for both the paper and yellow tones. The analysis of the chromaticity shift in the paper shows that during the first three months, a change occurs with an average value of $\Delta C_{0\text{-}3m} = -6.56$. Following this period, the substrate exhibits a shift toward a yellow-red tone, with an average value of $\Delta C_{6\text{-}18m} = -7.29$ over the 6 to 18 months period.

The chromaticity change in the 10% TV patch is minimal, with an average value of $\Delta C_{6\text{-}18m} = -0.70$ over the period from 6 to 18 months. In the 20% TV patch, a sharp decrease in chromaticity change is observed compared to the 10% TV patch, with an average value of $\Delta C_{6\text{-}18m} = -7.38$ for the same period. Significantly greater changes are obtained in the 40% TV patch up to the ninth month, when the chromaticity change reaches $\Delta C_{9m} = -15.23$. After that, the values remain nearly constant, with the average $\Delta C_{9\text{-}18m} = -15.00$.

For the 70% TV patch, chromaticity changes steadily increase until the twelfth month, reaching a recorded value of $\Delta C_{12m} = -21.99$. After this point, the changes stabilise, and the average value of $\Delta C_{12\text{-}18m} = -21.94$. The colour solid patch shows a linear increase in chromaticity change, wih an average change of 4.97 per three-month period. Specifically, the chromaticity change after three months is $\Delta C_{3m} = -1.01$, and after eighteen months, it reaches $\Delta C_{18m} = -24.91$. It is assumed that the change would continue to increase with further ageing.

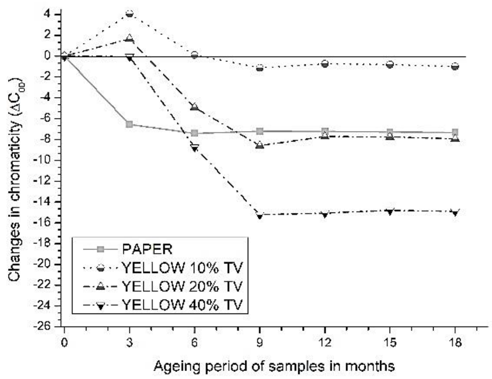

Figure 3: Diagram of changes in chromaticity of light and mid-tones

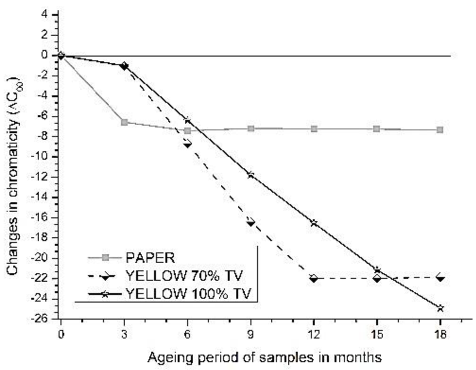

Figure 4: Diagram of changes in chromaticity of dark tones

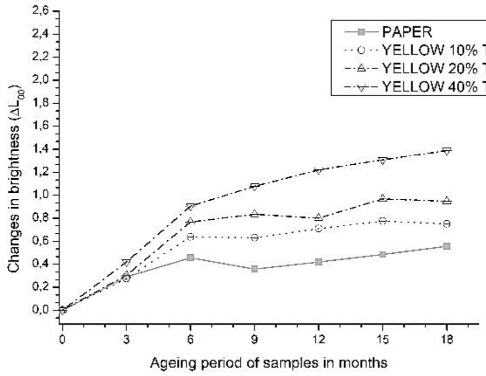

Figure 5: Diagram of changes in brightness of light and mid-tones

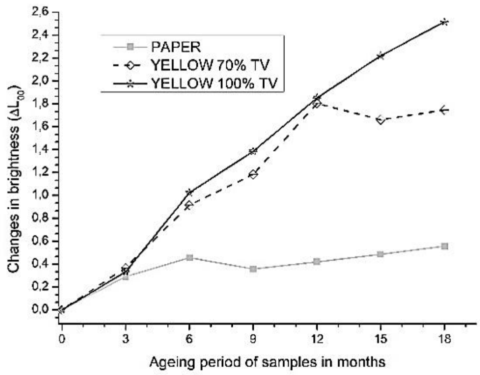

Figure 6: Diagram of changes in brightness of dark tones

Changes in brightness

The analysis of the brightness changes reveals that paper substrate exhibits smaller variations in brightness compared to the yellow tone patches. Brightness increases until the sixth month, reaching a value of $\Delta L_{6m} = 0.46$. After this period, only slight variations are observed, with the average brightness change between 6 and 18 months being $\Delta L_{6\text{-}18m} = 0.46$.

