International Journal of New Technology and Research (IJNTR)
ISSN: 2454-4116, Volume-4, Issue-6, June 2018 Pages 01-09

The Effect of Organic Flaxseed Paste on The Colorimetric Parameters of Demineralized Tooth Surface

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Abstract— **Objective: The aim of the study is to evaluate the efficacy of flaxseed paste on the surface lightness (L), chroma (C) and hue (h) of extracted teeth. Materials and Methods: Thirty extracted human teeth (incisors and canines) were selected and grouped into control (no treatment), flaxseed (treatment) and fluoride (positive control) groups. Teeth in control group were placed in saline throughout the experiment, whilst the teeth in flaxseed and fluoride groups were immersed in a carbonated drink for two days to induce demineralisation prior to the treatment using fluoride toothpaste and 1gm/ml of freshly prepared flaxseed paste respectively. The values L, C and h were measured at 3 stages (initial, during treatment, after treatment) using a spectrophotometer. Computerized digital imaging analyses were performed using Photoshop CS6 software (Adobe, San Jose, CA, USA). Statistical analyses were performed using repeated measures ANOVA. Results: At the final reading, spectrophotometric analysis showed decrease in L in both positive control and test groups. Fluoride was more effective, but not significant, in reducing the lightness (L=55.69 ± 5.38, p=0.070) than flaxseed (L=67.60 ± 5.34, p=0.070). The mean C value was higher in flaxseed group (C=2.75 ± 2.73, p=0.010) compared to fluoride group (C=2.78 ± 2.73, p=0.010). In contrast, the mean h value for flaxseed group was much lower (h=121.50 ± 10.53, p=0.000) when compared to fluoride group (h=260.02 ± 10.53, p=0.000). Conclusion: Flaxseed paste has shown to be effective in reducing L. Although fluoride toothpaste produced obvious decrease in L, organic flaxseed paste shows promising effect in alleviating surface lightness, hence enhancing tooth surface mineralisation that may be explored further in future research.**

Index Terms— **Flaxseed, digital imaging analysis, lightness, mineralisation, spectrophotometer.**

I. INTRODUCTION

The first clinically observable stage of caries initiation is the development of white spot lesion (WSL) (Hallgren, Akyalcin, English, Tufekci, & Paravina, 2016). Besides being an aesthetic challenge, WSLs are regions of demineralized enamel which are porous and structurally weaker (Figure 1). The mechanism of action is the dissolution of mainly calcium and phosphorus in the enamel matrix by acids.

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Figure 1: White spot lesions developed after orthodontic treatment due to poor oral hygiene

Under optimal circumstances, salivary constituents have a natural buffering system that maintain the pH at optimum levels, and acts as a physical mechanism to remove acids from enamel surfaces. However, as the oral cavity becomes increasingly acidic, the pH of dental biofilm will decrease as well (Igarashi, Hamada, Nishimaki, Sakurai, & Kamiyama, 1987; Wolff & Larson, 2009).

Derived from the Flax plant, flaxseed (*Linum usitatissimum L.*) has been touted as a superfood, owing to its high omega-3 fatty acid α-linolenic acid (ALA) and high fibre content (Shim, Gui, Arnison, Wang, & Reaney, 2014). Flaxseed, also known as linseed, boasts of several distinctive qualities. Previous study suggested that flaxseed's has polyphenol compound called lignans which possesses antibacterial activity against the cariogenic bacteria, *Streptococcus mutans* (Imran et al., 2015). The mucilage or soluble fiber in flaxseed is believed to be a suitable saliva replacement in dry mouth patients (Andersson et al., 1995). The mineral composition in flaxseed, per 100g, was found to be 255mg, 392mg, 642mg, and 813mg for calcium, magnesium, phosphorus, and potassium, respectively (Goyal, Sharma, Upadhyay, Gill, & Sihag, 2014). The availability of calcium, phosphorus and fluoride in the oral cavity is one of the factors which affect remineralization rates of enamel (Ramashetty Prabhakar & Arali, 2009). When salivary pH level is above the critical pH, calcium and phosphorus will be precipitate into hydroxyapatite as part of enamel remineralization (ten Cate, 2008). Furthermore, it was found that a test dentifrice which contained potassium nitrate showed significant remineralization of artificially demineralized enamel (Zero et al., 2006).

