SPECTROPHOTOMETRIC ANALYSIS OF TOOTH DISCOLOURATION INDUCED BY COFFEE AND TEA GROWN IN SOUTH INDIA – AN *IN VITRO* STUDY

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ABSTRACT

Billions around the world start their day with a hot beverage, coffee and tea are considered to be the world's most popular hot beverages. Staining of teeth is a common finding in both tea and coffee drinkers. This study was conducted to evaluate the discolouration caused by two different types of coffee and tea commercially grown in South India

Methods: A sample of 40 extracted, caries and stain free teeth were immersed for two minutes,four times a day for ten days in two different types of coffee (Robusta and Arabica) and tea (Organic and Green tea). Baseline and final values were obtained for color change, lightness, chroma and hue according to the CIELAB system using a spectrophotometer. Intragroup comparisons were carried out using Wilcoxon signed rank test and intergroup comparisons were carried out using Kruskal Wallis test (p value 0.05)

Results: Colour changes of stained teeth were not statistically significant when compared amongthe different groups,but the intragroup changes in lightesschroma and hue were statistically significant when compared between the baseline and final values.

Conclusion: The study suggests that both coffee and tea may cause external staining on the tooth surface

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INTRODUCTION

Tea and coffee are considered to be the world's most preferred hot beverages with billions of cups being consumed everyday (Ponte, 2002).Both tea and coffee causes discoloration of the tooth surface. Tooth discoloration is an aesthetic problem that is linked to a variety of causes and it could be a source of embarrassment, leading to reduced self-esteem. Dental stains, the pigmented deposits on the tooth surface are the first dental variation noticeable in a person, causing an aesthetic problem for the patients. They differ in etiology, appearance, composition, location, severity and degree of adherence to the tooth (Hattab et al., 1999). Discoloration of the teeth has been divided according to the origin of the stain into extrinsic or intrinsic staining (Gorlin& Goldman, 1971). The extrinsic as the name suggests, is found on the outer surface of the tooth while intrinsic stains are found within the tooth structure. Extrinsic and intrinsic stains can also exist in combination (Addy & Moran, 1995). Tannin compounds found in tea and coffee could be the cause of brown stains deposition on teeth surfaces (Norton, 1998). The color of enamel surfaces is usually defined by the combined effects of intrinsic and extrinsic discoloring agents (Watts & Addy, 2001).

The phenomenon of color appearance consists of three entities, and is described according to the Munsell color space in terms of value L,C and H values in which L represents the brightness of the color, C denotes the degree of saturation of a color in an object and h represents the pure colors. Spectrophotometer and colorimeter devices are presently employed to assess teeth color and give better and accurate results over the traditional methods which are affected by variables such as age, experience of the viewer, fatigue of the eyes, lighting conditions.

MATERIAL AND METHODS

After obtaining clearance from the Institutional Ethical

Committee, PCDS/IEC/K20/10/17 Forty upperand lower caries and stain free premolars, extracted for orthodontic purposes were collected and then polished with a prophylaxis paste using a polishing brush. After preparation the samples were stored in isotonic 0.9% saline solution. The teeth were randomly divided into four groups of ten teeth each,which were immersed into two varieties of coffee (Arabica and Robusta) and tea (Organic and Green tea).

Each tooth was placed in the corresponding solution for two minutes,four times a day for ten days. The color was assessed before and after staining, according to the CIEL*A*B* system with a spectrophotometer (VITA Easy shade compact). After each immersions for two minutes in the corresponding solution the teeth were washed in running water and kept in the isotonic solution for the next immersion.

Statistical analysis

The information and data were statistically analyzed using the SPSS software version 17. Intra group comparisons were carried out using Wilcoxon signed rank test and inter group comparison was carried out using Kruskal Wallis test (p value 0.05).

