

Making Ink with Tea and Iron

Summary

Tea plants contain hundreds of compounds among which is a class of compounds called tannins, which give you the dark color you see in tea upon steeping. Historically, tannins extracted from oak galls were used for making ink by mixing them with iron compounds, such as iron(II) sulfate to form complex, water-soluble blue-black compounds. On standing, the complex becomes darker and insoluble, producing a permanent ink, called iron gall ink.¹ This ink has been used to write historic documents such as the Declaration of Independence. We will make this ink using both tea and iron.

Materials

1. Common orange pekoe teabags (2 per working group)
2. Iron(II) sulfate tablets (1 per working group) (available as a dietary supplement in pharmacies);
3. Teacups (or other suitable container – 2 per working group) (Note: It might be best to not use teacups in the actual activity so that students and children don't get the idea that one can use the same containers for experiments and food.)
4. Paintbrush and paper

Safety Suggestions

- Protective clothing suggested
- Caution hot liquids (Caution: with young children)
- Do not eat or drink any of the materials used in this activity
- Thoroughly wash hands after this activity

Procedure

Prep work: Prepare boiling water; take proper precautions when pouring it

Step	Teacup 1	Teacup 2	
A	Place teabag in cup and add boiling water $\frac{3}{4}$ way up; brew for 2 minutes	Place teabag in cup and add boiling water $\frac{3}{4}$ way up; brew for 2 minutes	
B	Remove teabag	Remove teabag	Observe & describe the color of the liquid in both cups
C		Add one iron(II) sulfate tablet to cup 2 and stir for 5 minutes	Observe & describe the color of the liquid in both cups
D		Paint an image or word on paper using the liquid in cup 2	Observe and describe
E		Wait about 20 minutes and observe and describe your artwork again	

Where's the chemistry?

Tannins contained in tea contain compounds that chemically react with iron in solution. A word equation for this reaction is

tannin + iron(II) → iron gall ink

More specifically, the tannin contains a compound called gallic acid which reacts thus:

gallic acid + iron(II) → gallatoiron(II) which oxidizes to bis(gallato)diiron(III) (iron gall ink)²

What did you see?

Step A: The teabags are steeping in the cups

Step B: The color of the liquids in both cups should be equal; the dark color is because the tannins in the tea have already reacted with some trace amounts of iron that were in the brewing water – this comes from the pipes and the water supply

Step C: Upon addition of the iron(II) sulfate to cup 2, a dark color appears – the additional iron makes the reaction produce more of the iron gall ink

Step D: The image painted should be a very light gray (not shown in photograph)

Step E: The image should have darkened with time and small grains of black precipitate should be seen.

Photographs



Step A



Step B



Step C



Step E

References

¹The Iron Gall Ink Website. https://irongallink.org/igi_index.html (accessed Feb. 21, 2019).

² Wilson, H. Analysis of the Current Research into the Chemistry of Iron Gall Ink and its Implications for Paper Conservation. Master's Thesis, St. Anne's College, Oxford, 2007; DOI: 10.13140/2.1.4803.2000.

Acknowledgment: The idea for this activity came from a post by Joe Schwarcz of the McGill Office for Science and Society, November 22, 2018. Schwarcz, J. Did you know there is ink in your tea? <https://mcgill.ca/oss/article/did-you-know/did-you-know-when-you-are-drinking-tea-you-are-also-drinking-some-ink>. (accessed February 21, 2019).

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