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# OPTIMIZATION OF PETAL INK PRODUCTION PROCEDURE FROM NATURAL FLOWERS

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**ABSTRACT**

Colour is a vital and vibrant ingredient of our existence, adding aesthetic and fascinating elements to our world. Natural inks, derived from flowers, offer an eco-friendly alternative to synthetic inks. An experiment conducted at Dr. YSRHU-Citrus Research Station, Tirupati, located in the Rayalaseema region of Andhra Pradesh, during the year 2022-2023, aimed to extract natural ink from different flower petals using various boiling durations. Among all the interventions, only two treatments, $T_{10}$ (Rose flowers boiled for 45 minutes) and $T_{35}$ (Clitoria petals boiled for 45 minutes), produced ink that could be used for writing. $T_{10}$, with L, a, b values of 40, 36, -4 and $T_{35}$, with L, a, b values of 53, -5 and -37, showed bright ink colour after writing on 70 GSM (Gram per Square Meter) paper according to the RHS colour chart, compared to 50 GSM paper. The colour of the ink after writing on 70 GSM paper received the highest overall acceptability score of 4.43 from consumers and the maximum benefit-cost ratio recorded was 3.33.

***Key words :*** Petal ink, Colour, Value added products, Natural ink, Eco-friendly.

## Introduction

Human life has always had a natural affection for flowers, but floral waste, consisting of 16% of total river pollutants, presents a significant environmental challenge (Samadhiya *et al.*, 2017). When compared to kitchen and other municipal waste, managing flower waste is more challenging. Repurposing floral waste into value added products helps in waste management and may generate income in a sustainable manner.

Colour is vital and vibrant ingredient of our existence, adding aesthetic and fascinating elements to our world. Natural inks, derived from flowers, offer an eco-friendly alternative to synthetic inks. These inks are non-toxic, non-allergenic, biodegradable and often have antimicrobial properties. They do not contain harmful chemicals or carcinogens and can be extracted using simple aqueous boiling. Natural flower inks facilitate artists to explore a rich palette inspired by nature, while also promoting environmental health by fusing tradition, sustainability, and creativity. Natural dyes or inks are becoming more and more popular due to their sustainability and biodegradability as interest in eco-friendly methods grows. The industry is seeing a resurgence of natural dyes, pigments, and inks due to rising living standards and environmental awareness.

## Materials and Methods

The present investigation was carried out at the AICRP on Fruits, Dr. YSRHU- Citrus Research Station, Tirupati, which is situated in the Rayalaseema region of Andhra Pradesh during the years 2022-2024. It was located at an elevation of 162 metres above mean sea level (MSL), $13^0$ 65′ North latitude and $79^0$ 42′ East longitude. The experiment was laid out in Factorial completely randomized design replicated twice with 2 factors. Factor one having 7 levels of flowers (yellow chrysanthemum, red rose, orange marigold, white tuberose, pink lotus, purple orchids, blue clitoria and factor two with 5 levels of boiling durations (10, 15, 20, 30 and 45 minutes). Observations were recorded and data analysed by using OPSTST software.

**Procedure for petal ink preparation**

The flowers were procured from temples, function halls, home gardens and flower markets. The petals were separated from the flower heads and 250 grams of petals were weighed and added to 1000 ml of water. The mixture was then heated on an induction stove set to 14 watts under pressure cooker mode. The bowl was closed with a lid, and the material was stirred with a spoon to avoid blackness and ensure complete, even extraction from the flower petals. After boiling for the specified duration, the petals were removed by squeezing and the extract was strained using a strainer, muslin cloth, and filter paper. The extract was measured and natural preservative was added. The cooled extract was stored in glass bottles at room temperature. The inks were then poured into a manual ball pen ink filling machine and 0.5 ml of ink was filled into each ballpoint pen. The pen tips were placed using a tip-fitting machine, and the ink-filled pens were centrifuged for 1 minute. Finally, the pens were capped and used for writing.

**Observations recorded**

**Colour intensity of dye (petal ink) extract**

Colour intensity of the various flower inks was measured in hunter colour flex calorimeter in the form of L, a, b, values.

The colour intensity is decided based on their respective L, [L: Lightness, ranging from 0 (black) to 100 (white). Higher values indicate lighter colours, while lower values indicate darker colours], a (a: Red-green axis, where positive values indicate redness and negative values indicate greenness), b (b: Yellow-blue axis, where positive values indicate yellowness and negative values indicate blueness) values representation.

