

# Evaluation and Comparison of Color Stability of Recent Esthetic Archwires: An In Vitro Study Under Spectrophotometer

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## Abstract

**Introduction:** Invisible orthodontics is in demand in today's times of esthetic dentistry. Metal bracket or steel appliances are being replaced by either esthetic brackets or lingual appliances.

**Objective:** The objective of the study is to evaluate the color stability of five esthetic archwires at different time periods.

**Materials and Methods:** A total of 120 samples were evaluated after 7, 14, and 21 days of immersion in staining coffee solution. Color measurements were performed using a spectrophotometer according to the CIE L\*a\*b\* system, and color changes ( $\Delta E^*$ ) and National Bureau of Standards units were computed. Statistical differences were investigated using analysis of variance and Tukey's *post-hoc* test.

**Results:** All wires showed staining after 7<sup>th</sup> day, but at different intensities which change its stability with different period except Galaxy archwire which remains constant till the long period.

**Conclusion:** All the esthetic archwires assessed showed noticeable color change after 21 days. The JJ orthodontics archwire showed the highest amount of color alteration. The rabbit force archwires presented appreciable color change till 14 days which becomes less after that.

**Key words:** Esthetic archwires, Color stability, Spectrophotometer

## INTRODUCTION

Invisible orthodontics is in demand in today's times of esthetic dentistry. Metal bracket or steel appliances are being replaced by either esthetic brackets<sup>1,2</sup> or lingual appliances.

Metal archwires coated with plastic resins are used to resemble tooth color.<sup>3</sup> However, the color of the wire tends to change over time, and the coating may also split during use in mouth.

There are many causes for discoloration of coated wires.<sup>4</sup> It can be caused by food dyes or mouth washes. Our daily consumption of tea, coffee and cola drinks promotes discoloration of these wires.<sup>5</sup>

Coffee is considered as the most chromogenic agent in comparison to other drinks. Considering this, the study was planned to compare the color stability of esthetic wires along with the use of coffee.

## MATERIALS AND METHODS

In this study, five brands (Orthodirect, JJ Orthodontics, Rabbit Force (G & H), Galaxy, Prime Ortho) of esthetic archwires were assessed. In this study, 6 samples from each brand at every group were taken (Figure 1 and Table 1)

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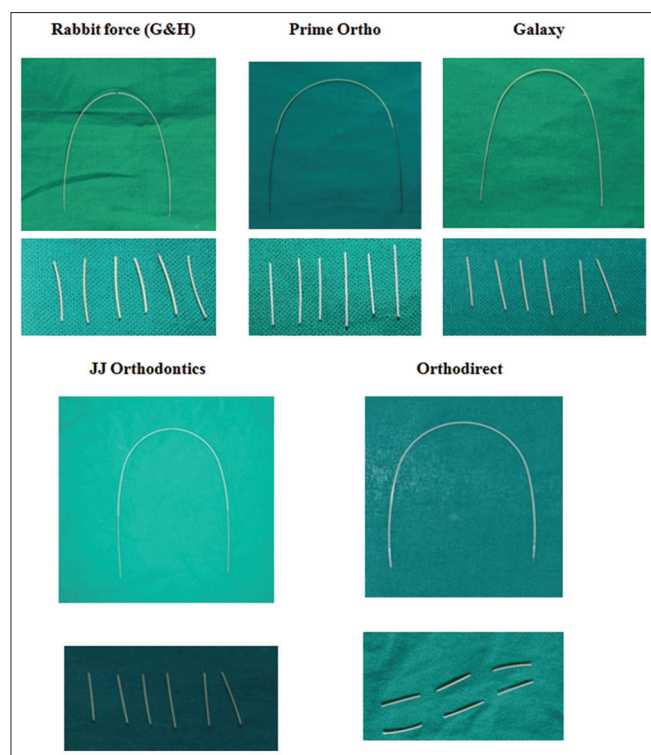


Figure 1: Esthetic archwires

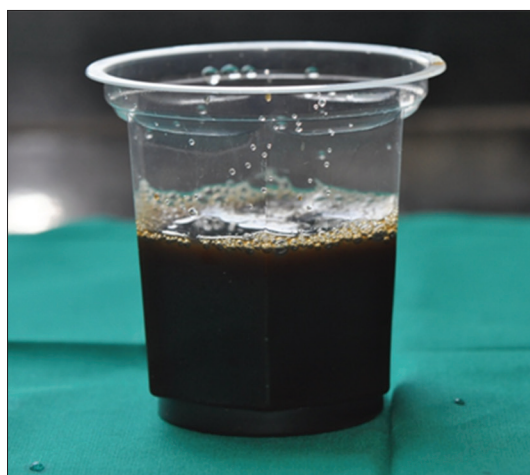


Figure 2: Coffee solution

Each sample was 10 mm long wire segment.

### Staining Solution Preparation

A staining coffee solution was prepared by pouring 500 ml of boiled distilled water over 15 g of coffee powder. The solution was stirred every 30 min for 10 s until it cooled down to 37°C and then was filtered through a paper filter (Figure 2). This liquid mixture was then poured into a pot and kept in an incubator during the entire experiment. The solution was freshened once every 7 days. In addition, to reduce the precipitation of particles, the mixture was stirred once a day for 1 min.