The color of enamel surface, can be objectively measured via spectrophotometric analysis (Lunardi, Correr, Rastelli, Lima, & Consani, 2014; Peskersoy, Tetik, Ozturk, & Gokay, 2014; Vieira, Arakaki, & Caneppele, 2008). Its function is based on a principle that is uniform across all color-measuring devices, which is the illumination of an object by an internal light source (Yang, Murakami, & Yamaguchi, 2012). The authority on the science of light and color Commission.

Internationale de l'Eclairage (CIE), has defined the L*C*h color space as a means of expressing colour attributes in numerical terms (Acton & Dawson, 2004). The spectrophotometer scans the object and translates it into color constituents represented by the three axes in the L*C*h color model (Figure 2), namely lightness (L), chroma (C), and hue (h). L sits on the vertical axis. It is the measure of an object's brightness, which ranges from 0 (no lightness/absolute black) to 100 (maximum lightness/absolute white). C represents the saturation of an object, where 0 is completely unsaturated (*i.e.* a neutral grey, black or white). A chroma value of 100 or more represents very high saturation. Hue is every possible saturated colour, represented by degrees, 0° (red) through 90° (yellow), 180° (green), 270° (blue) and back to 0° (Kimura, 2018).

The purpose of this study is to investigate the efficacy of flaxseed as an organic remineralizing agent through colorimetric values of L, C and h using a spectrophotometer. Supplemental analysis of the same parameters is achieved by using an image-editing computer software, Photoshop CS6 (Adobe, San Jose, CA, USA).

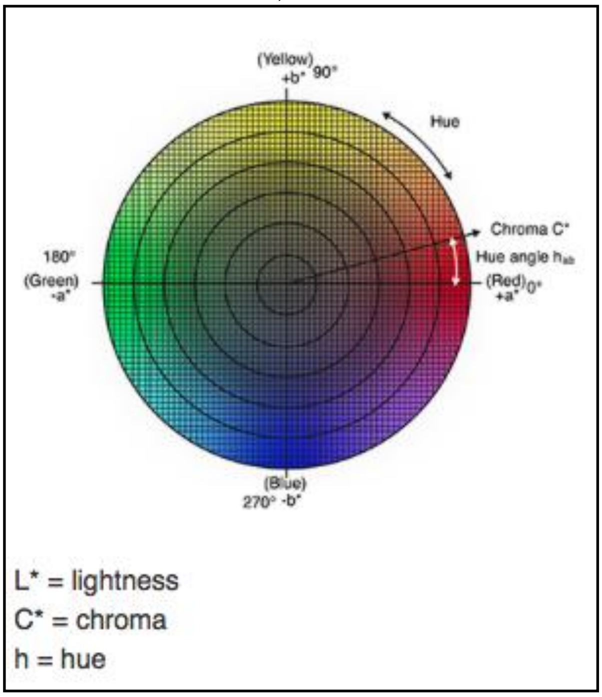

Figure 2: Illustration of L*C*h color space model (Acton & Dawson, 2004)

II. MATERIALS AND METHODS

Thirty human teeth consisting of incisors and canines were collected. The samples were grouped into control (no treatment), fluoride (positive control) and flaxseed (treatment) groups (Figure. 3). Ten teeth in the control group were placed in normal saline. The remaining ten teeth for flaxseed paste treatment and ten teeth for fluoride paste treatment were immersed in carbonated drink (Coke) for two days (Dincer, Hazar, & Sen, 2002; Kitchens & Owens, 2007; Seow & Thong, 2005) [7, 8, 32]. After two days of immersion, spectrophotometer (Spectrophotometer CM-5, Konica Minolta, Tokyo, Japan) (Figure 4) was used to measure the L, C and h for all the groups on only the labial surfaces.

