

ORIGINAL ARTICLE

A Comparative Survey-Based Investigation of Chemical and Herbal Hair Dyes

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ABSTRACT

Considering the worldwide popularity of hair dying, there is an urgent need to understand the toxicities and risks associated with marketed chemical hair dyes. The current survey-based study is focused mainly on comparison of chemical hair dyes used by public, associated side effects and interest/preference of herbal hair dyes by public. In 2020, the global hair colour market generated a value of about 21.4 billion U.S. dollars as per the Consumer Goods & FMCG survey. Considering the global market of hair dye formulations, frequent hair dye usage by both males and female candidates all over the world to mask grey hairs and associated side effects of chemical hair dye, this study explored the potential of herbal hair alternatives. Herbal hair color formulations would be an effective alternative to the currently marketed chemical hair dye formulation as easily available in nature, cost-effective, with better hair improvement potential and no or less side effects. Survey conducted revealed the major issues faced by chemical hair dye users, associated side effects and many participants shown their interest towards herbal hair color formulation which would be considered as important milestone to cosmetic industries to develop an effective herbal hair color formulation to mask grey hairs.

Keywords: Chemical hair dyes, Herbal hair dyes, Cost-effective, Antioxidant

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INTRODUCTION

Grey hair (white hair) develops either spontaneously or prematurely as a result of a progressive and ultimately complete loss of melanocytes in the hair follicle throughout the aging process of humans (1, 2). As people age, their scalp hair turns grey. Human skin is composed of three main layers: the epidermis (outer protective layer), the dermis (middle layer containing connective tissue, blood vessels, hair follicles, and glands), and the hypodermis or subcutaneous tissue (innermost layer made of fat and connective tissue that provides insulation and cushioning) (3). The hair follicle is embedded mainly in the dermis, which supplies it with nutrients and oxygen through its blood vessels, while the base of the follicle (hair bulb) may extend into the upper part of the hypodermis. According to statistics, more than 50% of people have grey scalp hair. In comparison to natural hair dyes, synthetic hair dyes are reported

to cause skin and other skin-related diseases. The manufacturing process is hazardous to the health of the people involved in the process and its applications lead to environmental pollution and also cause potential side effects to the consumers of the product (9). The fear of side effects from the synthetic dyes has limited its use by health-conscious customers throughout the world and has to overcome various regulatory barriers before it reaches its destination. A dye can generally be described as a colored substance that has an affinity to the fiber or hair. The dye is generally applied as an aqueous solution and may require a mordant to improve the fastness of the dye on the fiber or hair. Natural dyes are also referred as mordant dyes. Different mordants will give different color with the same dye. A mordant is thus an agent which allows a reaction to occur between the dye and the fiber, hair (8). Hair dyes include dyes modifiers, antioxidants, alkalizers, soaps, ammonia, wetting agents, fragrance, and a variety of other chemicals used in small amounts that impart special qualities to hair such as softening the texture or giving a desired action to the dye. The chemicals that are normally used in the dye are amino compounds (4-amino-2-hydroxytoluene and m-Aminophenol). Metal oxides, such as titanium dioxide and iron oxide, are also often used as colorants in the process. Colorants are classified as being temporary or permanent. In temporary coloring, the color can be washed from hair easily. Permanent colouring of hair involves the addition of aromatic diamine or hydric phenols or poly-compounds such as para-phenylenediamine in the formulation (1). Continuous usage of such compounds containing dye on natural hair causes so many side effects such as skin irritation, erythema, loss or damage of hair, and skin cancer. Other chemicals used in hair dyes act as modifiers, which stabilize the dye pigments or otherwise act to modify the shade. There hasn't been a survey on the awareness, knowledge, and behaviour of hair dye use despite the fact that it has been linked to a number of negative effects. In order to understand, avoid, and cure the negative effects of hair colouring products, a survey was conducted in the present study by considering different aspects of chemical hair dyes and its regular usage (1).

