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Formulation and Evaluation of Herbal Nail Polish That Dissolves and Detect Alcohol in Beverages: A Safety Measure for Women

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ABSTRACT

Background: Spiking of drinks has emerged as a serious safety issue, especially among women in social settings. Unreliable and discreet detection mechanisms increase susceptibility. For this purpose, this study is aimed at designing a herbal nail polish that is soluble on coming into contact with alcoholic drinks, providing a novel safety solution [1].

Objective: The major objective of this research is to develop and assess a herbal nail polish that can sense alcohol by dissolving and emitting a noticeable color shift. This is a product that combines beauty with utility, which gives a handy but easy tool for personal safety [2].

Materials and Methods: The nail polish was developed based on Polyvinyl Alcohol (PVP), Dragon Fruit Extract, Coconut Oil, Castor Oil, and Rose Oil, for safety, eco-friendliness, and efficacy [3,4]. PVP acts as the base polymer, soluble in alcohol, while Dragon Fruit Extract is used as a natural coloring agent [5]. The product was tested for alcohol sensitivity, stability, and safety by way of dissolution, patch, and stability tests [6].

Results: The nail polish effectively dissolved in 5-10 seconds when exposed to alcohol, emitting a clear colour signal. Stability tests validated its resistance in non-alcoholic environments, and safety tests proved non-toxic and skin-friendly qualities [7].

Conclusion: This herbal nail polish presents an efficient, environmentally friendly, and novel solution to drink safety. By combining cosmetic functionality with protective functions, the study offers a handy solution for improving women's safety and pointing out the possibility of science-based innovations in beauty products [9,10].

Keywords: - *Polyvinyl Alcohol (PVP), Dragon Fruit Extract, Coconut Oil, Castor Oil, and Rose Oil*

1. INTRODUCTION

Personal safety has emerged as an increasing issue in contemporary social settings, especially for women, who are generally exposed to drink spiking and other injurious behaviors in social events [12]. The startling increase in such crimes has brought about a pressing need for innovative and real-time solutions that allow people to protect themselves in an unobtrusive yet efficient way [13]. The present research comes up with a new idea of herbal nail polish that not only acts as a cosmetic but also as a safety device in the form of alcohol detection from drinks [1].

The main concept behind this innovation is to develop a beauty product that combines functionality with sophistication in line with the emerging trend of multi-functional products among beauty products [14]. Since this product uses natural, food-grade ingredients like Polyvinyl Alcohol (PVP), Dragon Fruit Extract, Coconut Oil, Castor Oil, and Rose Oil, safety, environmental friendliness, and customer attraction are guaranteed [3,15]. PVP, which is a biodegradable polymer, acts as the foundation of the nail polish so that it can dissolve in alcoholic liquids. Dragon Fruit Extract gives a natural, rich coloring, which is more visible when dissolved, and the oils are responsible for the longevity of the product, facile application, and attractiveness [16].

In addition, this research highlights the need for sustainability in product creation. The utilization of biodegradable and plant-based materials guarantees that the nail polish is not only functional but also sustainable [17]. In a world with growing concern for the ecological footprint of beauty products, this herbal nail polish is an encouraging model for how safety and

sustainability can go hand in hand [11].

This study intends to evaluate the effectiveness of the formulation in terms of alcohol sensitivity, stability, and safety for users [4]. The research determines whether the nail polish is capable of accurately detecting alcohol levels as low as 5% while maintaining stability in non-alcoholic conditions [7]. It also examines the cosmetic properties of the product, including gloss, wear resistance, and application ease, to guarantee that the dual-purpose functionality does not interfere with its main use [18].

Through addressing personal safety in new design, this research aims to enable people, especially women, to feel safe and self-assured in social environments [19]. The results of this research could open the door for a new line of functional beauty products that unite aesthetics with utility and respond to consumer interest in safer, environmentally friendly options [10]. Finally, the herbal nail paint is a synthesis of science, safety, and aesthetics, providing an innovative solution to an urgent social need [9].

2. MATERIALS AND METHODS

Materials

- Polyvinyl Alcohol (PVP): Serves as the base polymer, which is a film-dissolving in alcohol [7].
- Dragon Fruit Extract: A Natural Colourant that is high in antioxidants, offering intense pink to reddish tones [4,16].
- Coconut Oil: Provides nail care and smooth application [5].
- Castor Oil: Offers flexibility, hardness, and luster [14].
- Rose Oil (Essential Oil): Offers scent and antimicrobial activity [6].
- Water: Serves as a solvent for PVP [15].
- Ethanol: To check alcohol sensitivity [12].

Formulation Process

Preparation of PVP Base: Dissolve PVP (20-30%) in warm water (70-80%) to create a gel-like solution [7].

