



## Controlling Effect of Food Dyes used World Wide on Colour Stability of Orthodontic Composite Bracket- An in vitro study

Dr. Priyanshi Mahajan<sup>1</sup>, Dr. Purva Joneja<sup>2</sup>, Dr. Tanveer Akhtar<sup>3</sup>, Dr. Gargi Singh<sup>4</sup>, Dr. Dhiraj Agrawal<sup>5</sup>, Rishabh Joneja<sup>6</sup>

<sup>1</sup>PG Student, Department of Orthodontics and Dentofacial Orthopedics, Bhabha College of Dental Sciences Bhopal, Madhya Pradesh, India

<sup>2</sup>Professor and HOD, Department of Orthodontics and Dentofacial Orthopedics, Bhabha College of Dental Sciences Bhopal, Madhya Pradesh, India

<sup>3</sup>Associate Professor, Department of Orthodontics and Dentofacial Orthopedics, Bhabha College of Dental Sciences, Bhopal, Madhya Pradesh, India

<sup>4</sup>PG Student, Department of Orthodontics and Dentofacial Orthopedics, Bhabha College of Dental Sciences, Bhopal, Madhya Pradesh, India (Corresponding Author)

<sup>5</sup>Reader, Department of Orthodontics and Dentofacial Orthopedics, Bhabha College of Dental Sciences, Bhopal, Madhya Pradesh, India

<sup>6</sup>5<sup>th</sup> Year Medical Student, First Faculty of Medicine, Charles University, Prague Czech Republic

**Corresponding Author:** Dr. Gargi Singh, PG Student, Department of Orthodontics and Dentofacial Orthopedics, Bhabha College of Dental Sciences, Bhopal, Madhya Pradesh, India

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### KEYWORDS

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### ABSTRACT:

**T Aim:** The aim of this study was to evaluate the colour stability of esthetic orthodontic composite bracket after immersion in various food dyes and its control measurement. Composite bracket were immersed into four different solutions: coffee, tea, turmeric, coca cola solution. Sample was kept at in 37 degree Celsius. Colour reading were evaluated after T0, T1 (24 hour), T2 (72 hour), T3 (144 hour) immersion. All examined orthodontic bracket showed a significant difference in discoloration and for controlling effect of food dyes same orthodontic composite bracket are brushed using hydrogen peroxide dentifrice for 30 days.

**Objective:** To assess colour stability of esthetic orthodontic composite bracket after immersion in various food dyes and control measures.

**Material and Method:** Orthodontic composite bracket were divided into 4 group n= 4, each group contains 4 orthodontic composite bracket and the solution in which they were immersed (coffee, tea, turmeric, coke). Chromatic changes were analyzed with the aid of visual inspection at four specific time intervals. First assessment was as received from manufacturer calibrated as T0. Thereafter 24 hour T1, 72 hour T3, 144 hour T4. Readings were observed. The stained orthodontic bracket was removed from the solution the specimen immersed in food dyes were brushed for and brushed with dentifrice containing hydrogen peroxide 1 min daily with hydrogen, stored in artificial saliva until next day, the cycle was repeated for 30 days after this bracket were brushed for 30 days using hydrogen peroxide containing dentifrice, the colour assessment was done using visual assessment.

**Conclusion:** Orthodontic composite bracket shows colour variation when exposed to food dyes like turmeric coffee, black tea, coca-cola. Maximum staining reported with turmeric followed by coffee, coca-cola and tea. Hydrogen peroxide containing dentifrice reduces stain within clinically perceptible range. The cosmetic manufacturing industry of India is rapidly expanding, driven by rising consumer demand, formulation innovations, and globalization. However, India's Cosmetic Industry requires many approvals before it can fully commence. One of which is the approval from the Central Pollution Control Board. The Central Pollution Control Board engages in an essential regulatory role in mitigating the environmental impacts through frameworks such as Consent to Establish and Consent to Operate. This article meticulously



examines the environmental regulations imposed on cosmetic manufacturers, the pollution index score-based classification of industry sectors, and the effluents and emissions treatment measures. It highlights recent regulatory developments, technological interventions for sustainability, and compliance challenges, offering recommendations for a more harmonized and environmentally conscious cosmetic industry in India.

