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Chemical Traps: Role Of Phenolphthalein in Anti-Corruption

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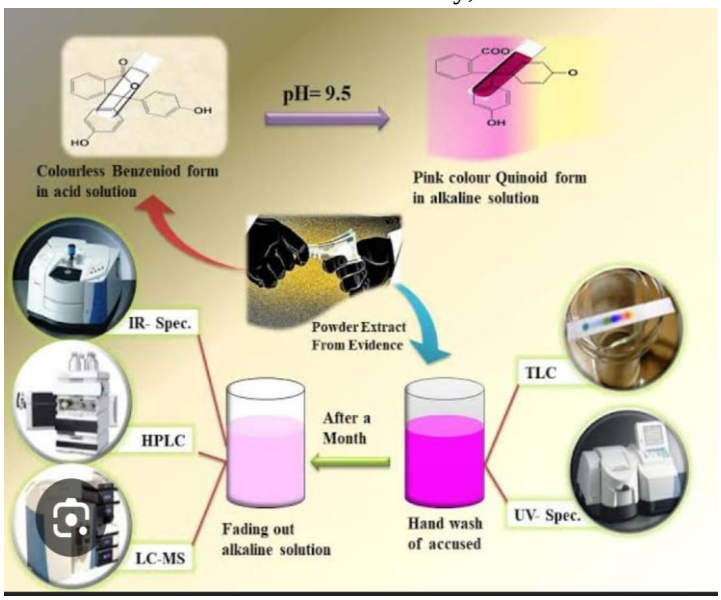
Abstract-

Phenolphthalein is causes dissociation to visualize the hue pink. It is a crucial component frequently employed in bribe trap investigations. Smeared on bank notes, private papers and other official documents, an alkaline hand wash containing phenolphthalein powder was the source of the pink hue. Numerous analytical techniques were used to ascertain its existence. Furthermore, a tiny quantity of hydroquinone was added to lessen this issue. Smeared phenolphthalein powder was collected by hand washing the suspected individual with Na2CO3 or KOH bases. The transferred evidence shreds were gathered from the accused's body, hand and clothing and they were sent to forensic science laboratories for additional analysis. TLC, IR, UV-Visible spectrophotometer, HPLC and LC-MS analytical methods were employed for analysis in this review paper. Our goal is to use a variety of analytical methods to determine whether phenolphthalein is present. When it comes to criminal bribery trap instances, that can help develop scientific evidence.

Introduction-

One legitimate field of forensic identification is the use of sophisticated and digital analytical techniques to investigate bribery crimes. The approach will raise awareness of advanced digital criminal detection techniques and forensic chemical science. Thus the chemical law enforcement agency's approach to introducing the concept and fundamental practice of trapping approaches. Smooth and white in appearance, phenolphthalein powder is typically applied in trace amounts on sensitive documents, banknotes and other items that are likely to come into touch with hands or clothing. Trace artifacts were cleaned with an alkaline solution like sodium carbonate or potassium hydroxide. The colourless solution displays a pink tint, indicating that the secret paper was touched. An alkaline solution was collected and forwarded to forensic labs for testing. Instrumental analysis and confirmative evaluation can be valuable evidence in court hearings. However, the alkaline solution began to fade after a few days or months, indicating a shift in equilibrium. The amount of phenolphthalein in an alkaline solution was determined by its strength. Both a higher H+ concentration or the breakdown of phenolphthalein into other colo0rless products, such as 2[4-hydroxy-benzoyl]-benzoic acid and phenol, which can be brought on by the action of alkaline, heat, light and oxygen in the air caused the equilibrium to shift to a backword reaction. Phenolphthalein produces a pink tint in alkaline solutions at low concentrations. This provides positive proof of the suspects contact with monetary notes. Bribe instances include the employment of a variety of tracing materials, including staining substances, fluorescent powder, chemical detector and radioactive indicator. The acids or weak bases indicator dissociated, causing the colour change. The colour of the dissociated form differs from that of the undissociated form of phenolphthalein. The weak acid indicator has minimal