Table 1: Esthetic archwires used in the study

Wire name and manufacturer	Cross section size	Composition	Coating surface
Orthodirect	0.014"	NiTi	All surfaces
JJ orthodontics	0.014"	NiTi	All surfaces
Rabbit force (G & H)	0.014"	NiTi	All surfaces
Galaxy	0.014"	NiTi	All surfaces
Prime ortho	0.014"	NiTi	All surfaces

Table 2: Critical marks of color change according to the National Bureau Standards

NBS unit	Definitions of color differences	
0.0-0.5	Trace	Extremely slight change
0.5-1.5	Slight	Slight change
1.5-3.0	Noticeable	Perceivable change
3.0-6.0	Appreciable	Marked change
6.0-12.0	Much	Extremely marked change
12.0+	Very much	Change to other color

Table 3: Total color difference ( $\Delta E^*$ )

Wire name and manufacturer	7 <sup>th</sup> Day	14 <sup>th</sup> Day	21 <sup>st</sup> Day
Orthodirect	8.804	1.103	5.277
Galaxy	3.985	4.976	6.088
Rabbit force G & H	6.414	5.660	0.690
Prime ortho	1.133	0.395	2.092
JJ orthodontics	10.959	9.268	8.666

### Color Measurements

Before the specimens were immersed into the solution, they were stored in distilled water at 37°C for 24 h. After 24 h of immersion (T<sub>0</sub>), the color of each sample was measured using the spectrophotometer (Figure 3). After the first measurement (T<sub>0</sub>), the samples were placed in a container with the prepared staining coffee solution. Color measurements were repeated after 7 days (T<sub>1</sub>), 14 days (T<sub>2</sub>), and 21 days (T<sub>3</sub>) of immersion in the solution. Before each measurement, samples were removed from the solution and rinsed with distilled water in an ultrasonic cleaning bath for 5 min. Excess water on the surfaces was removed with tissue papers, and the samples were allowed to dry.

Before performing the measurements, the spectrophotometer was calibrated according to the manufacturer's instructions. Six measurements of each group of all the five brands' archwire were made. The average value of these six readings of each sample was recorded by the examiner. Color changes were characterized using the Commission Internationale de l'Eclairage L\*a\*b\* color space (CIE L\*a\*b\*).

These systems represent adequately the visual perception of color differences. Total color differences are expressed by the formula  $(\Delta E^*) = ([\Delta L^*]^2 + [\Delta a^*]^2 + [\Delta b^*]^2)^{1/2}$ ,

**Table 4: Color change of archwires converted to NBS units and remark of color difference**

Group	7 <sup>th</sup> Day		14 <sup>th</sup> Day		21 <sup>st</sup> Day	
	NBS units	Color change	NBS units	Color change	NBS units	Color change
Orthodirect	8.09968	Much	1.01476	Slight	4.85484	Appreciable
Galaxy	3.6662	Appreciable	4.57792	Appreciable	5.60096	Appreciable
Rabbit force G & H	5.90088	Appreciable	5.2072	Appreciable	0.6348	Slight
Prime ortho	1.04236	Slight	0.3634	Trace	1.92464	Noticeable
JJ orthodontics	10.08228	Much	8.52656	Much	7.97272	Much

NBS: National Bureau of Standards



**Figure 3: Spectrophotometer**

where  $\Delta L^*$ ,  $\Delta a^*$ , and  $\Delta b^*$  are differences in  $L^*$ ,  $a^*$ , and  $b^*$  values before ( $T_0$ ) and after immersion at each time interval ( $T_1$ ,  $T_2$ ,  $T_3$ ). To relate the amount of color change ( $\Delta E^*$ ) to a clinical environment, the data were converted to National Bureau of Standards (NBS) units<sup>6</sup> as follows:

$$\text{NBS units} = \Delta E^* \times 0.92.$$

## RESULTS

Table 2 shows the total color difference ( $\Delta E^*$ ) of the esthetic archwires after 7, 14, and 21 days of immersion in the staining solution. The data were converted into NBS units, to relate the amount of color change ( $\Delta E^*$ ) recorded by the spectrophotometer with that of the clinical environment. The results of this conversion are shown in Table 3 and described in terms of the NBS defined color differences in Table 4. All brands showed staining after 7 days, but at different intensities which changes its stability with different period except Galaxy archwire which remains constant till the long period.

## DISCUSSION

In addition to the color differences initially observed between the different existing esthetic archwires, the color

stability of coated archwires during orthodontic treatment is also clinically important. In this study, the color stability of these archwires could be reliably evaluated. Ideally, the color of esthetic archwires should match that of natural teeth and esthetic brackets. However, the colors of natural teeth vary according to the color measurement protocols used and also by race, gender, and age.<sup>7,8</sup>

Color changes were characterized using the CIE  $L^*a^*b^*$  color space. The CIE  $L^*a^*b^*$  color space is currently one of the most popular and widely used systems of color measurement, and it is well suited for the determination of small color differences. Many authors<sup>9-12</sup> have used  $\Delta E^*$  values to evaluate the “perceptibility” of color differences, but criteria used for perceptibility was different. To find out such differences and disagreements in the criteria used, the NBS rating system is used to evaluate the degree of color difference since there is an absolute criteria by which  $\Delta E^*$  values can be converted to definitions with clinical significance.

Some studies<sup>9,10,13</sup> concluded that coffee was the most chromogenic agent when it was compared with other staining substances such as tea and cola drinks. For this reason, a coffee solution was used in this study to determine the effect of staining.

## CONCLUSION

All the esthetic archwires assessed showed noticeable color change after 21 days. The JJ orthodontics archwire showed the highest amount of color alteration. The rabbit force archwires presented appreciable color change till 14 days which becomes less after that.

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