Side effects associated with chemical hair dyes

The redox mechanism of most of hair dye components are involved in the carcinogenicity and triggers cancer. The CIR expert panel has concluded that a number of coloring ingredients for hair dyes and many chemicals as carcinogenic to animals and unsafe for application. The use of these chemicals as raw materials for producing hair dyes may result in the synthesis of other components which are toxic and have increased risk of carcinogenesis (6,7).

Prominent limitation of hair dyes is that it causes chemical induced depigmentation of the skin (5).

Many carcinogenic and allergic synthetic dyes are banned, may not be completely safe. (4)

Most synthetic dyes are not biodegradable; they accumulate on lands and in river causing ecological problems (3).

MATERIAL AND METHODS

This study was observational and used a questionnaire. It included participants who met the criteria (aged over 20, with visible grey hair, regardless of past dye use). Exclusion criteria included individuals with scalp infections, skin conditions, or those who did not agree to provide informed consent (11,12). The questionnaire (Table 1) was created based on earlier studies (1, 4, 10) and checked for face and content validity by subject experts. A pilot test with 10 participants was done to improve clarity and relevance. We collected data through direct interviews and online responses. We compiled and analyzed the responses using descriptive statistics (frequency, percentage) to summarize participant characteristics and preferences. We conducted a comparative analysis to assess differences between users of herbal and chemical dyes.

A questionnaire survey was conducted for adult males and females aged over 40 who had gray hair regardless of the use of hair colouring products. A total of 122 people participated in the questionnaire survey. The total responses of 122 survey subjects were used for analysis (13-17).

Methods

The questionnaire was composed of 16 questions. The questionnaire asked for basic information including gender and age, clinical findings of gray hair and the related information, use or non-use of hair coloring products and the status of use, hair dyeing-related side effects and recognition of side effects (table1). Some question items were designed so that the survey subjects could make multiple choices (1).

Table 1. A questionnaire about the awareness, knowledge and behaviour of hair dye use

Q. No.	Question	Response Options
1	Age in years	<20, 21–30, 31–40, ≥40
2	Gender	Male, Female
3	Frequency of hair dye use	Once/week, Once/month, Once/2 weeks, Once/3 weeks, Rarely
4	Reason for dyeing	Fashion, Hide greying, Look younger, Change colour, Conditioning
5	Any side effects after dyeing?	Yes, No, Not sure
6	Preferred dye type	Chemical, Herbal
7	Side effects of chemical dye	Dryness/frizz, Headache, Staining, Facial swelling, Itching, Dry skin
8	Future preference	Low-cost herbal (no side effects), Costly herbal (no side effects), Costly chemical (some side effects)
9	Allergic testing with herbal dye?	Yes, No
10	Allergy test before organic dye?	Yes, No
11	Aware of herbal dye benefits?	Yes, No
12	Still using chemical dye after side effects?	Same brand, Different brand, Stopped use
13	Brands used	List
14	Known herbal remedies	List
15	Monthly dye cost	Rs. 0–100, Rs. 100–1000, Rs. 1000–2000
16	Affordable future cost	<Rs. 500, Rs. 500–1000, Rs. 1000–3000, >Rs. 4000