**Colour of the ink extract after writing on the paper (50 and 70 GSM Paper)**

Ink-filled ballpoint pens were used to write on 50 GSM and 70 GSM paper to determine the colour using the RHS (CIE Lab D65/10$^0$) colour chart values.

**Overall acceptance by consumer for ink on paper**

Displayed the written papers and took overall acceptance from five judges using a 5-point scale (4.5 to 5 Excellent, 3.0 to 4.4 Good, 2.0-2.9 Fair, 1-1.9 Average, 0-0.9 Poor).

**Benefit cost ratio**

Flower ink filled in pens (Value-added product) costs incurred will be assessed economically and commercially. The profitability of natural ink pens was examined on the basis of gross returns and net benefit was estimated calculating B:C ratio. The following formulae were used to work out B:C ratio.

Net returns = Gross returns – Total expenditure

Benefit Cost ratio = Gross returns / Total expenditure

## Results and Discussion

**Colour intensity of dye extract**

The hunter colour flex colorimeter values for colour intensity of ink extract were furnished in Table 1 and

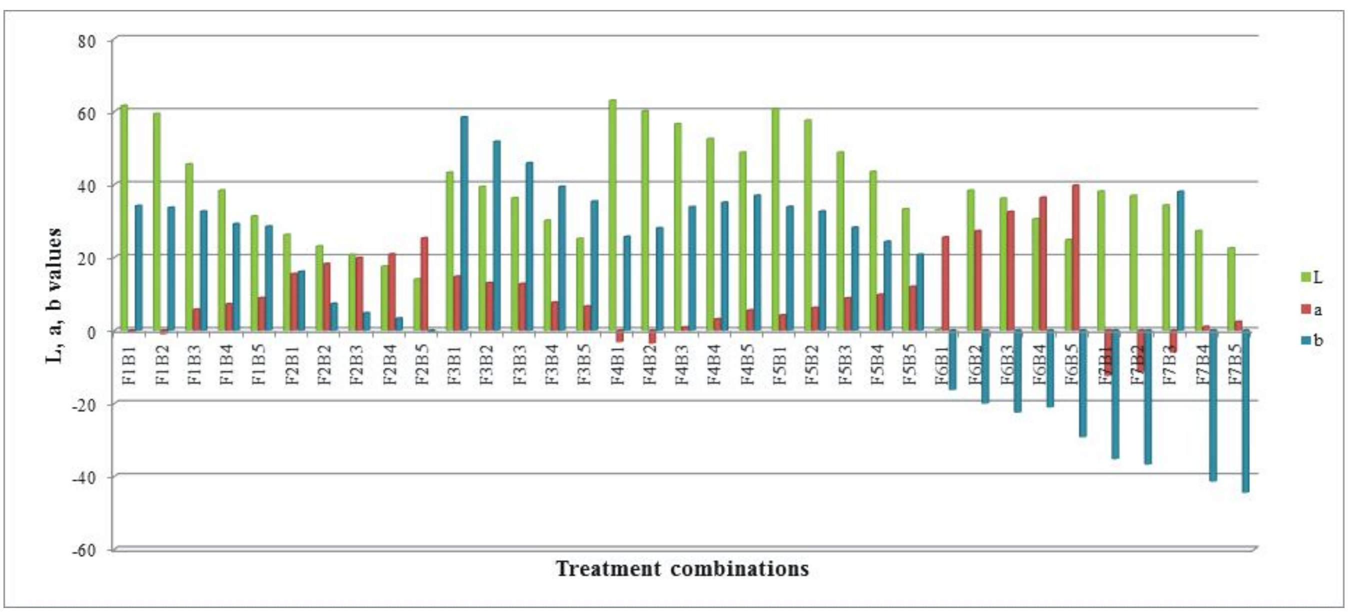


**Fig. 1 :** Influence of different dye extracts at various boiling times on colour intensity. $F_1$-Chrysanthemum, $F_2$-Rose, $F_3$-Marigold, $F_4$-Tuberose, $F_5$-Lotus, $F_6$-Orchids, $F_7$-Clitoria; $B_1$= 10 minutes, $B_2$= 15 minutes, $B_3$= 20 minutes, $B_4$= 30 minutes, $B_5$= 45 minutes.

