

Comparative Print Quality Analysis Of Conventional And Bio-Based Inks Using Offset Printing Process

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The primary aim of this study is to explore various quality control criteria for evaluating the print quality of bio-based and conventional inks used in offset printing. The research involves printing test samples using both ink types on a standard quality control master test chart. Parameters such as solid ink density, dot gain, print contrast, greyness, and colour difference data are compared. The findings of this study reveal that bio-based inks exhibit different absorption and drying characteristics compared to conventional inks, affecting their overall print performance. While bio-based inks offer environmental benefits, challenges such as reduced ink density and contrast require optimization for commercial printing applications.

KEYWORDS: Bio-based Inks, Conventional Inks, Solid Ink Density, Print Contrast, Offset Printing, Print Quality

INTRODUCTION

Offset printing remains a widely used technology in commercial print production. It operates based on the repulsion between inks and water. The printing plate selectively attracts ink in image areas while rejecting it in non-image areas, ensuring precise transfer onto paper via a rubber blanket. Ink formulation plays a critical role in determining print quality. Bio-based inks, derived from renewable sources, present an eco-friendly alternative to conventional petroleum-based inks but exhibit different rheological properties that influence printing performance (Patel, 2019).

Print quality in offset printing is determined by various parameters that influence the final appearance and readability of printed materials. Solid Ink Density (SID) measures the optical density of the printed ink, affecting color richness and vibrancy. Print Contrast determines the ability to maintain differentiation between solid ink and shadow tones, essential for image depth and readability. Dot Gain refers to the unintentional spread of ink, which can blur fine details and affect color accuracy. Gray Balance ensures neutral grey tones without unwanted color shifts, maintaining color fidelity in images. These parameters collectively play a vital role in assessing the print performance of bio-based and conventional inks, as their unique

formulations impact absorption, spreading, and drying characteristics on different substrates (Sharma, 2018).

RESEARCH OBJECTIVES

The primary objective of this study is to evaluate the print quality differences between bio-based and conventional inks in offset printing. This research aims to identify key quality control parameters, such as solid ink density, dot gain, print contrast, and gray balance, which influence ink performance on different paper substrates. By comparing these metrics, the study seeks to provide insights into the feasibility of using bio-based inks for commercial printing applications and recommend potential improvements to optimize their printability.

- To analyse print quality factors related to bio-based and conventional inks in offset printing.
- To identify quality control parameters influencing ink performance on different paper substrates.
- To compare print quality metrics, including ink density, dot gain, print contrast and readability.

RESEARCH METHODOLOGY

The research follows a systematic approach to evaluate print quality using bio-based and conventional inks in offset printing. A Six-colour sheet-fed offset press is used for printing test samples under controlled conditions. The study involves printing on art gloss coated paper, maintaining consistency in variables such as ink viscosity, roller pressure, and printing speed. A standard quality control master test chart is employed, containing solid patches, halftones, and gray balance scales to assess print attributes accurately. The printed samples undergo detailed evaluation using a densitometer for solid ink density and print contrast, a spectrophotometer for colour measurements, and for dot gain analysis. The research also considers drying time, ink adhesion, and overall visual consistency to determine ink performance. The findings from these evaluations contribute to optimizing bio-based ink formulations for commercial offset printing applications.

The study is conducted in a Quality Control laboratory using a test form with standardized text, images, and quality control patches. A six-color offset press is utilized to evaluate print quality on coated and uncoated papers. The data presented in this study corresponds to coated paper, unless otherwise specified. Surface characteristics of printed samples are analyzed using a densitometer and spectrophotometer.

DATA COLLECTION AND ANALYSIS

To evaluate the print performance of bio-based and conventional inks, various print quality parameters were measured. The data collected includes solid ink density, print contrast, dot gain, and gray balance. The following tables present the comparative analysis of these parameters, highlighting differences in ink performance. The results are further illustrated with

corresponding graphs to provide a visual representation of variations between bio-based and conventional inks.

Table 1. Solid Ink Density of Bio-based and Conventional Inks on Art Gloss paper

Ink Type	Cyan	Magenta	Yellow	Black
Bio-based Ink	1.13	1.22	0.95	1.61
Conventional Ink	1.18	1.27	0.98	1.66