RESULT AND DISCUSSION

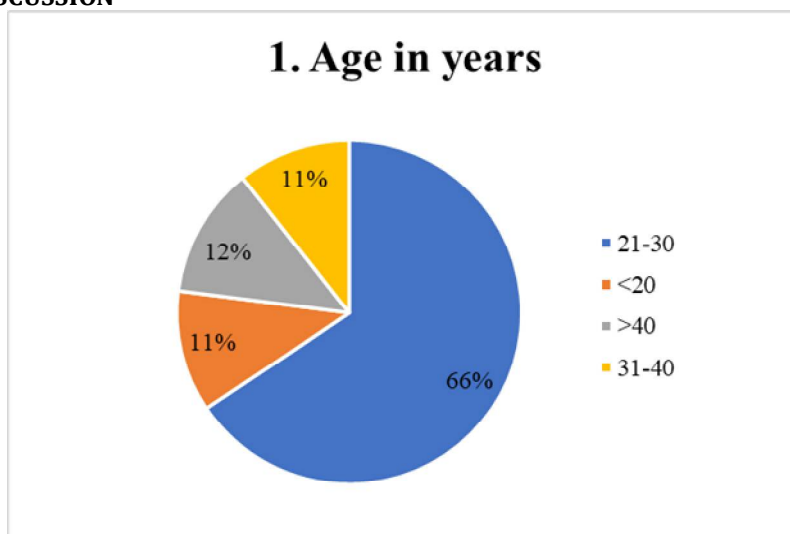


Figure 1: Age distribution of a group in years.

We conducted this survey for all of the age groups but maximum age group (66%) as shown in Figure 1 who filled the survey form were between 21–30 years of age, while, 11.5% people were of age group less than 20 years, 10.7% people were of 31–40 years of age, 9.8% of people were of greater or equal to 40 years of age and 2.5% of people were of age more than 40 years

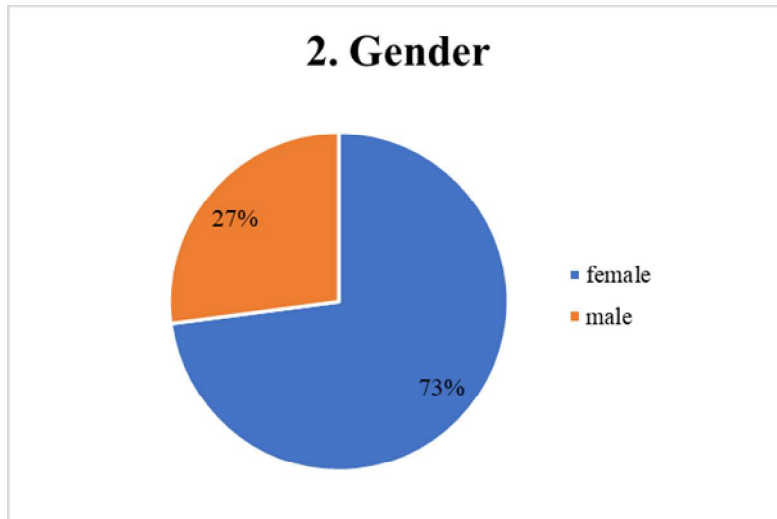


Figure 2: % of male and female responded in this survey

This Figure 2 shows % of male and female responded in this survey The maximum number of people who filled this survey form were female subjects (73%), rest were male subjects.(33%).