**Table 1 :** Influence of different dye extracts at various boiling times on colour intensity.

| Flowers (F) | Boiling time (B) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | | | | | | a* | | | | | | b* | | | | | |
| | $B_1$ | $B_2$ | $B_3$ | $B_4$ | $B_5$ | Mean | $B_1$ | $B_2$ | $B_3$ | $B_4$ | $B_5$ | Mean | $B_1$ | $B_2$ | $B_3$ | $B_4$ | $B_5$ | Mean |
| $F_1$ | 61.58 | 59.35 | 45.55 | 38.38 | 31.30 | 47.23 | -0.67 | -1.00 | 5.72 | 7.24 | 8.90 | 4.71 | 34.12 | 33.65 | 32.62 | 29.18 | 28.48 | 31.61 |
| $F_2$ | 26.21 | 23.06 | 20.77 | 17.53 | 14.03 | 20.32 | 15.48 | 18.23 | 19.87 | 20.90 | 25.29 | 19.95 | 16.09 | 7.33 | 4.76 | 3.30 | -0.62 | 6.42 |
| $F_3$ | 43.25 | 39.35 | 36.27 | 30.11 | 25.11 | 34.82 | 14.75 | 13.04 | 12.77 | 7.66 | 6.61 | 10.97 | 58.42 | 51.71 | 45.86 | 39.35 | 35.35 | 46.14 |
| $F_4$ | 62.96 | 60.06 | 56.54 | 52.48 | 48.75 | 56.16 | -3.18 | -3.56 | 0.86 | 3.09 | 5.52 | 3.24 | 25.67 | 28.02 | 33.82 | 35.05 | 36.94 | 31.90 |
| $F_5$ | 60.74 | 57.54 | 48.77 | 43.48 | 33.24 | 48.75 | 4.17 | 6.22 | 8.83 | 9.79 | 11.99 | 8.20 | 33.88 | 32.63 | 28.21 | 24.34 | 20.80 | 27.97 |
| $F_6$ | 40.11 | 38.34 | 36.17 | 30.35 | 24.79 | 33.95 | 25.52 | 27.24 | 32.51 | 36.41 | 39.70 | 32.28 | -16.28 | -20.00 | -22.47 | -21.05 | -29.22 | 21.80 |
| $F_7$ | 38.08 | 36.90 | 34.27 | 27.24 | 22.51 | 31.80 | -12.42 | -11.37 | -6.00 | 1.00 | 2.40 | 6.64 | -35.21 | -36.69 | -38.00 | -41.36 | -44.43 | 39.13 |
| Mean | 47.56 | 44.94 | 39.76 | 34.22 | 28.53 | | 10.88 | 11.52 | 12.37 | 12.30 | 14.34 | | 31.38 | 30.00 | 29.39 | 27.66 | 27.98 | |
| Comparing Means | | SEm(±) | | | CD @5% | | | SEm(±) | | | CD @5% | | | SEm(±) | | | CD @5% | |
| Flowers (F) | | 0.104 | | | 0.299 | | | 0.025 | | | 0.073 | | | 0.036 | | | 0.103 | |
| Boiling time (B) | | 0.088 | | | 0.252 | | | 0.022 | | | 0.062 | | | 0.030 | | | 0.087 | |
| F × B | | 0.232 | | | 0.668 | | | 0.057 | | | 0.164 | | | 0.080 | | | 0.231 | |

$F_1$-Chrysanthemum, $F_2$-Rose, $F_3$-Marigold, $F_4$-Tuberose, $F_5$-Lotus, $F_6$-Orchids, $F_7$-Clitoria; $B_1$ = 10 minutes, $B_2$ = 15 minutes, $B_3$ = 20 minutes, $B_4$ = 30 minutes, $B_5$ = 45 minutes. (L=0 Dark; L=100 Light), (+a=Red; -a= Green), (+b=Yellow; -b=Blue).

illustrated in Fig. 1.

The hunter colour flex colorimeter values (L, a*, b*) used to examine the colour intensity of the dye extracts were significantly different. The data were furnished in Table 1, Fig. 1 and Plate 1.

The colour intensity is decided based on their respective L values - L: Lightness, ranging from 0 (black/ dark shade) to 100 (white/ light shade). Higher values indicate lighter colour shades, while lower values indicate darker colour shades. A*: Red-green axis, where positive values indicate redness and negative values indicate greenness, b*: Yellow-blue axis, where positive values indicate yellowness and negative values indicate blueness.