Then, 1gm/ml flaxseed paste was prepared using freshly ground flaxseed and mixed with deionised distilled water. The mixture was then properly mixed to the desired consistency. Ten teeth in the flaxseed group were then treated with the flaxseed paste for 14 days. For the positive control group, the teeth were placed in 1450ppm fluoride toothpaste (Colgate: Sugar Acid Neutralizer) for the same period of 14 days. The L, C and h were measured again. The immersion in flaxseed paste and fluoride toothpaste was repeated. The final reading was taken after another 14 days. At each stage, clinical photo of the teeth were saved as a JPEG file and computerized digital imaging analyses were performed using Photoshop CS6 software (Adobe, San Jose, CA, USA) (Table 3).

Figure 3: Thirty extracted teeth placed and labelled as control (no treatment), fluoride (positive control) and flaxseed (treatment group)

Figure 4: Spectrophotometer

The spectrophotometer (Spectrophotometer CM-5, Konica Minolta, Tokyo, Japan) was calibrated using zero calibration first, followed by white calibration. Then, each sample was placed on the target mask, ensuring the tooth is as close as possible to the specimen measuring port. Measurements were taken three times and average readings were taken. The measurements were then transferred to the computer and the data were saved.

Computerized digital imaging analyses were performed using Photoshop CS6 software (Adobe, San Jose, CA, USA). All the clinical photos that were taken and saved as JPEG format were analysed using eyedropper tool which was targeted on a point on the photo. The details of the L, C and h can be obtained from the foreground colour (Figure 5).

The results for spectrophotometric readings were analysed by statistical analysis software SPSS 24.0 (IBM, Endicott, NY, USA) using repeated-measures analysis of variance (ANOVA) followed by a multivariate Pillai test. All tests were carried out at a 5% level of significance.

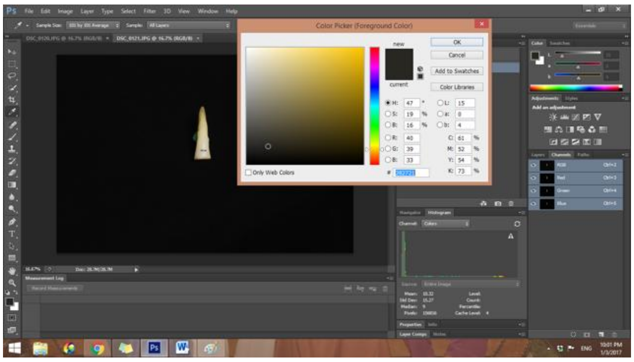

Figure 5: Computerized digital imaging analysis using Photoshop CS6 software

III. RESULTS

A. *Spectrophotometric Results & Analysis*

All the teeth in the two treated (flaxseed and fluoride) groups showed decrease in lightness in the final reading. In the fluoride group, the mean percentage of decrease in L is 29.62% whereas the flaxseed group showed 12.58% in mean L reduction. The percentage of changes of L, C, and h is illustrated in Figure 6. All ten samples in the flaxseed group showed decrease in lightness at the second post-treatment reading, whereas only 90% of the fluoride group showed L reduction. As for chroma, there was only 7.95% reduction in mean C value in the fluoride group, whereas flaxseed group showed a decrease of 35.75%, which is four times this value. Overall, C decreased in both groups. It was found that there was a staggering difference between the rise in mean hue in two treatment groups. The fluoride group showed a 130% increase, but there was only 10.58% rise from the flaxseed-treated teeth.

