BS 192: Chemistry Lab Report
Experiment 2: Fingerprint detection using Ninhydrin

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Abstract* — *Ninhydrin is a well-known reagent used for detecting amino acids and latent fingerprints. This experiment explores its reaction with L-alanine and its application in forensic science. In the first part, ninhydrin reacts with L-alanine, producing Ruhemann's purple, a characteristic purple-colored complex that confirms the presence of amino acids. The second part involves using ninhydrin to detect latent fingerprints on different paper surfaces, including regular, filter, and blotting paper. The effectiveness of ninhydrin in visualizing fingerprints depends on the paper type and the presence of amino acid residues in sweat. The experiment demonstrates the practical application of ninhydrin in forensic fingerprint analysis and highlights factors that influence its effectiveness in different substrates.

Index Terms* - *Fingerprint Detection, Ninhydrin, L-Alanine, Ruhemann's Purple

I. Introduction

Finding and examining fingerprints is a key part of solving crimes, and ninhydrin is a handy chemical that helps with this. It reacts with natural oil on our skin and creates a purple colour known as Ruhemann's purple. This highlights fingerprints, which helps investigators see them clearly and even determine the amount of amino acids present in the sample. There are two steps to this experiment. We first mix ninhydrin with an amino acid named L-alanine, shake it and heat it until it becomes blue or purple. Then, we create fingerprints on various paper forms, apply ninhydrin, and heat them to see the purple prints. We compare them to fingerprints made with an ink pad.

This experiment will show that ninhydrin is good at revealing hidden fingerprints. It follows common forensic science practices and makes fingerprints easier to find.

Always follow general safety procedures while performing any experiments. Wear safety glasses, gloves, and a chemical-resistant apron to protect yourself from ninhydrin, as it is an irritant and biologically active reagent and will stain the skin. Limit your exposure to ninhydrin to reduce the risk of irritation or unwanted contact. Never use bare hands for any task and use forceps wherever possible. Ninhydrin is dissolved in an alcoholic solvent (flammable), so keep them away from flames or other dangerous areas. Wash all the apparatus carefully after the experiment is complete.

II. Materials and Methods

A. Materials Required

1) 25 mmol/L Ninhydrin solution in Methanol
2) 25 mmol/L L-Alanine solution
3) Two pieces of Blotting Paper
4) Two pieces of Filter Paper
5) Two pieces of Regular Paper
6) Aluminum Foil
7) Test Tubes
8) Dropper
9) Petri Dish
10) Hot Plate
11) Ink Pad
12) Forceps
13) Safety Glasses
14) Gloves

B. Methods

- Preparation of stock ninhydrin solution (250 ml of 100 mM ninhydrin solution)
  1) Calculate the number of moles of ninhydrin required to prepare 250 ml solution of 100 mM ninhydrin solution using the formula:

     n = M x V

     where n, M and V are the no. of moles of ninhydrin, the molarity of ninhydrin solution (here M = 100 mM) and the volume required (here V = 250 ml) respectively.
     Therefore, we need 25 mmol ninhydrin for the stock solution.
     Hence, 4.4535 g of ninhydrin is required. (using g = n x M_o where g, M_o are the required mass and molar mass of ninhydrin.)
  2) Weigh 4.4535 g ninhydrin on a weighing balance.
  3) Dissolve it in 20 ml of methanol in a volumetric flask.
  4) Add isopropyl alcohol to the same volumetric flask up to the 250 ml mark so that the final solution of ninhydrin, we get, is 250 ml.
  5) Now, we dilute it to 25mM by adding 1 ml of 100 mM ninhydrin solution to 3 ml isopropyl alcohol.