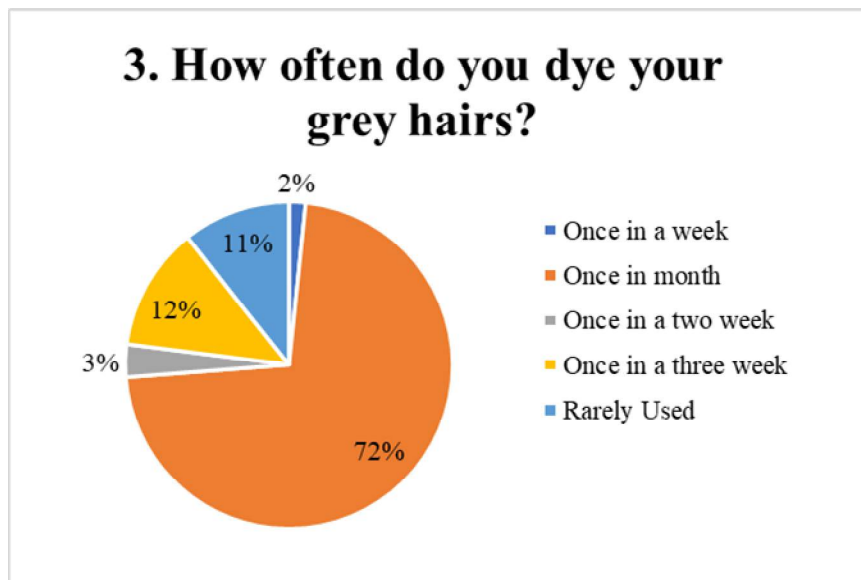


Figure 3: Frequency of hair dye use

Figure 3 shows that a significant proportion of individuals engage in the practice of dyeing their hair on a monthly basis from this survey we can conclude that maximum people (72%) are dyeing their hair once in a month, 12% of people are dyeing their hair once in three weeks, 11% people rarely use hair dye, 3% people are dyeing hair once in two weeks and 2% people once in a week.

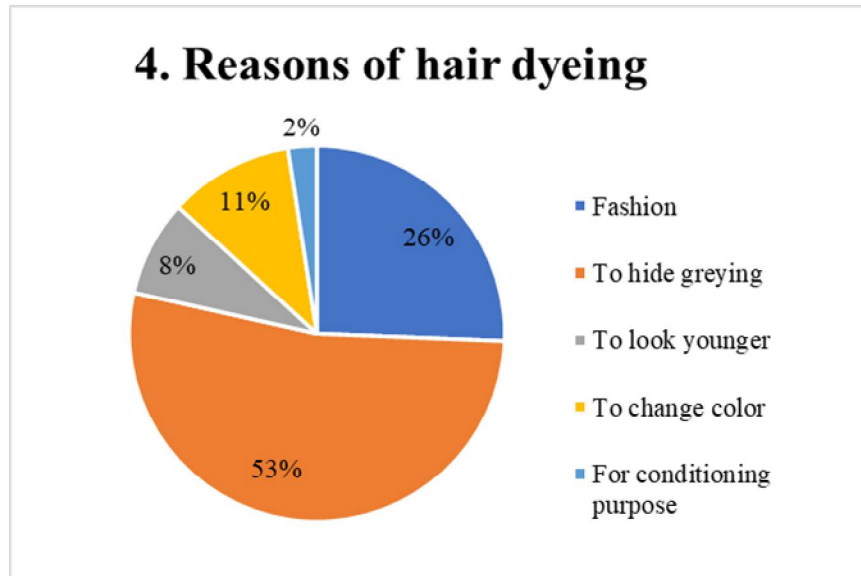


Figure 4: Reason for dyeing

As Figure 4 shows that the predominant motivation for individuals to utilize hair dye is to conceal the presence of grey hair. The reason for which people are using hair dye is to hide grey hair mostly (53.3%), while 25.4% people are dyeing their hair for fashion purpose, 11.5% people are using dye to change their hair color, 8.2% people are dyeing hair to look younger and 2.5% people are using it for conditioning purpose.