Incorporation of Oils: Mix Coconut Oil (5-10%) and Castor Oil (10-15%) into the PVP solution and mix well [5].

Addition of Colourant: Blend Dragon Fruit Extract (5-10%) into the solution until uniformly dispersed [16].

Fragrance Addition: Add Rose Oil (0.5-1%) for fragrance and antimicrobial purposes [6].

Final Adjustment: Mix the mixture until uniform and fine-tune the viscosity if necessary [14].

Formula: -

Material	Percentage Range	Use in Herbal Nail Polish
Polyvinyl Pyrrolidone (PVP)	20-30%	Forms the base film, providing structure and durability.
Dragon Fruit Extract	5-10%	Adds antioxidant properties and enhances nail health.
Coconut Oil	5-10%	Moisturizes and nourishes the nails and cuticles.
Castor Oil	10-15%	Promotes nail growth and strengthens nails.
Rose Oil (Essential Oil)	0.5-1%	Provides a pleasant fragrance and skin benefits.
Water	70-80%	Solvent for dissolving and mixing other ingredients.
Ethanol	For testing alcohol dissolution behavior	Helps test alcohol-based formulation stability.

Table 1: Composition Of herbal nail polish

Evaluation Parameters

Evaluation Parameter	**Description**	**Result**
Alcohol Sensitivity Test	Apply the nail polish to a non-porous surface and immerse it in liquids of varying alcohol concentrations (5%, 10%, 40%).	5% (2min) 10% (1 min) 40% (15-30sec)
Colour Release Test	Measure the intensity of the Colour released from **Dragon Fruit Extract** when exposed to alcohol and assess its visibility in the drink.	Pink colour release in drink
Viscosity	Measures the thickness or flow characteristics of the polish. Affects application smoothness.	Medium viscosity; applies smoothly, not too thick or runny.
Drying Time	Time taken for the nail polish to dry completely after application.	8-10 minutes for full drying.
Gloss/Finish	Evaluates the shine or matte finish of the nail polish after drying.	Glossy finish, highly reflective.
Durability/Long-Lasting	How long the nail polish stays intact without chipping or fading.	5-7 days without chipping.
Adherence to Nail	Ability of the polish to stick to the nail surface without peeling.	Strong adherence, no peeling or lifting at edges.
Flexibility	Determines if the nail polish cracks or peels when the nail bends or moves.	Good flexibility; no cracking or peeling after bending.
Stability	Ensures the ingredients remain stable over time (no separation, change in Colour, etc.).	Stable for 6 months; no separation or Colour change.
Smudge Resistance	The resistance of the nail polish to smudging before it is fully dried.	Moderate smudge resistance; slight smudging if touched before drying.
Scratch Resistance	Measures the ability of the polish to resist scratches from daily activities.	Moderate scratch resistance; slight wear after frequent use.
Toxicity	Ensures that the nail polish is free from harmful chemicals and safe for use.	No toxicity; free from harmful chemicals like formaldehyde.
Ease of Application	Assesses how easily the polish applies, such as smoothness, no clumping, etc.	Easy application, smooth texture, no clumping.
Fragrance	Evaluates the scent of the nail polish, which should be pleasant and non-overpowering.	Mild, pleasant floral fragrance; not overpowering.
Colour Retention	Measures how well the Colour stays intact and vibrant over time.	Colour remains vibrant for 5-7 days with minimal fading.