A summary of the spectrophotometric readings is shown in Table 1.The pattern of change in lightness, chroma, and hue for all three groups is shown in Figure 7. Overall, there was a significant difference ($F = 6.086$, $p < 0.007$) of mean L value among three different groups based on time (Table 2). At the final reading, there was a difference of mean lightness value between flaxseed group and fluoride group. Fluoride had a lower mean L value ($L=55.69 \pm 5.38$, $p=0.070$) than flaxseed ($L=67.60 \pm 5.34$, $p=0.070$). Figure 9 shows the mean C value was higher in flaxseed group ($C=2.75 \pm 2.73$, $p=0.010$) compared to fluoride group ($C=2.78 \pm 2.73$, $p=0.010$). In contrast, the mean h value for flaxseed group was much lower ($h=121.50 \pm 10.53$, $p=0.000$) when compared to fluoride group ($h=260.02 \pm 10.53$, $p=0.000$) (Figure10).

Control group showed no significant changes between the L mean values but had differences in C and h and in the initial (L: 71.09, C: 3.29, h: 116.48) and final (L:70.54, C: 7.58, h: 101.40) readings.

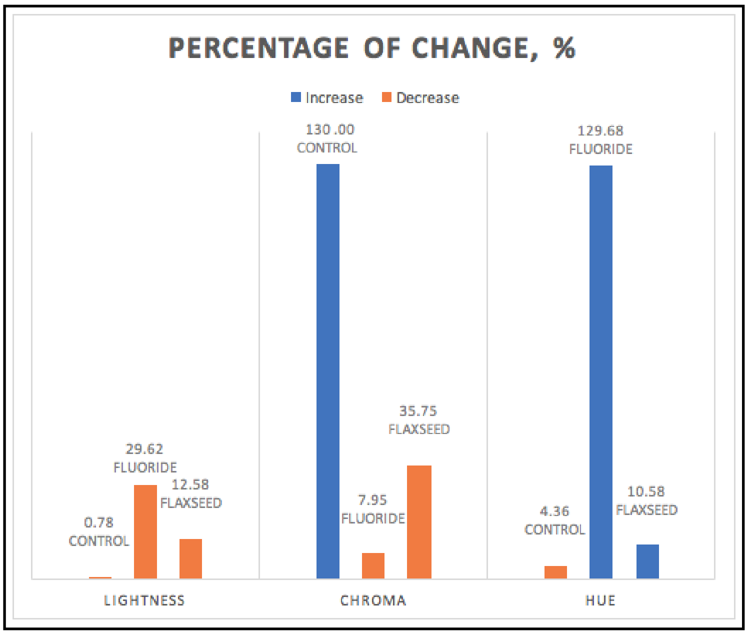

Figure 6: Percentage of changes in three groups for L*C*h parameters

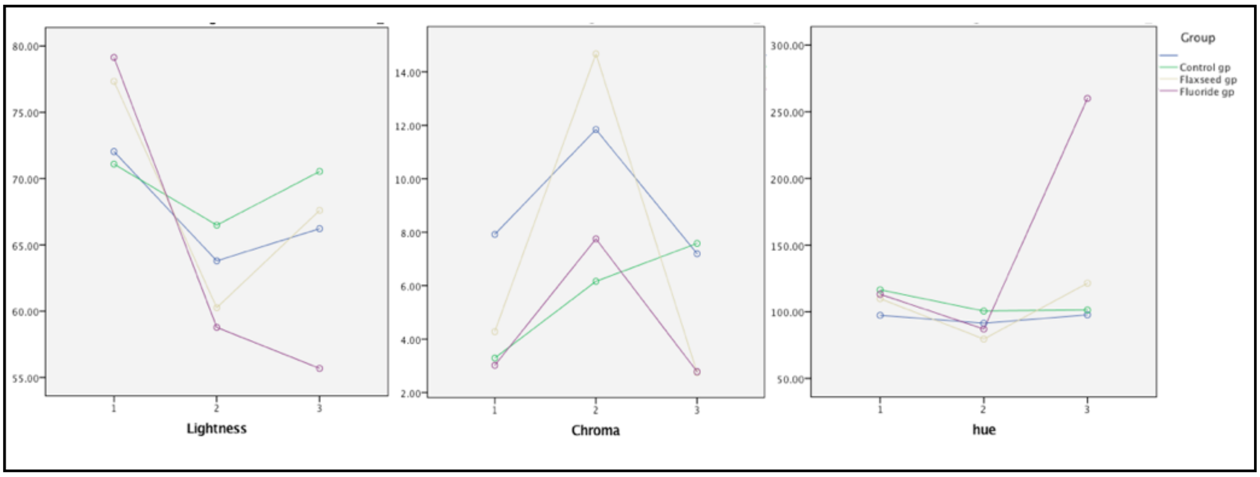

Figure 7: Line plots from mean values obtained from spectrophotometer for L, C and h.

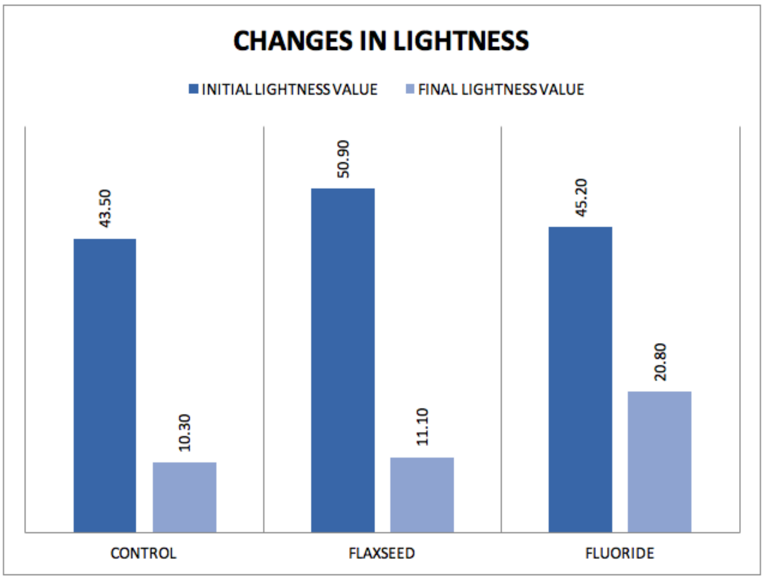

Figure 8: Mean difference in lightness when measured using computerized digital imaging analysis for control, flaxseed and fluoride

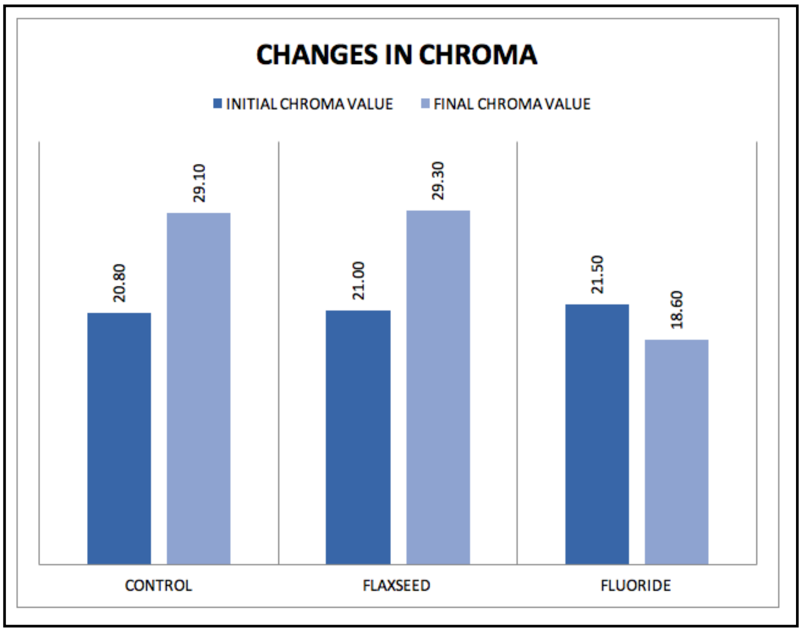

Figure 9: Mean difference in chroma when measured using computerized digital imaging analysis for control, flaxseed and fluoride