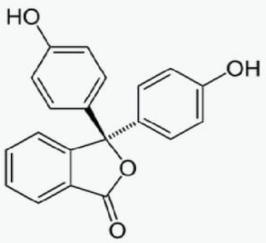
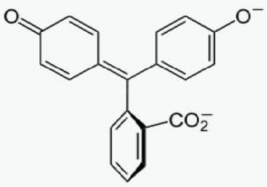
ionization in acids due to ubiquitous H+ ions, but is well ionized in alkalise. Similarly, if the indicator is a weak base, its ionization is high in acids and low in alkaline.



GRAPHICAL ABSTRACT

Chemistry of phenolphthalein-

Phenolphthalein in its undissociated condition appeared colourless, however as it dissociated, it took on a pink hue. Because there is a greater concentration of H+ ions in the acidic medium, equilibrium moves to the left. The solution would therefore continue to be colourless. By adding alkaline, the excess H+ ions were neutralized, forming a water molecule and shifting the equilibrium to the right. According to Yadav and Goutam's article, phenolphthalein can be found in three different forms, as seen in figure[a]. The two tautomeric structures of the phenolphthalein indicator have distinct structures. Namely, the colourless benzenoid form and the pink quinonoid form [B]. because the tautomeric forms interconvert into one another, the colours of the two forms would differ. [C] one of the two forms exists in an acidic medium, whereas the other one exists in an alkaline one. By altering the medium's ph, the shift in the tautomeric structure would be the cause of the colour shift [5-6]. Table 1 lists the many chemical sample techniques used to demonstrate the presence of sodium carbonate and phenolphthalein in the collected material. The presence of sodium carbonate and phenolphthalein in the forensic evidence was demonstrated if these chemical tests yielded a positive results [7-12]. The phenolphthalein molecule exists in four different forms, each of which produces a distinct colour depending on the pH of the solution. In acidic solutions, it becomes colourless, while in basic solutions it turns pink. The colour of the phenolphthalein solution varies with the pH value. It appears orange in highly acidic solutions [pH close to zero].it appears colourless when the pH is between 0-8.2 but it looks fuchsia, with a pH range of 8.2-12. It will once more turn colourless, like that of acidic or neutral solutions, if the pH value is higher than 12. Conventional chemical analysis techniques are frequently used in forensic science labs to confirm the presence of sodium carbonate and phenolphthalein. Sections 7,12,13[1][d] and 13[2] of the prevention of corruption act, 1988, as well as section 161 of the Indian penal code, are typically used to record the offences against the accused[13]. The phrase indicates whether or not phenolphthalein powder was used to smear these private records or notes. The spontaneous value was explained by a few analytical tests of phenolphthalein and sodium carbonate, which are displayed in table 1. The Indian penal code defines bribery in section 171B and addresses its punishment in section 171E. Every acceptance of unlawful content, regardless of whether a demand was made beforehand, is punishable by the prevention of corruption act of 1988 with a fine ranging from six months to seven years

Structure		
pH	0-8.2	8.2-12
Conditions	acidic or near-neutral	basic
Color name	colorless	pink to fuchsia
Color		

Material and methods –

Chemical techniques-

Trap case involve use of various chemicals which are called tracing materials, staining material, fluorescent powder, chemical detector, radioactive indicator.

pH Test: Use the pH paper to observe the solution's pH. A pink or red colour that is higher than pH 9 (pH range 8.3–10) indicates a positive test for phenolphthalein.

ACID –ALKALI TEST- The pink hue vanishes when a few drops of diluted hydrochloric acid are added. The pink hue returns when a few drops of a diluted sodium hydroxide solution are added to water. When the pink colour appears and then goes away, the test for phenolphthalein is positive.