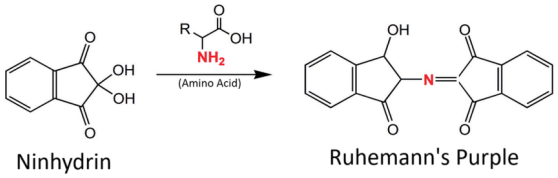

Fig. 1: Reaction of ninhydrin with amino acid

- Formation of Ruhemann's purple:
  1) Take 4 ml methanol solution of ninhydrin (25 mmol/L) and 2 ml L-alanine (25 mmol/L) solution, and mix them in a test tube. (2:1 ratio)
  2) Cover the test tube with aluminum foil.
  3) Shake the test tube carefully to start the reaction. A light blue color will appear, indicating the formation of Ruhemann's blue product.
  4) Heat the reaction mixture in a hot water bath to increase the speed of the reaction. The intensity of blue color increases upon heating.
- Fingerprint Detection:
  1) Take 2 ml of ninhydrin solution in a petri dish using a dropper.
  2) Make a set of fingerprints on a sheet of regular paper.
  3) Dip the paper in the petri dish containing the ninhydrin solution and allow it to soak for about one minute.
  4) Pick up the paper using forceps, drain the excess solution, and let it air dry using fanning motion.
  5) After air drying, hold the paper about 10 cm above the hot plate (at about 80°C) for 2-3 minutes to dry it completely. Do not burn the paper by holding it too close to the hold plate.
  6) Repeat steps 1 to 5 on for filter and blotting paper.
  7) Produce a corresponding fingerprint on a separate piece of paper using a water-soluble ink pad to use as the reference fingerprint.
  8) If the fingerprint produced on the regular, filter or blotting paper isn't clear enough, try to repeat steps 1 to 5 for that paper to get a better result and then use the best produced one.

III. Results

A. Formation of Ruhemann's purple

We obtained a bluish-purple solution in the test tube after mixing the methanol solution of ninhydrin and L-alanine, indicating the formation of Ruhemann's purple. The color intensified after being heated in a hot water bath. This indicates that the intensity of the color depends on the temperature of the reactants.

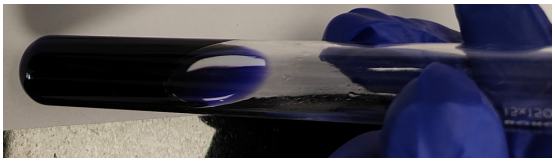

Fig. 2: Ruhemann's purple obtained on reacting ninhydrin and L-alanine

B. Fingerprint Detection

We obtained bluish-purple fingerprints after heating our papers. This indicates that our experiments were successful. We could also see that the level of detail and accuracy improved as we used finer and sharper papers. Regarding the color, experiments indicated that the intensity of blue color depended on the concentration of ninhydrin solution, the amount of sweat (amino acids) present on the individual's finger, the type of paper used and the amount of heating of the paper.

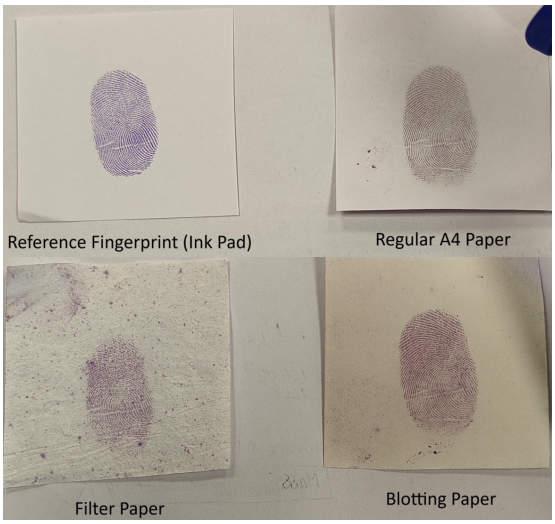

Fig. 3: Reference and detected fingerprints

IV. Conclusion

The result of these experiments is to show the ability of ninhydrin to react with amino acids to form a Ruhemann's purple colored product.

In the first part of the experiment, on heating, the pale blue mixture of ninhydrin and L-alanine intensifies the blue color, which concludes that we can confirm the presence of the amino acid in the compound by this.

In the second part of the experiment, the application of this principle in forensic science is demonstrated. This experiment shows the effectiveness of ninhydrin in detecting fingerprints on different types of paper by reacting with the amino acids in skin oils or sweat. On warming, the reaction produced visible purple-colored fingerprints (Ruhemann's purple). Blotting paper was more effective than regular paper (A4 sheet) due to its better absorption of the solution. Getting good results using the filter paper was challenging due to the uneven

surface causing difficulty in leaving a clean fingerprint on it. The difference between the fingerprints with ninhydrin and those made with ink highlights the specificity of ninhydrin the reaction to detecting the presence of amino acids. This experiment confirms its role in the identification of amino acids and the discovery of latent fingerprints.