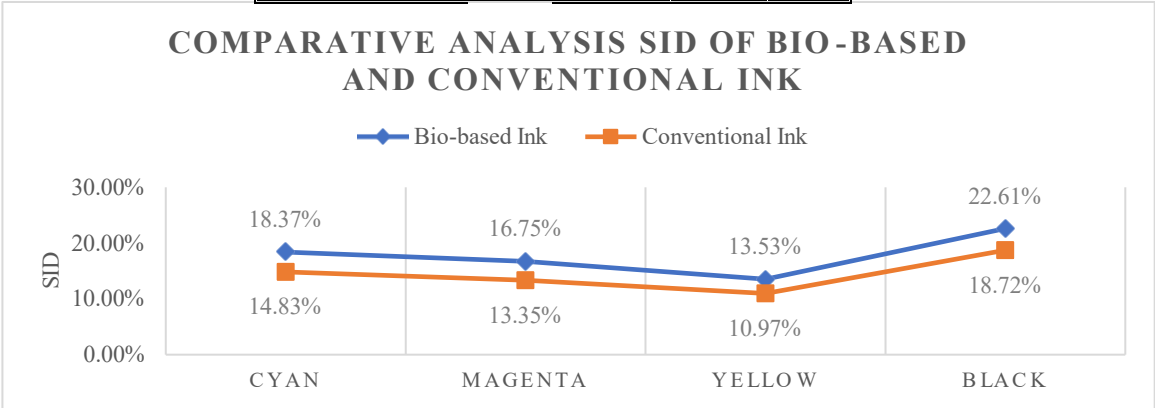


Fig. 1, Comparative Analysis Solid Ink Density of Bio-based and Conventional Ink on Art Gloss Paper.

Table 1 presents the solid ink density (SID) values on art gloss paper using bio-based and conventional inks for cyan, magenta, yellow, and black inks using bio-based and conventional inks. The results indicate that bio-based inks generally have lower SID values compared to conventional inks, leading to reduced color vibrancy and density. Bio-base have maximum value 1.61 on black and lowest value 0.95 on yellow on the other side conventional ink have highest vale on black (1.66) and lowest 0.98 on yellow.

Table 2. Print Contrast Comparison Between Bio-based and Conventional Inks on Art Gloss paper

Ink Type	Cyan	Magenta	Yellow	Black
Bio-based Ink	31.61%	32.35%	30.88%	26.52%
Conventional Ink	28.83%	27.77%	23.16%	20.85%

Table 2 compares the print contrast of bio-based and conventional inks across different colors on art gloss paper. Print contrast is essential for maintaining tonal depth and image clarity. The data shows that conventional inks exhibit lower print contrast, particularly in darker shades, which may impact readability and print sharpness. Highest print contrast value shows 32.35% in magenta in case of bio-based ink, on the other hand the highest value on cyan (28.82%) in case of conventional ink.

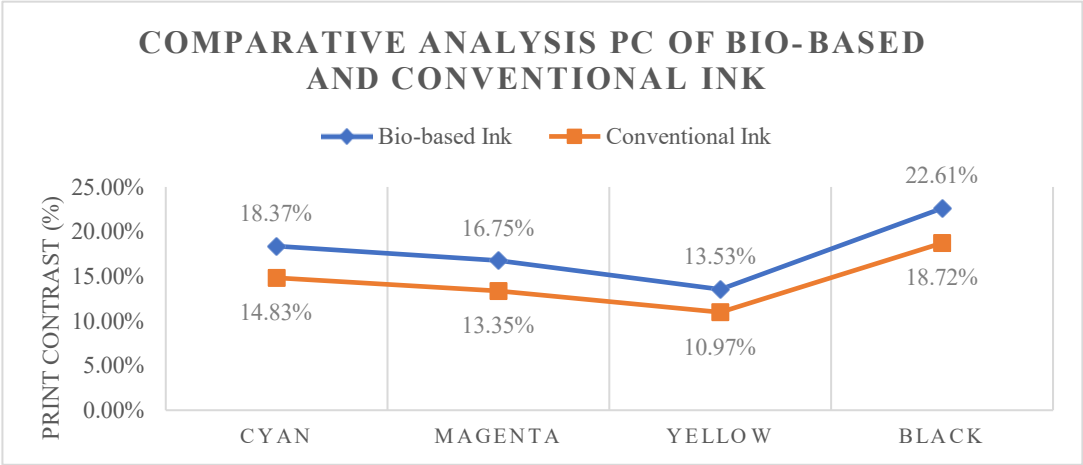


Fig. 2, Comparative Analysis Print Contrast of Bio-based Ans Conventional Ink on Art Gloss Paper.

Table 3. Dot Gain Comparison Between Bio-based and Conventional Inks Art Gloss paper

Ink Type	Cyan	Magenta	Yellow	Black
Bio-based Ink	18.37%	16.75%	13.53%	22.61%
Conventional Ink	14.83%	13.35%	10.97%	18.72%

Table 3 illustrates the dot gain levels of bio-based and conventional inks for cyan, magenta, yellow, and black on art gloss paper. Higher dot gain in bio-based inks suggests more ink spread, which can lead to loss of fine detail and less precise color reproduction. Conventional inks maintain a more controlled dot gain, ensuring sharper image quality. Highest dot gain value 22.62% at the black in case of bio-based ink and the lowest value shows on yellow (10.97%) in case of conventional ink.