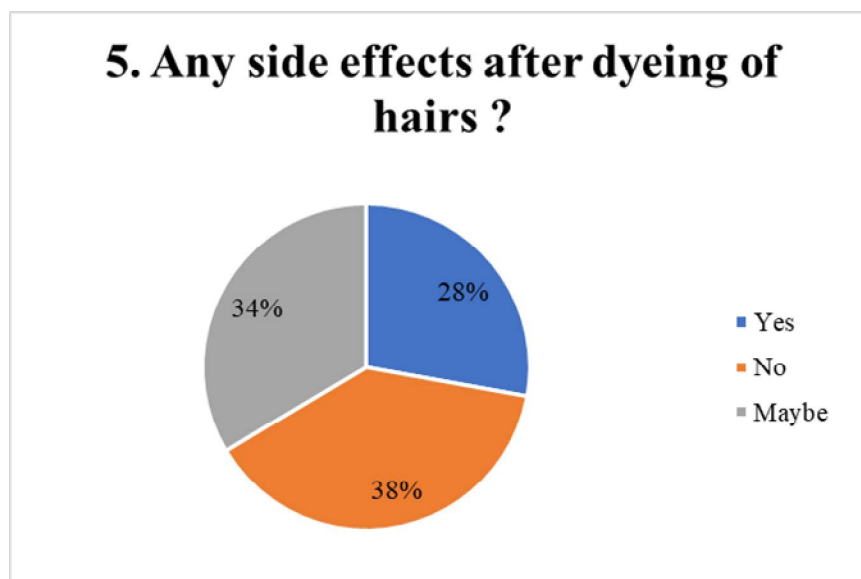


Figure 5: Side effects after dyeing

Figure 5 shows that 38.5% people have not suffered any side effects from dyeing their hair, while 27.9% people have observed side effects because of dyeing and 33.6% people are not sure about side effects.

6. Which hair color product you prefer for dying your hairs?

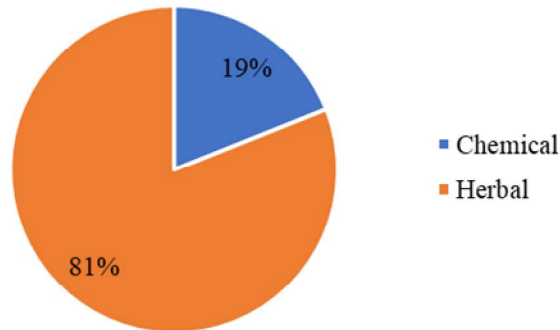


Figure 6: Preferred dye type

Figure 6 shows that the herbal products are vastly more popular, where 81% of the group opted for them. 19% of the group prefers chemical products. The graph shows emphatically the popularity of herbal hair coloring products compared to chemicals.

7. Do you experience any side effects after application of chemical dye?

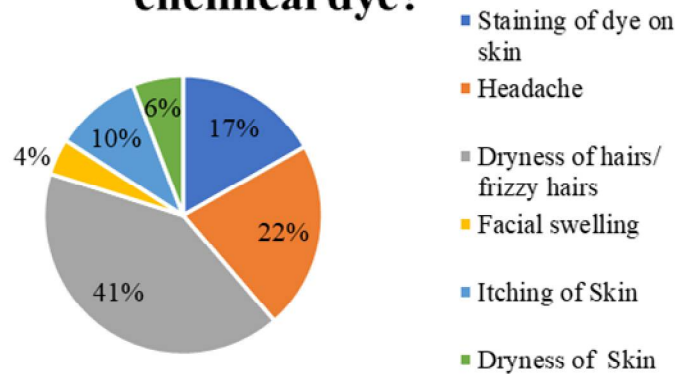


Figure 7: Side effects after the use of chemical hair dyes

This survey question's response (Figure 7) is showing that maximum people (40.2%) have suffered from dryness of hair/ frizzy hair as a result of application of chemical hair dye, 22.1% of people are suffering from headache, 16.4% people observed staining of dye on skin, 9.8% people have itching of skin, 9% of people have dryness of skin and 4.1% people have suffered from facial swelling as a result of application of chemical hair dyes.