Dye extracts were prepared from different flowers showed a colour (L, a*, b*) values when placed under a hunter flex colorimeter. $F_1$: yellow chrysanthemum (28.48 to 34.12), $F_3$: orange marigold (The dye extracted from the orange marigold resulted yellow colour, 35.35 to 58.42) and $F_4$: tuberose (25.67 to 36.94) recorded positive b* values which indicated yellow colour at different boiling durations. Positive a* value was observed in $F_2$: red rose (15.48 to 25.29).

The dye extracted from the $F_5$: pink lotus resulted yellow-orange to light brown colour, the value lie on +a (4.17 to 11.99) and +b (20.80 to 33.88), $F_6$: purple orchids ink range from +a (25.52 to 39.70) and -b (-16.28 to -29.22) and $F_7$ :blue clitoria showed blue colour, resulted -b value ranging from -35.21 to -44.43. All the dye colours on a* and b* co-ordinate values indicated the intensity of the colour along with L value, which varied differently among the flowers depending on the boiling time.

Here, the L value represents a* and b* values colour as lighter or darker (dye extract) so, considering this make a significant difference among different flowers lowest L value (dark shade) was showed in $F_2$ (Rose, 20.32) and highest (light shade) was recorded in tuberose ($F_4$, 56.16). Between the boiling times which

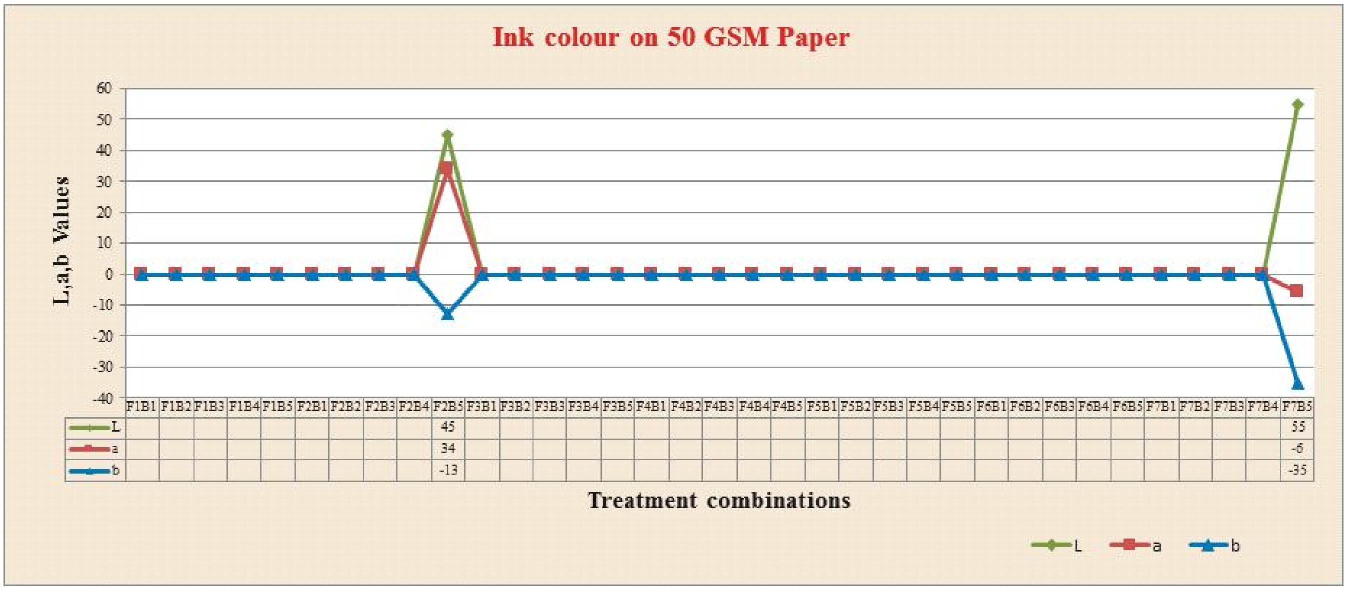


**Fig. 2 (a) :** Influence of different petals at various boiling times on colour of the inksafter writing on the 50 GSM paper. $F_1$-Chrysanthemum, $F_2$-Rose, $F_3$-Marigold, $F_4$-Tuberose, $F_5$-Lotus, $F_6$-Orchids, $F_7$-Clitoria; $B_1$= 10 minutes, $B_2$= 15minutes, $B_3$= 20minutes, $B_4$= 30minutes, $B_5$= 45minutes.