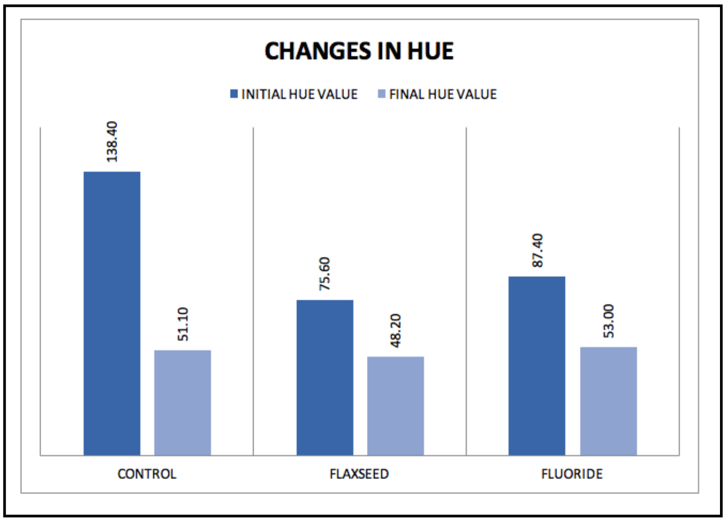

Figure 10: Mean difference in hue when measured using computerized digital imaging analysis for control, flaxseed and fluoride.

Table 1: Summary of spectrophotometric L, C, h values

Group	Tooth	Initial*			Post-treatment**					
		L_0	C_0	h_0	L_1	C_1	h_1	L_2	C_2	h_2
Control	1	71.09	3.29	116.48	66.49	6.16	100.62	70.54	7.58	101.40
	2	71.56	6.30	101.35	68.96	8.23	97.74	63.38	8.66	98.97
	3	69.22	9.37	97.45	59.18	6.31	103.17	72.93	14.71	92.92
	4	55.53	5.10	90.69	64.97	9.83	88.72	68.75	9.24	90.42
	5	56.01	7.34	89.78	64.72	9.56	84.53	67.49	11.38	85.85
	6	72.88	2.62	116.49	57.12	1.71	200.75	57.40	2.41	122.09
	7	65.15	4.38	98.55	75.72	6.74	101.10	66.74	4.09	106.82
	8	74.97	7.42	99.18	66.91	6.91	101.19	70.78	7.99	97.70
	9	68.45	11.51	88.10	63.06	9.32	90.25	54.45	5.87	92.75
	10	74.23	12.65	92.57	68.79	13.00	93.26	59.14	9.23	92.67
Fluoride	1	79.13	3.02	113.21	58.78	7.75	87.10	55.69	2.78	260.02
	2	64.97	3.44	112.35	64.98	8.06	90.66	68.58	6.23	98.86
	3	75.72	11.04	97.67	64.10	18.44	79.13	71.49	8.06	96.67
	4	77.11	5.17	108.81	65.30	15.16	84.47	69.84	3.27	121.84
	5	79.32	11.76	88.55	64.92	19.41	78.67	75.24	9.94	90.87
	6	76.51	12.45	86.45	63.18	17.80	75.84	71.82	6.90	88.64
	7	75.53	9.85	95.98	68.39	12.40	86.77	68.77	7.22	94.28
	8	65.87	4.83	98.77	52.40	12.12	81.26	68.60	2.10	122.65
	9	78.06	9.89	99.24	66.05	19.23	81.38	71.24	5.79	106.86
	10	73.58	6.11	106.25	53.76	16.40	78.02	74.27	7.55	97.86
Flaxseed	1	77.33	4.28	109.88	60.27	14.67	79.63	67.60	2.75	121.50
	2	77.59	6.91	97.67	64.03	12.49	86.18	64.73	6.75	92.18
	3	71.34	4.72	102.65	66.27	7.02	93.65	64.48	3.85	98.36
	4	76.70	10.06	94.40	63.22	10.13	91.52	63.23	6.79	100.09
	5	67.54	11.60	83.11	56.79	16.82	72.66	58.90	9.88	83.81
	6	81.14	8.59	101.34	64.99	14.74	85.26	64.04	6.95	88.26
	7	78.91	9.60	98.63	57.41	10.95	86.10	59.56	7.68	91.39
	8	68.23	3.57	103.85	65.18	12.33	87.62	64.25	7.79	95.57
	9	77.94	7.73	99.46	63.44	13.59	85.26	66.30	5.78	104.20
	10	70.97	9.82	80.84	68.67	11.07	83.51	61.65	8.11	87.61