RESULTS

TABLE 1 - SHOWS THE COMPARISON BETWEEN BASELINE AND FINAL VALUES FOR ROBUSTA COFFEE IN COLOR CHANGE, LIGHTNESS CHROMA AND HUE. THE CHANGES IN LIGHTNESS, HUE AND CHROMA WERE FOUND TO BE STATISTICALLY SIGNIFICANT WHEREAS COLOR CHANGES WERE NOT STATISTICALLY SIGNIFICANT

	Color		Lightness		Chroma		Hue	
Group	Baseline	Final	Baseline	Final	Baseline	Final	Baseline	Final
Mean	4.120000	4.410	-1.540	-2.38000	-4.3400	-3.780	.980000	0.340
Std deviation	0.4131182	0.1449	.3098	.2898275	.2065591	.1932	.1549193	0.0966
Median	3.800000	4.500	-1.300	-2.20000	-4.500000	-3.900	1.100000	0.400
Minimum	3.8000	4.2	-1.9	-2.8000	-4.5000	-3.9	.8000	0.2
Maximum	4.6000	4.5	-1.3	-2.2000	-4.1000	-3.5	1.1000	0.4

Wilcoxon signed rank test with a p value of 0.05 was carried out to compare the baseline and final values

TABLE 2 - SHOWS THE COMPARISON BETWEEN BASELINE AND FINAL VALUES FOR GREEN TEA IN COLOR CHANGE, LIGHTNESS CHROMA AND HUE. THE CHANGES IN LIGHTNESS HUE AND CHROMA WERE FOUND TO BE STATISTICALLY SIGNIFICANT WHEREAS COLOR CHANGES WERE NOT STATISTICALLY SIGNIFICANT

	Color		Lightness		Chroma		Hue	
Group	Baseline	Final	Baseline	Final	Baseline	Final	Baseline	Final
Mean	4.120000	4.350	-1.540	-2.500000	-4.340000	-3.700	.980000	.300
Std deviation	.4131182	0.1581	0.3098	0.3162278	0.2065591	0.2108	.1549193	.1054
Median	3.800000	4.350	-1.300	-2.500000	-4.500000	-3.700	1.100000	0.300
Minimum	3.8000	4.2	-1.9	-2.8000	-4.5000	-3.9	0.8000	0.2
Maximum	4.6000	4.5	-1.3	-2.2000	-4.1000	-3.5	1.1000	0.4

Wilcoxon signed rank test with a p value of .05 was carried out to compare between the baseline and final values

TABLE 3 - SHOWS THE COMPARISON BETWEEN BASELINE AND FINAL VALUES FOR ARABICA COFFEE IN COLOR CHANGE, LIGHTNESS CHROMA AND HUE. THE CHANGES IN LIGHTNESS HUE AND CHROMA WERE FOUND TO BE STATISTICALLY SIGNIFICANT WHEREAS COLOR CHANGES WERE NOT STATISTICALLY SIGNIFICANT

	Color		Lightness		Chroma		Hue	
Group	Baseline Color change	Final Color change	Baseline lightness	Final lightness	Baseline Chroma	Final Chroma	Baseline Hue	Final Hue
Mean	4.120000	4.440	-1.540	-2.320000	-4.340000	-3.820	0.980000	0.360
Std deviation	0.4131182	0.1265	0.3098	0.2529822	0.2065591	0.1687	0.1549193	0.0843
Median	3.800000	4.500	-1.300	-2.200000	-4.500000	-3.900	1.100000	0.400
Minimum	3.8000	4.2	-1.9	-2.8000	-4.5000	-3.9	0.8000	0.2
Maximum	4.6000	4.5	-1.3	-2.2000	-4.1000	-3.5	1.1000	0.4

Wilcoxon signed rank test with a p value of .05 was carried out to compare between the baseline and final values