## Introduction

There are different types of esthetic orthodontic bracket like ceramic or composite as per their material of manufacturer.<sup>1-2-3</sup> Orthodontic composite bracket are made from polymer based materials, offering more aesthetic alternative to traditional metal bracket. These brackets are typically tooth -coloured light weighted and less visible making them a preferred choice for patient seeking orthodontic treatment. Orthodontic composite bracket provide satisfactory mechanical performance and improved comfort, exhibit higher frictional resistance as compared to ceramic bracket, like ceramic bracket which are brittle and can fracture under pressure. This flexibility of orthodontic composite bracket also reduces risk of enamel damage during bracket removal a common concern with ceramic bracket. Additionally, composite bracket are gentler on opposing teeth, making them a safer choice in cases with deep bite. While both ceramic and composite provide aesthetic benefits, composite bracket are often more cost effective, easier to handle clinically. One additional benefit with composite orthodontic bracket is ease with which it can be customized in terms of colour, allowing better aesthetic blending with natural teeth or specific patient preference.

**Colour stability** can be defined as the ability of a material to maintain its initial colour for certain period of time in response to variety of factor in a particular environment and is an important physical feature for dental material.<sup>1-2-3</sup> The colour modification of material is a multi-factorial process. The discoloration can be result of multiple intrinsic or extrinsic factors. Consumption of pigmented food and drinks, using coloured mouth rinses, smoking, poor oral hygiene and plaque are included in extrinsic discoloration factor.<sup>1</sup> Intrinsic discoloration of the orthodontic bracket depends on the degree of polymerization; changes in temperature, rate of colour pigment absorption are also potential threat to the colour stability of esthetic orthodontic bracket. Today's high consumption of food and beverage full of natural and synthetic colour can result in unsatisfactory esthetic performance of orthodontic bracket. Many previous studies have confirmed that esthetic orthodontic bracket are not colour stable in the long term and are susceptible to pigments commonly found food and drinks. Therefore the aim of this study was to evaluate colour stability of esthetic orthodontic composite bracket and measure to

restore its colour after discoloration. Coffee is one of the most widely consumed beverages in the world. Excessive or inappropriate intake can pose several health hazards like caffeine dependence and withdrawal headache, fatigue, sleep disruption, increased blood pressure heart rate.<sup>14</sup> Soft drink consumption affect kidney, liver and bone function. Soft drink increase oxidative stress resistance. The renal study on rat revealed that coca-cola cause mild congestion in renal histopathology. Deleterious histopathology changes were reported in bone and liver of the coca cola group.<sup>13</sup> Turmeric is generally safe, but it may also cause gastric irritation, diarrhoea, nausea, allergic skin reaction and anti thrombosis activity interfering blood clot formation.<sup>15</sup> In this study we have used consumption of food dyes within the range which do not harm the health of a person.

## Material and Method

For this experiment study, sixteen orthodontic composite brackets from the same manufacturer taken were immersed into four different food dyes like (TAB 1) coffee, turmeric, tea, coca-cola at 37 degree Celsius temperature for 24 hour, 72 hour and 144 hour. 85-95 mg of coffee is poured in 10ml of water, 50-80mg of tea is pored in 10ml of water, and 500mg of turmeric is pored in 10ml of water. The solution was renewed after every 24 hour of storage during experimental period. The per capita consumption level of caffeine for all consumers (all age group) is approximately 120mg per day, or a mean intake of 1.73mg /kg body weight /day (knight et al 2004)

**Table 1.** Medium used in present investigation for discoloration

Product	Brand	Ingredients
Turmeric	Catch Masala	Diaryl Heptanoid (Curcuminoid, Curcumin) Sesquiterpenes, Ketones and Monoterpenes
coffee	Nescafe	Caffeine, Sugar, Salt, Palm Kernel Oil, Instant Coffee
Black Tea	Lipton	Caffeine, Lemon Peel, Flavonoids
Coca cola	The Coca Cola Company	Carbonated Water, Phosphoric Acid, Caffeine, Natural Flavour



For the control value, each orthodontic bracket was analyzed for its original colour value before its immersion into the food dyes solution. The values were recorded and were taken as standard value for further comparison with experimental group.