***After two days of immersion in carbonated drink**
****14 and 28 days after treatment**

Table 2: Results of statistical analysis for spectrophotometric L parameter

Group	Lightness	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
	L_0	72.038	1.261	69.445	74.631
	L_1	63.797	.968	61.807	65.787
	L_2	66.224	1.035	64.097	68.351
Control	L_0	71.090	6.554	57.617	84.563
	L_1	66.490	5.030	56.150	76.830
	L_2	70.540	5.377	59.488	81.592
Flaxseed	L_0	77.330	6.554	63.857	90.803
	L_1	60.270	5.030	49.930	70.610
	L_2	67.600	5.377	56.548	78.652
Fluoride	L_0	79.130	6.554	65.657	92.603
	L_1	58.780	5.030	48.440	69.120
	L_2	55.690	5.377	44.638	66.742

Multivariate Test

	Value	F	Hypothesis df	Error df	Sig.
Pillai's trace	.327	6.086[a]	2.000	25.000	.007

Lightness	Group	Mean L value	95% CI
Initial lightness, L_0	Flaxseed	77.33	63.86, 90.80
	Fluoride	79.13	65.66, 92.60
	Control	71.09	57.62, 84.56
Lightness measured after 7 days, L_1	Flaxseed	60.27	49.93, 70.61
	Fluoride	58.78	48.44, 69.12
	Control	66.49	56.15, 76.83
Lightness measured after 14 days. L_2	Flaxseed	67.60	56.55, 78.65
	Fluoride	55.69	44.64, 66.74
	Control	70.54	59.49, 81.59

***Values rounded off to two decimal places**

Table 3: Results of statistical analysis for spectrophotometric C parameter

Group	Chroma	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
	C_0	7.920	.582	6.724	9.115
	C_1	11.843	.857	10.082	13.605
	C_2	7.193	.526	6.112	8.275
Control	C_0	3.290	3.022	-2.922	9.502
	C_1	6.160	4.453	-2.992	15.312
	C_2	7.580	2.734	1.959	13.201
Flaxseed	C_0	4.280	3.022	-1.932	10.492
	C_1	14.670	4.453	5.518	23.822
	C_2	2.750	2.734	-2.871	8.371
Fluoride	C_0	3.020	3.022	-3.192	9.232
	C_1	7.750	4.453	-1.402	16.902
	C_2	2.780	2.734	-2.841	8.401

Multivariate Test

	Value	F	Hypothesis df	Error df	Sig.
Pillai's trace	.306	5.524[a]	2.000	25.000	.010

Chroma	Group	Mean C value	95% CI
Initial chroma, C_0	Flaxseed	4.28	-1.93, 10.49
	Fluoride	3.02	-3.19, 9.23
	Control	3.29	-2.92, 9.50
Chroma measured after 7 days, C_1	Flaxseed	14.67	5.52, 23.82
	Fluoride	7.75	-1.40, 16.90
	Control	6.16	-2.99, 15.31
Chroma measured after 14 days. C_2	Flaxseed	2.75	-2.87, 8.37
	Fluoride	2.78	-2.84, 8.40
	Control	7.58	1.96, 13.20