TABLE 4 - SHOWS THE COMPARISON BETWEEN BASELINE AND FINAL VALUES FOR ORGANIC TEA IN COLOR CHANGE, LIGHTNESS CHROMA AND HUE. THE CHANGES IN LIGHTNESS HUE AND CHROMA WERE FOUND TO BE STATISTICALLY SIGNIFICANT WHEREAS COLOR CHANGES WERE NOT STATISTICALLY SIGNIFICANT

	Color		Lightness		Chroma		Hue	
Group	Baseline Color change	Final Color change	Baseline lightness	Final lightness	Baseline Chroma	Final Chroma	Baseline Hue	Final Hue
Mean	4.120000	4.290	-1.540	-2.620000	-4.340000	-3.620	0.980000	0.260
Std deviation	0.4131182	0.1449	0.3098	0.2898275	0.2065591	0.1932	0.1549193	0.0966
Median	3.800000	4.200	-1.300	-2.800000	-4.500000	-3.500	1.100000	0.200
Minimum	3.8000	4.2	-1.9	-2.8000	-4.5000	-3.9	0.8000	0.2
Maximum	4.6000	4.5	-1.3	-2.2000	-4.1000	-3.5	1.1000	0.4

Wilcoxon signed rank test with a p value of .05 was carried out to compare between the baseline and final values

TABLE 5 - SHOWS THE INTERGROUP COMPARISON FOR COLOR CHANGE, LIGHTNESS, CHROMA AND HUE.NONE OF THE VALUES WERE FOUND TO BE STATISTICALLY SIGNIFICANT

Colour change among the groups	0.870
Change in Lightness among the groups	0.331
Change in Chroma among the groups	0.331
Change in hue among the groups	0.721

Kruskal Wallis test with a p value of 0.05 was carried out for the intergroup comparisons

DISCUSSION

A number of methods are available for evaluating tooth shade changes. In this study in order to achieve consistent and accurate results, spectrophotometer was used.

Tooth discoloration is dependent on a variety of factors, such as the pH value of the staining solution (Addy et al., 1979).Acidic solutions can increase demineralization, while others containing ethanol and pigments can cause staining (Berger et al., 2008).

The causes of extrinsic staining can be divided into two categories; those compounds which are incorporated into the pellicle and produce a stain as a result of their basic color, and those which lead to staining caused by chemical interaction at the tooth surface. Many original laboratory and clinical studies showed coffee produced less staining than tea(Addy et al., 1979) - But in our study both varieties of coffee and tea did not show statistically significant differences when compared among them. The short duration of the study could be a probable cause for these findings.

Direct staining has a multi-factorial etiology, with chromogens derived from dietary sources or habitually placed in the mouth. These organic chromogens are taken by the pellicle and the color imparted is determined by the natural color of the chromogen, tobacco smoking and chewing are known to cause staining as are particular beverages such as tea and coffee.The color seen on the tooth is thought to be derived from polyphenolic compounds which provide the color in food(Pearson, 1976) Tannins are astringent, polyphenolic compounds that bind to and precipitate proteins and various other organic compounds including amino acids and alkaloids found in both coffee and tea in varying concentrations.

When comparing the color change ΔE from baseline to the final value, in Groups 1-4 none of the values were found to be statistically significant. In this study all the four groups showed statistically significant changes in chroma,hue and lightness. The intergroup comparisons also didn't show statistically significant differences amongthe groups in any of the parameters.

Studies by Karadas& Seven (2014) showed that coffee didnot not produce statistically significant color changes whereas tea and cola produced contrary to our study where none of the solutions showed statistically significant differences.

Different varieties of tea and their staining potential were compared in a study by Al Abdulwahab et al.(2015) and had shown that red tea caused the maximum staining.

Our study didnot show statistically significant differences in color changes maybe due to the short span of the study. However,considering that the study parameters chroma,hue and lightness showed statistically significant changes within each given group, it can be concluded that tea and coffee may cause staining of the teeth. Further long term studies are needed to understand the staining potential of tea and coffee grown in different parts of the world.

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