**Table 2.** Medium used in present investigation for stain reversal measure

Product	Scientific Name/Brand	Ingredients
Toothpaste	Dentifrice	2%Hydrogen Peroxide, Sodium Lauryl Sulfate, Silica, Water, Calcium Pyrophosphate, Butylated Hydroxytoluene, Water

This sixteen orthodontic stained composite bracket were brushed for 30 consecutive days for 1 minute using hydrogen peroxide containing dentifrice. (Table 2) After brushing, stained bracket are stored in artificial saliva for 24 hour at 37 degree Celsius temperature<sup>16</sup>. This procedure was repeated for 30 days.

#### Visual Assessment

Visual assessment of orthodontic composite bracket was performed at the same time interval 24, 72,144 hour. Orthodontic bracket of each group was washed with distilled water; air dried and placed on white surface behind bracket with had not been immersed in any staining solution, for comparison. This analysis aimed to visually detect potential orthodontic bracket staining and related it to the immersion in different solution. Whenever any visual colour change was detected. It was recorded. After 30 days of daily tooth brushing all orthodontic composite bracket cleaned and dried visual assessment of this bracket revealed that hydrogen peroxide containing dentifrice reduces the stains within clinically perceptible range.<sup>15</sup>

#### Statistical Analysis

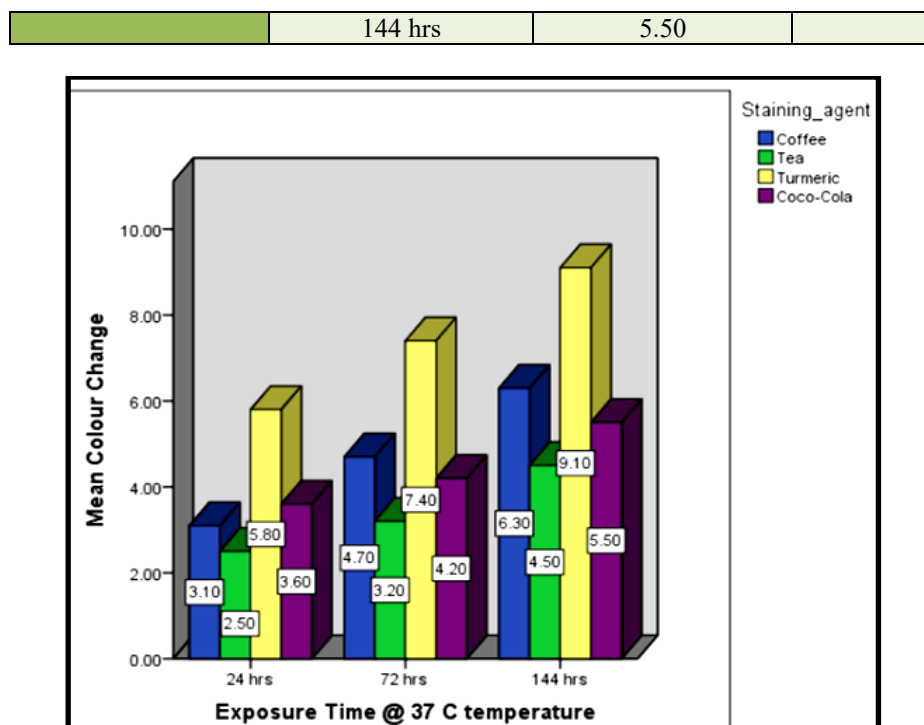
The statistical analysis was done using statistical package of social sciences (SPSS) software, v.22, the mean comparison of follow up values between groups was calculated by using independent student t test. The difference between the time periods was calculated using one way ANOVA test. The difference will be considered as significant, when the P value is below 0.05 and highly significant, when a P value is below 0.001. All the qualitative data were compared using the ANOVA test and Post Hoc test.