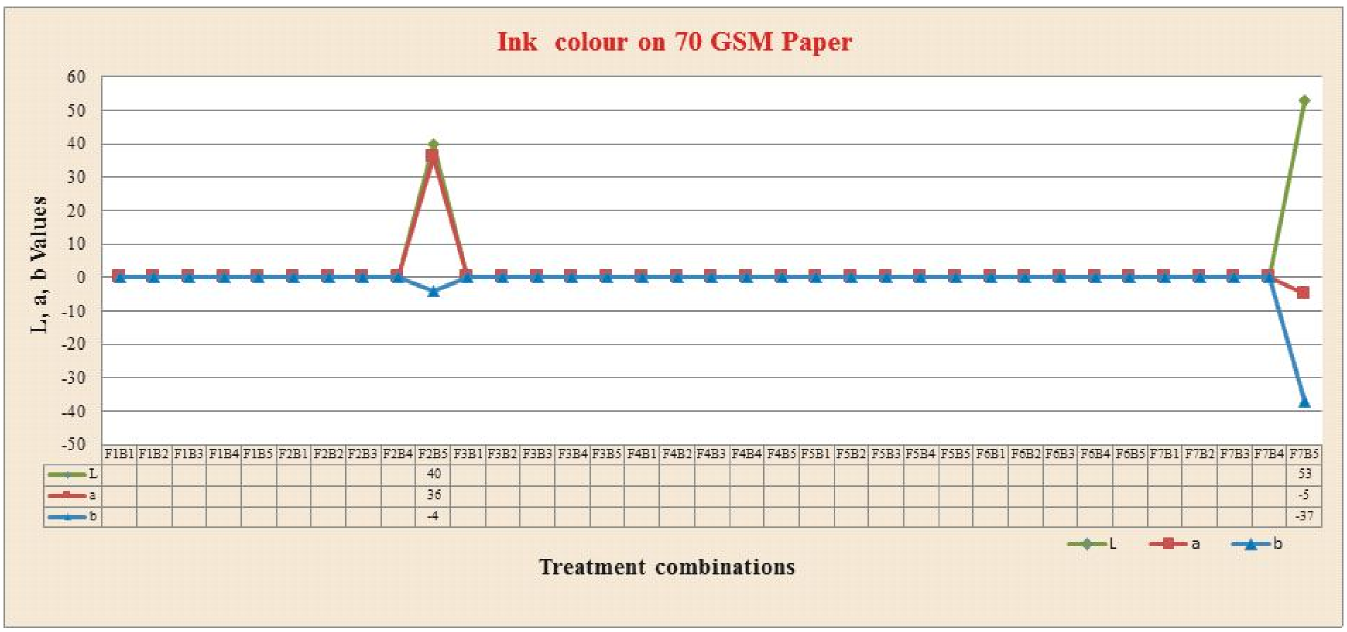


**Fig. 2 (b) :** Influence of different petals at various boiling times on colour of the inksafter writing on the 70 GSM paper. $F_1$-Chrysanthemum, $F_2$-Rose, $F_3$-Marigold, $F_4$-Tuberose, $F_5$-Lotus, $F_6$-Orchids, $F_7$-Clitoria; $B_1$= 10minutes, $B_2$= 15minutes, $B_3$= 20minutes, $B_4$= 30minutes, $B_5$= 45minutes.

showed lowest L value (dark shade) of 28.53 when boiled for 45 minutes ($B_5$), it was followed by 30 minutes ($B_4$) with 34.22 and highest L value (light shade) of 47.56 was observed in 10 minutes of boiling period ($B_1$). With increase in boiling period the L value changed and represented darker shade.

Interaction effect of colour intensity among all the treatments showed significant difference. Lowest L value (dark shade) of 14.03 was recorded in rose petals with 45 minutes ($F_2B_5$) of boiling period, it was followed by clitoria petals boiled for 45 minutes ($F_7B_5$, 22.51) and highest L value (light shade) of 62.96 was observed in tuberose petals with 10 minutes of boiling period ($F_4B_1$).

From the above results, as the boiling time increased the colour intensity (lowest L values) of the dye extract escalated and it was also in correlation with the dye/ink consistency with respect to their co-ordinating a* and b* colour values so, it can be interpreted that boiling period and flower dye colour were equally important to get the better shade of the ink.