Regarding the yellow tone patches, it is observed that all light yellow tones show an increase in brightness (Fig. 5). The 10% TV yellow patch exhibits the greatest change in brightness at the sixth month, with a difference of $\Delta L_{6m} = 0.64$.

Following this, only mild variations occur, with an average brightness change of $\Delta L_{6\text{-}18m} = 0.71$. A very similar trend is observeed in the 20% TV yellow patch, where the brightness change after six months is $\Delta L_{6m} = 0.77$, and the average brightness change for the period from 6 to 18 months is $\Delta L_{6\text{-}18m} = 0.87$.

The medium yellow tone patch (40% TV) shows a clear increase in brightness as the ageing process progresses. After six months, the brightness change is $\Delta L_{6m} = 0.90$, and the values continue to rise until the 18th month, reaching $\Delta L_{18m} = 1.39$. Since the values consistently increase without signs of stabilisation, it is assumed that the brightness change will continue to rise with further ageing.

Larger changes in brightness were observed in the dark tonal patches – 70% TV and solid patch (Fig. 6). In the 70% TV patch, brightness increases up to the twelfth month, reaching $\Delta L_{12m} = 1.80$. After that, brightness slightly decreases and stabilises during the period from 15 to 18 months. The average brightness change for the period from 6 to 18 months is $\Delta L_{6\text{-}18m} = 1.18$.

The solid patch is characterised by an almost linear increase in brightness. After six months of ageing, the brightness change is $\Delta L_{6m} = 1.02$. The maximum brightness change is recorded after 18 months, with $\Delta L_{18m} = 2.52$, and the average change for the period from 6 to 18 months is $\Delta L_{6\text{-}18m} = 1.80$. It is assumed that this value will continue to increase with a further ageing.

CONCLUSION

This study is based on the research of the lightfastness of a new inkjet yellow water-based ink. The research was conducted through the analysis of colour differences, as well as changes in chromaticity and brightness of tone patches with 10% TV, 20% TV, 40% TV, 70% TV, and 100% TV coverage. The changes were induced using a Solarbox accelerated aging chamber and evaluated spectrophotometrically.

The obtained results indicate that the impact of light on yellow tone patches is significant. As the surface coverage increases, the colour difference also increases, with the 10% TV patch showing the smallest colour change, while the 70% TV patch recording the greatest colour difference, even higher than the solid patch. Furthermore, the paper substrate influenced the yellow tone patches through its own chromatic alterations, primarily due to the fading of optical brighteners.

A more detailed analysis reveals that chromaticity changes are the primary contributor to colour instability, especially in darker tonal patches. Brightness changes were present but to a lesser extent. The results demonstrate that yellow tone patches rapidly alter their initial colourimetric properties, indicating their instability over time when exposed to light.

It was concluded that the primary cause of fading in the yellow tone patches is the photodegradation of organic pigments under prolonged exposure to light, particularly ultraviolet radiation. This degradation is more pronounced in tonal patches with higher pigment concentrations, suggesting a strong correlation between tone value and light sensitivity. The anomalous behavior observed in the 70% TV patch, which showed greater changes than the solid patch, may be due to nonlinear interactions between ink layer thickness, pigment density, and paper absorption characteristics.

Since the substrate itself undergoes significant changes, its influence on the perceived fading of the imprint is substantial and must be considered in practical applications. The interaction between pigment and substrate plays a key role in overall print stability.

It is therefore recommended to avoid the use of this type of yellow ink in applications where long-term colour stability is critical. Instead, its use should be limited to products with lower durability requirements and simpler colour compositions.

To further broaden the current knowledge, future research should explore different printing substrates, protective varnishes, and analyse secondary and tertiary colours involving yellow. Additionally, identifying the chemical structure of pigments through analytical methods could provide a deeper understanding of their degradation behaviour and support improvements in ink formulation.

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