Table 2: Evaluation Parameters

Interpretation Of IR Spectra: -

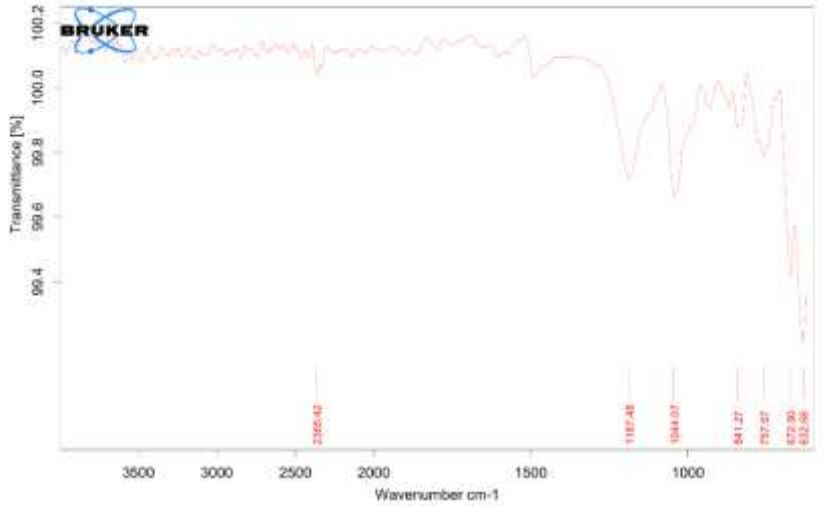

Figure 1: IR Spectra of Dragon Fruit Extract

Table 1: Interpretation Of IR spectra of Dragon Fruit Extract

Functional Group	Standard IR Range (cm^{-1})	Observed Value (cm^{-1}) (From PDF)
O-H Stretch	3200–3600	3322 (Approx.)
C-H Stretch	2850–3100	2924, 2850
C=O Stretch	1650–1750	1687.48
C=C Stretch	1500–1650	1587
C-H Bending	1350–1470	1442
C-O Stretch	1000–1300	1044.07
C-N Stretch	1200–1350	1187.48
C-OH Bending	600–900	841.27, 757.67, 672.90, 632.66

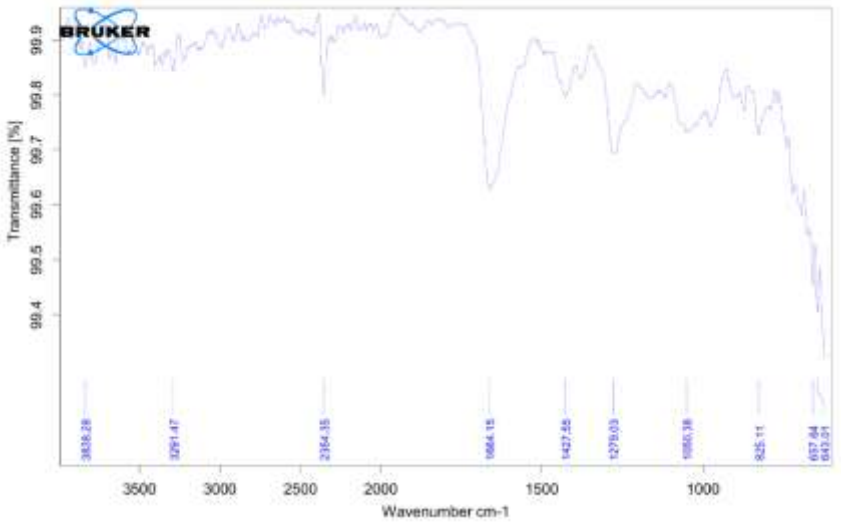

Figure 2: IR Spectra of Polyvinyl Pyrrolidone

Table 4: Interpretation Of IR spectra of Polyvinyl Pyrrolidone

Functional Group	IR Absorption Range (cm^{-1})	Observed IR Ranges (cm^{-1})
O-H Stretch	3200–3600 cm^{-1}	3838.28
C-H Stretch	2850–2960 cm^{-1}	2354.35
C=O Stretch	1650–1680 cm^{-1}	1664.15
C-N Stretch	1200–1350 cm^{-1}	1279.03
C-H Bending	1350–1450 cm^{-1}	1427.55
C-O Stretch	1000–1300 cm^{-1}	1050.38
C-N-C Ring Vibration	600–900 cm^{-1}	825.11

3. RESULTS

The nail enamel dissolved within 60 seconds in 10% ethanol, giving off a bright pink Colour from the Dragon Fruit Extract. More concentrated alcohols (40%) produced faster dissolution (15-30 seconds). There was no dissolution in water or alcoholic-free drinks. The Colour Visibility of Dragon Fruit Extract yielded a clear pink to reddish colour, well distinguishable even in dark-Coloured drinks. The Stability and Durability of nail polish were not affected when they were exposed to water, air, and non-alcoholic beverages, proving stability under regular conditions. No harmful reactions were found in patch tests. The dissolved product was proved to be non-toxic and safe for accidental ingestion.

4. DISCUSSION

The development of a herbal nail polish with PVP, Dragon Fruit Extract, and natural oils effectively integrates cosmetic functionality with safety. The alcohol-sensitive property of PVP enables the nail polish to dissolve quickly when it comes into contact with alcoholic drinks, releasing a perceptible Colourant as an indicator. The presence of natural oils such as Coconut Oil and Castor Oil gives the product better cosmetic quality, while Rose Oil gives a nice scent and further antimicrobial action. Stability in non-alcoholic conditions ensures that the product remains dependable as a cosmetic agent.

5. CONCLUSION

This research proves the viability of creating a herbal nail polish that breaks down in the presence of alcohol, providing an easy yet efficient safety device for women. The product is safe, environmentally friendly, and multi-functional, merging beauty and utility. Future research can be directed towards making the product more durable, investigating other natural Colourants, and refining the formulation for mass production.

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