STAINING METHOD- The staining method involves using a powdered substance that, when exposed to moisture, converts to a dye. The colour and look of the dye are unknown to the culprit who comes into contact with the linked object or currency. The most common use of phenolphthalein powder in India for anticorruption investigations is in the staining method behaviour of phenolphthalein matters. As I previously discussed, all weak acids, especially phenolphthalein, in its unionized form reflect a colourless appearance and in its ionized state display a pink colour. The scientific explanation for colour changes according to its physical state is simply the increase and decrease of H+ and OH-common ion concentrations. We can conduct experiments with changing phenolphthalein colour by suppressing the dissociation of phenolphthalein by increasing the concentration of H+ ions and enhancing the dissociation of phenolphthalein by decreasing the concentration of OH-ion by adding bases like KOH and NaOH .

Anion/cation test: * The colourless sample is mixed with an alkali (ammonia) * For the carbonate ion test: (A) Effervesce test: the addition of an acid causes brisk effervescence because carbon dioxide is generated. (B) Barium chloride test: barium chloride and sodium carbonate combine to generate a white precipitate of barium carbonate. For the test of sodium ions: (A) Platinum wire flame test with yellow flames. (B) Yellow ppt for the zinc uranyl acetate test

Method of thin-layer chromatography - Benzene is the solvent system: Acetic acid: Dioxane: 75:15:5 Acetone: chloroform: 80:20 Ammonia: methanol: 85:10:5 Spotting the sample and letting it run in the saturated chamber is known as plate development. Examine in the long (366 nm) and short (254 nm) UV ranges. Visualization (reagent spraying)- Pink dots are caused by a 2.5% sodium hydroxide solution. Pinkish red dots result from an acidified potassium permanganate solution (1% permanganate solution in 0.25% sulfuric acid.

Instrumental Analysis: Using a standard solution of phenolphthalein in base, take a tiny amount of the existing solution, filter it, and then use a spectrophotometer in the proper dilution to assess the absorbance value. The resulting solution has a pink hue and a lambda max between 550 and 555 nm. The experiment's blank solution is a sodium carbonate

aqueous solution. Phenolphthalein is also being detected using other instrumental techniques such as FTIR, GC-MS, and HPLC.

Barriers in situations using phenolphthalein traps: The primary likely issue with trapping operations is that the colour fades after a while and loses its evidence value, which the court truly desires. Colour discoloration results from two factors: i. phenolphthalein solution's p H imbalance; and ii. phenolphthalein solution degradation. In the first instance, eliminating the primary cause of color fading involves preserving the equilibrium of phenolphthalein by the addition of acid and base. Sometimes phenolphthalein's colour fades due to its breakdown in alkaline conditions into phenol and benzoic acid, and when O2 interferes, it breaks down into these two substances. This pink colour is maintained for months to years by giving the complainant phenolphthalein for the trapping operation in combination with hydroquinone because it has two benefits: it can make the colour last for a long time and prevent the breakdown of phenolphthalein from its original form into phenol and benzoic acid. If the culprit claims that he has been using phenolphthalein tablets for a long time because of a health issue, they should do so. Since hydroquinone is a component of laxative treatments, its presence is significant.

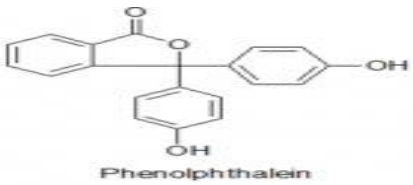
Table 1: Sodium carbonate and phenolphthalein was determined by various chemical analysis methods

Compound/ Ions	Name of Test	Reference
Test for Sodium ions	Uranyl Zinc Acetate Test	8
Test for Carbonate ions	Barium Chloride test	10
	Magnesium Sulphate test	10
	Silver Nitrate test	10
Test for phenolphthalein	Acid –Alkali Test	10,11
	Folin-Ciocalteu's reagent test	12

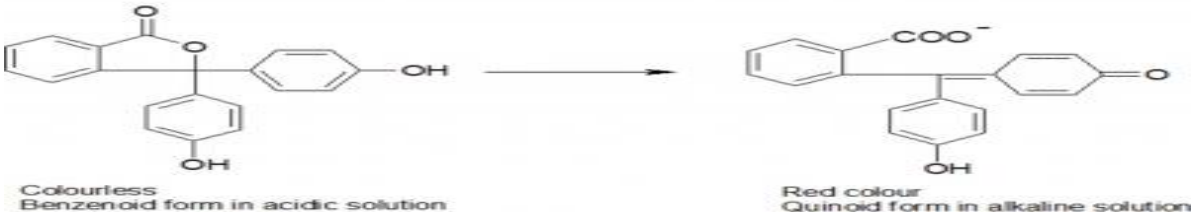
Table 2: List of spotting methods was used to determine the presence of phenolphthalein.