V. Images of Readings

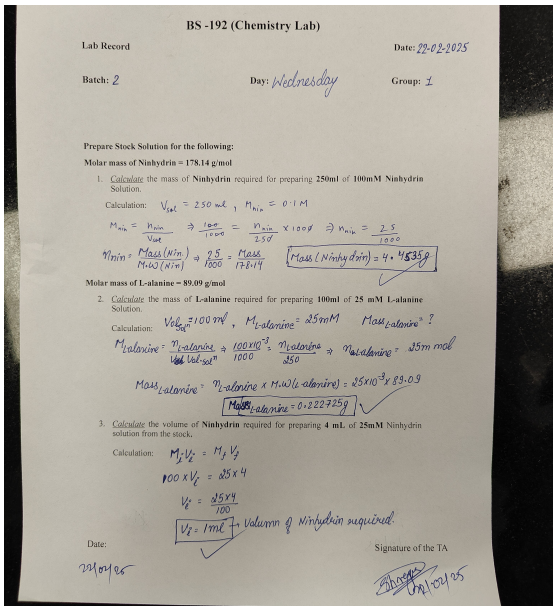

Fig. 4: Calculation Sheet Signed by TA

Fig. 4 shows the calculations required: We calculated the mass of ninhydrin and L-alanine required to prepare the stock ninhydrin solution and L-alanine solution respectively, and the volume of the stock ninhydrin solution required to dilute it.

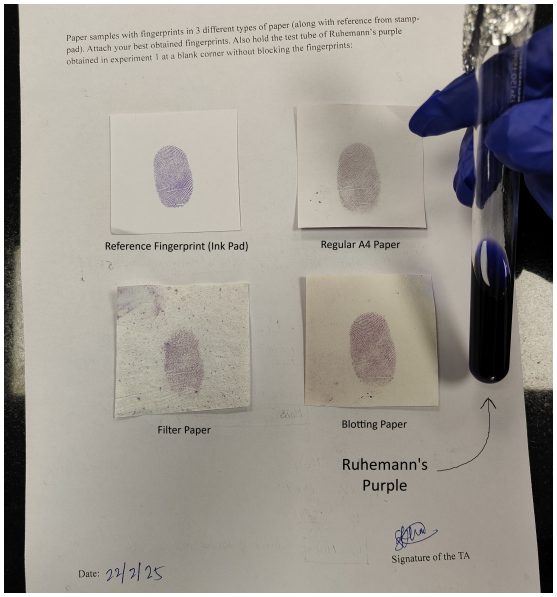

Fig. 5: Observation Sheet Signed by TA

Fig. 5 shows the reference fingerprint taken using an ink pad alongside the fingerprints obtained using ninhydrin on regular, filter, and blotting paper. It also shows the Ruhemann's purple obtained in a test tube on the right side.

VI. Author Contributions

1) Akshit Chhabra, 24110026
   - Performed the experiment and recorded the fingerprints on all the papers for fingerprint detection.
   - Completed the 'Abstract' and 'Author Contributions' sections and compiled, formatted the report on LaTeX.
2) Rayan Talukder, 24110294
   - Performed the experiment and helped conduct the reaction between ninhydrin and L-alanine and speed it up in the hot water bath.
   - Completed the 'Results' section.
3) Rhythem Soni, 24110296
   - Performed the experiment and assisted in detecting the fingerprints by pouring ninhydrin into the petri dish and air drying the paper samples.
   - Completed the 'Introduction' section and assisted in the 'Materials and Methods' section.
4) Rishi Soni, 24110297
   - Performed the experiment and assisted in detecting the fingerprints by heating them using the hot plate.
   - Completed the 'Conclusion' section.
5) Roshia Shweta, 24110304
   - Performed the experiment and prepared the stock ninhydrin solution.
   - Assisted in the 'Materials and Methods' section.

References

[1] BS 192 Chemistry Lab Manual