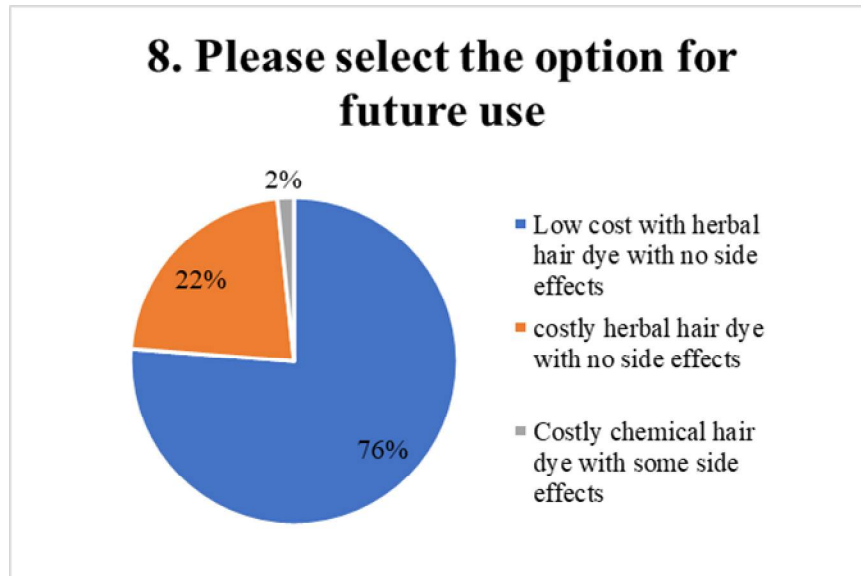


Figure 8: Future preferences

Figure No. 8 shows that Maximum people (76.2%) want herbal hair dye with low cost and no side effects for future uses, while 22.1% people want costly herbal hair dye with no side effects and 1.6% people costly chemical hair dye with some side effects for future use.



Figure 9: Allergic reactions by using herbal hair dye product

This question's response is showing that 84.3% of people have not experienced allergic testing while 15.7% people have experienced it by using herbal hair dye products shown in Figure No. 9

10. Have you had an allergy test before using organic hair dye products?

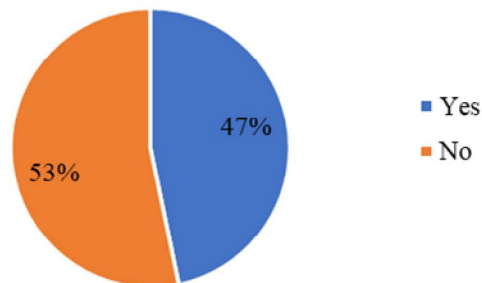


Figure 10: Allergy test before organic dye

Figure 10 is showing that 53.3% people have had an allergy test while 46.7% people have not had an allergy test before using organic hair dye products.

11. Are you aware about benefits of herbal hair color products?

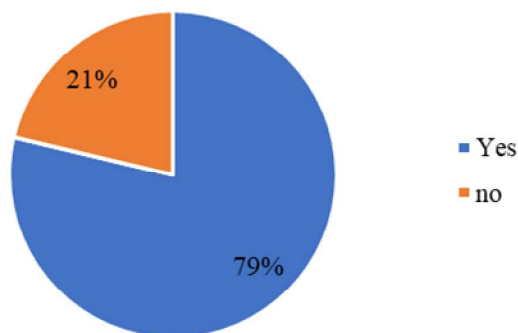


Figure 11: Awareness of herbal dye benefits

Most of the participants (79%) claimed they were informed about the advantages of herbal hair color products, whereas 21% showed no such information (Figure 11). The high awareness implies that most of the participants in the study population are well aware of the possible benefits of herbal dyes, such as less chemical exposure and hair health benefits. The 21% unaware category presents a key opportunity for educational programs and specific promotional efforts to further stimulate the uptake of safer herbal alternatives.