Mobile Phase	Visualizing reagent	References
Benzene: Dioxane: Acetic acid (75: 15: 10)	UV light	11
Chloroform: Acetone (4:10	Exposed to ammonia vapor	12
Ethyl acetate: Methanol: Ammonia (80:10:5)	Spray with a neutral ferric chloride solution	12
Stationary phase: Silica Gel G	Iodine fumes (With 1 % solution of potassium permanganate in 0.25 M sulphuric acid.)	12

SHOWING BEHAVIOUR OF PHENOLPHTHALEIN-



Phenolphthalein

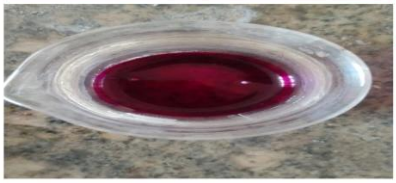
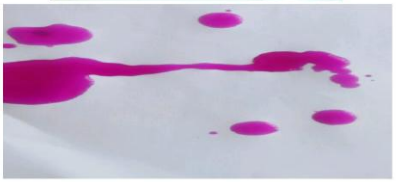


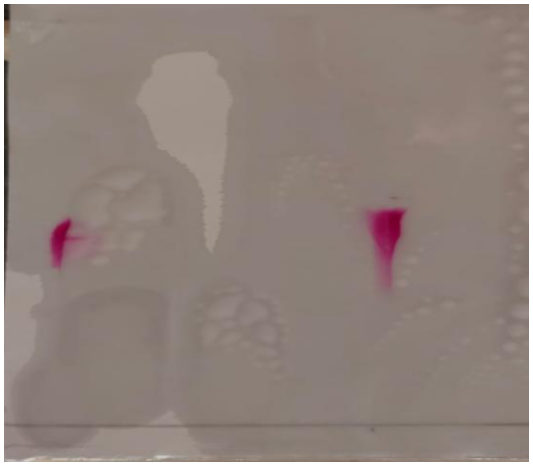
Colourless
Benzenoid form in acidic solution

Red colour
Quinoid form in alkaline solution

PHENOLPHTHALEIN TESTING-



TLC OF PHENOLPHTHALEIN

Result and Discussion-

When giving phenolphthalein for a trapping operation, the complainant should mix it with hydroquinone to preserve the pink colour of the solution. This is because hydroquinone has two advantages: it prevents phenolphthalein from breaking down into phenol and benzoic acid and makes the colour last for a maximum amount of time, such as months or years. This circumstance is always exploited by defense, but it can be avoided by adding a little quantity of hydroquinone in addition to With the use of hydroquinone, this issue can be resolved and the colour of phenolphthalein preserved for an extended length of time. This method also eliminates the possibility of criminals using cathartic and aperient materials as a form of appeal. When all thin-layer chromatography plates were seen under ultraviolet light, a pink spot emerged that was unmistakably the presence of the phenolphthalein chemical. This type of spot is only anticipated when phenolphthalein and hydroquinone are present.

Conclusion-

The alkali phenolphthalein solution is well maintained often for several month to year with combination with hydroquinone. otherwise colour may changed after sometime, and hence defense often take the advantage but this can be overcome by adding small amount of hydroquinone, depending upon the case processment it can't be guaranteed for longest period of time duration. Modern technique of traps like photographic instruments, mikes, undercover operation by volunteers is useful, full proof and having no loophole to escape out the criminal, and also reliability is more as compared to chemical based technique.

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