#### Result

The descriptive statistics were prepared and presented, of all the orthodontic brackets and colouring agents at various time intervals. The means and standard deviations of the colour change are presented. According to ANOVA results, colour change values showed significant differences among the groups. When compared in 24 hours, 72 hours and also 144 hrs it was found that the highest colour change was with Turmeric, and the least colour change was found with Tea. All the staining agents changed the colour of orthodontic bracket significantly from 24 hrs to 144 hr. [Table 3] The visual score of the stains were also analyses and tabulated in Table 4, which states that the Tea showed a mild colour change and rest all coffee, turmeric and coco-cola showed moderate colour change in 24 hrs, and by the end of 144 hours, every sample showed severe colour change but Tea only had moderate change. The ascending order of colour change due to agents can be stated as, Tea > Coffee > Coco-cola >Turmeric. There was significant difference between all the time intervals with P value<0.05. When we analyzed the stain removal using the brush with H<sub>2</sub>O<sub>2</sub> paste at various time intervals like, days 7,14,21 and 30, it was found that the stain reduced from severe to moderate among all the group. [Table 5]

**Table 3.** Comparison of the Mean Colour Change between Different Time Intervals among all the Staining Agents

Staining Agent	Exposure Time	Colour Change	P value
Coffee	24 hrs	3.10	0.037*
	72 hrs	4.70	
	144 hrs	6.30	
Tea	24 hrs	2.50	0.028*
	72 hrs	3.20	
	144 hrs	4.50	
Turmeric	24 hrs	5.80	0.016*
	72 hrs	7.40	
	144 hrs	9.10	
Coco-Cola	24 hrs	3.60	0.016*
	72 hrs	4.20	



Graph 1. Comparison of the mean colour change between different time intervals among all

Table 4. Comparison of the Visual score between different time intervals among all the staining agents

Staining agent	Exposure Time	Visual Score
Coffee	24 hrs	Moderate
	72 hrs	Moderate
	144 hrs	Severe
Tea	24 hrs	Mild
	72 hrs	Moderate
	144 hrs	Moderate
Turmeric	24 hrs	Severe
	72 hrs	Severe
	144 hrs	Severe
Coco-Cola	24 hrs	Moderate
	72 hrs	Moderate
	144 hrs	Severe

Table 5. Comparison of the Visual score of staining after brushing with H<sub>2</sub>O<sub>2</sub> Paste at various time intervals

Staining Agent	H <sub>2</sub> O <sub>2</sub> Brushing			
	Day 7	Day 14	Day 21	Day 30
Coffee	Severe	Severe	Moderate	Moderate
Tea	Moderate	Moderate	Moderate	Moderate
Turmeric	Severe	Severe	Moderate	Moderate
Coco Cola	Severe	Severe	Moderate	Moderate

Discussion



Coffee and turmeric are very well known product consumed worldwide. In addition they have potential to cause staining of dental material. For this reason they are around the most frequently used product in orthodontic bracket staining. The total immersion period was 14 days, since this period is long enough to cause perceptible colour modification of composite material. After this period tend towards modification is expected according to Guler<sup>4</sup>, the average time for consumption of coffee is 15 min, and avg consumption is 3.5 cups of coffee per day. Thus 24 hour simulate consumption of drink over 1 month. Therefore, 14 days consumption is period over one year, which co-relate to the duration of orthodontic treatment, same as for turmeric intake 2 meals for children and young adults, the primary sources of caffeine are soft drinks and teas, while for adults ages 25 and older; it is mostly derived from coffee [Knight et al., 2004]. However, a growing beverage category, energy drinks, is a popular choice with several age groups, and is a category to monitor for consumption in the coming years. Evidence from both scientific reviews and specific studies on consumption of caffeine generally concludes that daily consumption of 300 mg/day, or about three cups of coffee, is safe, even for more sensitive segments of the population, such as young children and pregnant women [Nawrot et al., 2003] per day. In the present study turmeric has greatest impact on colour stability followed by coffee and coca-cola according to literature coffee might produce more remarkable colour changes of the material in comparison with solution coca-cola even though these similar colour parameter reason . However, further researches are going on.

### Conclusion

1. The results of this study showed that orthodontic composite bracket showed maximum variation in colour stability. When this orthodontic bracket immersed in various food dyes like turmeric, coffee, black tea and coca cola maximum discoloration was seen in turmeric followed by coffee, coca cola and black tea.
2. Most affected turmeric and coffee stained orthodontic bracket was brushed for hydrogen peroxide containing toothpaste for 1 month. It was observed to decrease the discoloration within the clinically acceptable perceptibility range.
3. Patient is advised to limit intake of this food material during undergoing orthodontic treatment period to prevent staining of bracket.

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