12. Are you still using chemical hair dye even after experiencing side effects?

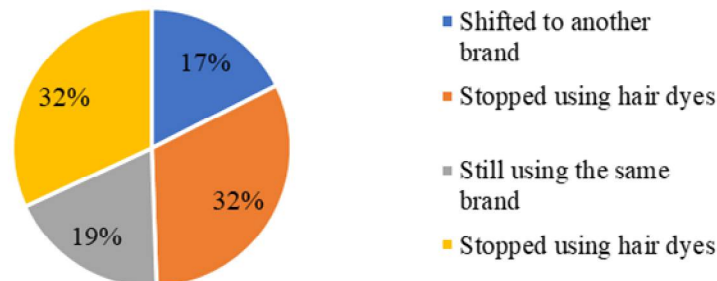


Figure 12: Continued use of chemical hair dye after experiencing side effects

When asked about continued chemical hair dye use despite experiencing side effects, **32%** of participants reported stopping the use of hair dyes altogether, while another **32%** stopped chemical dyes but did not specify switching to herbal alternatives (Figure 12). Notably, **19%** continued using the same brand despite adverse reactions, indicating strong brand loyalty or lack of awareness about safer options. Meanwhile, **17%** shifted to another brand of chemical dye, suggesting that side effects were perceived as brand-specific rather than formulation-related. This persistence in chemical dye use despite known side effects reflects findings by Foss-Skiftesvik et al. (4) and Gera et al. (5), who noted that convenience, aesthetic expectations, and habit often outweigh health concerns. The observed trend underscores the need for better consumer education on the risks of chemical hair dyes and the benefits of herbal alternatives.

Mention the names of marketed hair dyes that you used for dyeing of hairs.

After collecting data from peoples we get different name of marketed hair dyes that people used for dyeing hairs are:

- 1-Garnier
- 2-Heena
- 3-nisha
- 4-kama ayurvedic hair dyes
- 5-Nupur
- 6-Himalaya
- 7-Mamaearth
- 8-Streax
- 9-Indus valley
- 10-Megha
- 11-Vcare herbal dye
- 12-Indica
- 13-Khadi hair dye

Any herbal remedies you know which can be used for hair dyeing.

1. Nisha
2. Herbal Roots Herbal Henna Powder
3. Indus valley organically natural hair color
4. Biotique Bio Henna Fresh Powder Hair Colour
5. Herbatint Permanent Hair Color Gel.
6. Surya Brasil Henna Cream.

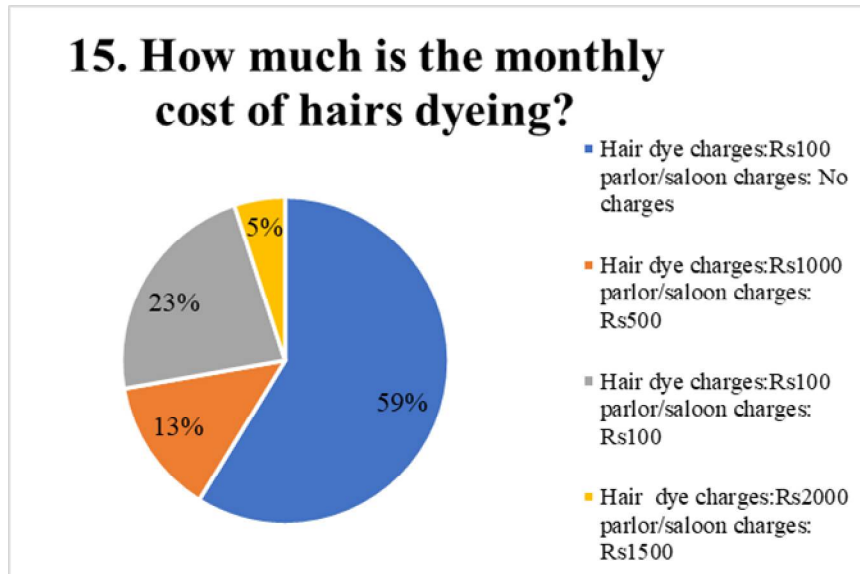


Figure 13: Monthly expenditure on hair dyeing and associated salon/parlor charges

For the monthly expense in hair dyeing, most participants (59%) indicated paying around Rs. 100 for hair dye with no salon/par charges (Figure 13). Another 23% paid Rs. 100 for hair dye and Rs. 100 as parlor/salon charges, whereas 13% indicated paying Rs. 1,000 for dye and Rs. 500 for parlor/salon charges. Only a minor percentage (5%) paid the highest amount of Rs. 2,000 in monthly expenses for dyeing and Rs. 1,500 in salon expenses. The findings show that low-priced products are preferred by most consumers, possibly for lack of sufficient funds to spend or due to the wide availability of cheaper products within the market. The lower segment with greater expenditure can be indicative of people choosing premium services or branded dyes and showing socio-economic variations in spending habits.