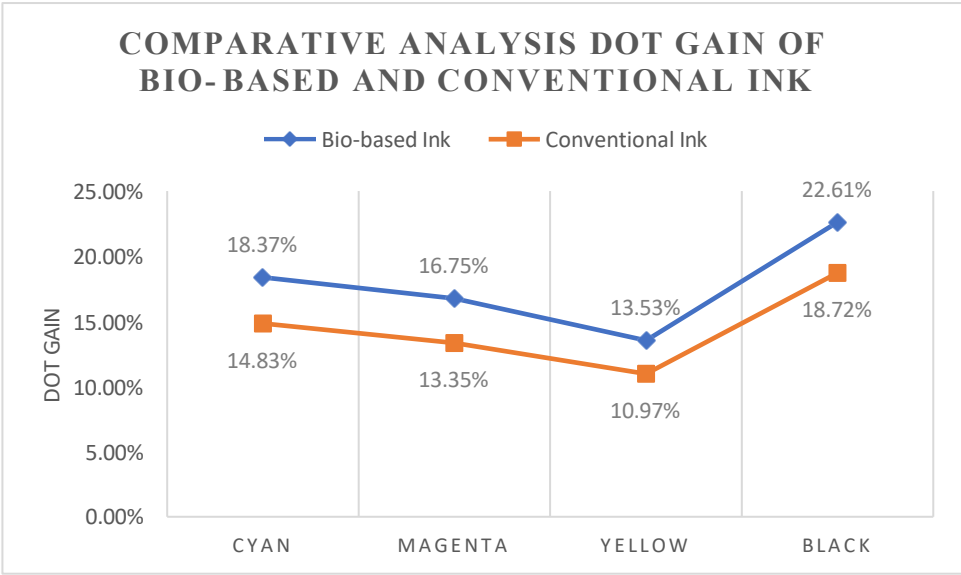
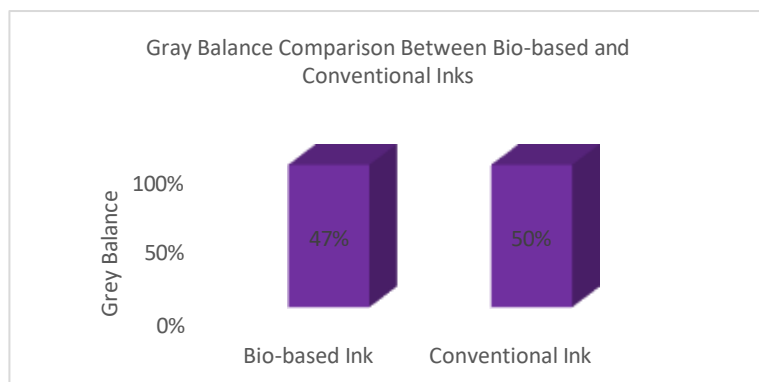


Fig. 3, Comparative Analysis Dot Gain of Bio-based Ans Conventional Ink on Art Gloss Paper.

Table 4. Gray Balance Comparison Between Bio-based and Conventional Inks on Art Gloss Paper

Ink Type	CMY Combination (%)
Bio-based Ink	47%
Conventional Ink	50%

Table 4 compares the gray balance performance of bio-based and conventional inks on art gloss paper. A balanced gray tone ensures accurate color reproduction without unwanted color shifts. The results suggest that bio-based inks slightly deviate from the ideal gray balance, requiring further calibration for neutral color accuracy.



RESULTS AND DISCUSSION

1. **Solid Ink Density Analysis:** Bio-based inks exhibit lower solid ink density due to their different absorption characteristics, resulting in lighter print tones compared to conventional inks.
2. **Print Contrast Analysis:** Print contrast, crucial for readability, is slightly lower in conventional inks, indicating a need for ink formulation improvements.
3. **Dot Gain Analysis:** Bio-based inks show higher dot gain, affecting sharpness and color accuracy, necessitating adjustments in prepress settings.
4. **Gray Balance Analysis:** The gray balance of bio-based inks is slightly lower than that of conventional inks, requiring color management adjustments to achieve neutral grays.

CONCLUSION

1. Bio-based inks, while environmentally friendly, exhibit lower ink density than conventional inks.
2. Optimizing bio-based ink formulations can enhance their suitability for commercial offset printing.
3. Further studies are recommended to improve the stability and printability of bio-based inks in offset processes.

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