**Plate 1 :** Inks prepared from different flower petals at various boiling times.

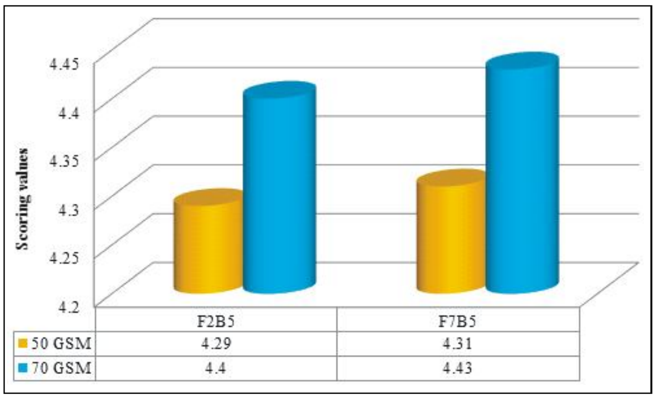


**Fig. 3 :** Impact of different petal inks on overall acceptability of written papers (50 and 70 GSM paper). $F_2$-Rose, $F_7$-Clitoria; $B_5$= 45 minutes.

The results revealed that, the lowest L (dark shade) value for petal ink colour was recorded on 70 GSM paper in both ($T_{10}$ and $T_{35}$) the treatment combinations when compared to 50 GSM paper with respect to their corresponded maximum +a (red for $T_{10}$) and -b (blue for $T_{35}$) values. This might be due to the quality of the written paper.

### Overall acceptance by consumer for ink on paper

Among all the 35 treatment combinations, ink from only two treatment combinations *i.e.*, $T_{10}$ and $T_{35}$ has functioned on both 50 and 70 GSM papers and data was outlined in Fig. 3.

Overall acceptability score of $T_{10}$ (Rose petals for 45 minutes boiling) was 4.29 and 4.31 on 50 and 70GSM papers, respectively. $T_{35}$ (Clitoria petals for 45 minutes boiling) recorded the overall acceptability score of 4.40 on 50 GSM and 4.43 on 70 GSM paper.

The score indicated from above results, the clitoria petals boiled for 45 minutes was recorded highest score on overall acceptability for both (50 and 70 GSM) the papers. This may attributed due to visibility of ink colour might attract the viewers with good ink flow on the papers while writing.

### Benefit cost ratio

The data on economics of best (written pens) treatment combination of flowers and boiling time was calculated and presented in Table 2.

**Table 2 :** Economic analysis of best performed petal inks (for a sample of 1000ml ink *i.e*. 2000 pens).

| Treatment combinations | Yield of ink from 1kg petals (ml) | Raw material (Rs.) | Labour costs (Rs.) | Electricity charges (Rs.) | Total costs (Rs.) | Selling price of each pen (Rs.) | Gross income (Rs.) | Net returns | BC Ratio |
|---|---|---|---|---|---|---|---|---|---|
| $F_2B_5$ | 200 | 677 | 1100 | 123 | 1900 | 3 | 6000 | 4100 | 3.15 |
| $F_7B_5$ | 376.5 | 632 | 1100 | 68 | 1800 | 3 | 6000 | 4200 | 3.33 |

$F_2$-Rose; $F_7$-Clitoria; $B_5$= 45 minutes.
Note: Out of 35 treatment combinations only above two treatment combinations of ink extracts were able to use as ink for pens.

### Colour of the ink extract after writing on the paper (50 and 70 GSM paper)

Data illustrated in Fig. 2 (a) and 2 (b) indicates the L, a, b values of ink colour on 50 GSM and 70 GSM papers respectively. Functionality of the ink was observed only seen in two treatments ($T_{10}$ and $T_{35}$). The results graphically depicted the L, a, b values (RHS colour chart) of 50 GSM as 45, 34, -13 and 70 GSM as 40, 36, -4 for $T_{10}$. The L, a, b values of 50 GSM as 55, -6, -35 and 70 GSM as 53,-5, -37 for $T_{35}$ during the initial day of investigation.

Clitoria petals for 45 minutes of boiling period recorded highest (3.33) benefit cost ratio whereas, the rose petals for 45 minutes of boiling noticed benefit cost ratio of 3.15.

## Conclusion

The findings indicate that both clitoria and rose petals boiled for 45 minutes have the potential to produce functional ink as new source for writing on paper. This optimized procedure for aqueous extraction of petal ink presents a sustainable and eco-friendly alternative to synthetic inks. The process is ecologically safe, inexpensive and preferable for producing natural inks.

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