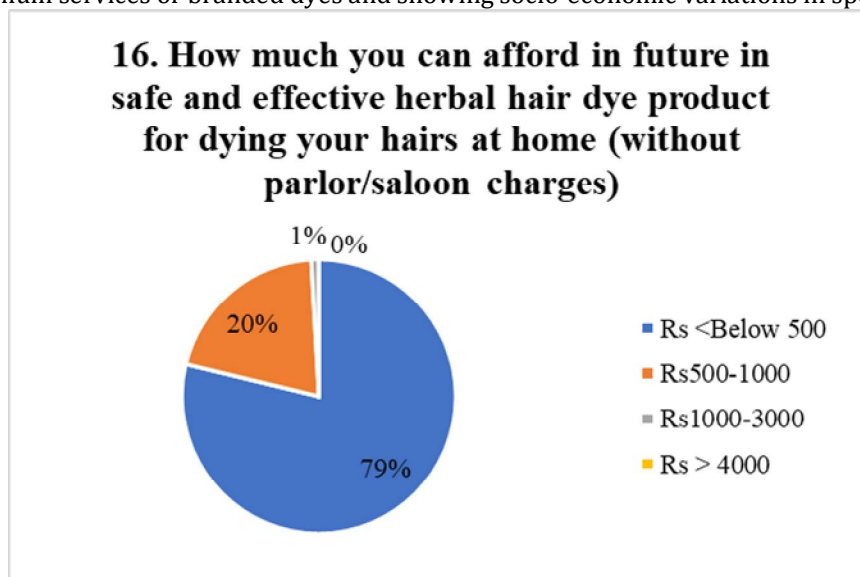


Figure 14: Future affordability preferences for safe and effective herbal hair dye products

When asked regarding how much they would pay for an affordable and effective herbal hair dye product (excluding parlor/ salon fees) in the future, 79% opted for products under Rs. 500 (Figure 14). An additional 20% expressed readiness to spend between Rs. 500–1,000, and only 1% were willing to spend between Rs. 1,000–3,000. No respondent was willing to spend more than Rs. 4,000. This reflects high price sensitivity among the target population, and the need to create affordable formulations to drive uptake.

We have conducted a survey on herbal and synthetic dye on various age groups, but most of the responses came from 21-30 age groups, which means people are suffering from, mostly from premature greying of hair. The number of responses we received from this survey was 122.

CONCLUSION

We have conducted a survey on herbal and synthetic dye on various age groups, but most of the responses came from 21-30 age group, which means people are suffering from, mostly premature greying of hair. Most of the people were facing the problem of dryness of hair or frizzy hair after using chemical hair dyes. A large number of people also suffered from headache and staining of dye on skin. Few people observed swelling of face, itching and dryness of skin. People were also not aware of patch testing before applying the dye on hair which is responsible for skin and other hair allergies which were not known to people before using it. Now, if we look into the uses of herbal hair dyes then we can conclude that maximum number of people is using herbal hair dyes because of side effects of chemical hair dyes. If we compare the cost of chemical and herbal hair dyes, the cost of herbal hair dyes are expensive as compared to chemical hair dyes. According to the responses we got from people we can conclude that people want herbal hair dye with less costing and less side effects. Maximum People want herbal hair dye with price less than Rs 500. So, there is need to introduce herbal hair dyes which are less expensive and affordable to people and also with very less side effects. From the overall conducted survey, we can conclude that there are number of side effects of chemical hair dyes which majority of people are preferring; also the people are aware with such side effects and showing the interest if cost effective natural hair color formulation will be available which can overcome the side effects of chemical hair dyes. Hence we can also investigate the effect of usage chemical hair dyes and faster greying of more hairs and many more negative aspects of chemical hair dyes. Cosmetic industries can come up with an effective long lasting, cost effective herbal hair dye for which many users are showing interest.

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