***Values rounded off to two decimal places**

Table 4: Results of statistical analysis for spectrophotometric h parameter

Group	hue	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
	h_0	97.414	1.607	94.111	100.717
	h_1	91.432	4.459	82.267	100.597
	h_2	97.785	2.027	93.618	101.952
Control	h_0	116.480	8.350	99.315	133.645
	h_1	100.620	23.168	52.997	148.243
	h_2	101.400	10.533	79.749	123.051
Flaxseed	h_0	109.880	8.350	92.715	127.045
	h_1	79.630	23.168	32.007	127.253
	h_2	121.500	10.533	99.849	143.151
Fluoride	h_0	113.210	8.350	96.045	130.375
	h_1	87.100	23.168	39.477	134.723
	h_2	260.020	10.533	238.369	281.671

Multivariate Test

	Value	F	Hypothesis df	Error df	Sig.
Pillai's trace	.824	58.397[a]	2.000	25.000	.000

Hue	Group	Mean h value	95% CI
Initial hue, h_0	Flaxseed	109.88	92.72, 127.05
	Fluoride	113.21	96.05, 130.38
	Control	116.48	99.32, 133.65
Hue measured after 7 days, h_1	Flaxseed	79.63	32.00, 127.25
	Fluoride	87.10	39.48, 134, 72
	Control	100.62	53.00, 148.24
Hue measured after 14 days. h_2	Flaxseed	121.50	99.85, 143.15
	Fluoride	260.02	238.37, 281.67
	Control	101.40	79.75, 123.05

*Values rounded off to two decimal places

Table 5: Summary of L, C, and h values determined using Adobe Photoshop CS6.

Group	Tooth	Initial* L_0	C_0	h_0	Post-treatment** L_1	C_1	h_1	L_2	C_2	h_2
Control	1	42	30	161	17	19	48	7	26	52
	2	45	26	156	15	19	47	3	32	56
	3	42	22	154	20	31	41	9	32	44
	4	43	23	162	16	33	38	6	22	48
	5	41	18	100	16	35	39	7	29	53
	6	45	17	143	18	11	55	12	26	45
	7	47	22	164	16	17	50	12	24	53
	8	45	16	106	20	24	25	16	28	47
	9	43	18	110	18	36	41	15	44	45
	10	42	16	128	18	25	49	16	28	68
Fluoride	1	44	18	142	21	17	44	23	13	45
	2	51	17	84	21	25	42	25	24	45
	3	46	26	66	25	30	44	14	20	57
	4	45	28	62	26	24	43	28	19	41
	5	50	32	67	25	34	42	24	31	41
	6	51	13	132	19	35	42	10	19	54
	7	41	20	78	21	33	44	17	12	55
	8	40	21	92	20	30	43	25	21	46
	9	44	18	78	22	25	45	26	15	80
	10	40	22	73	23	27	43	16	12	66
Flaxseed	1	53	18	63	31	17	44	8	20	51
	2	56	27	57	35	18	44	9	26	50
	3	59	22	65	33	31	41	8	34	44

4	53	19	90	30	23	41	8	23	56
5	50	33	55	26	36	41	7	35	46
6	41	15	93	31	17	45	29	26	45
7	55	26	59	29	21	45	8	24	52
8	40	10	112	25	32	39	7	26	50
9	51	19	81	32	20	45	10	29	49
10	51	21	81	27	34	40	17	50	39

***After two days of immersion in carbonated drink**
****14 and 28 days after treatment**

B. Computerized Digital Imaging Results & Analysis

Based on the data obtained from Table 2, a graph on changes in lightness (Figure 8) was made using the average value and reduction in L which was observed to decrease can be observed for teeth treated with flaxseed which is from 50.90 to 11.10 for teeth in flaxseed group. L kept on decreasing in value over time. The control group also showed reduction in lightness upon time. As for the fluoride group, there is a decrease in lightness although we can note the reduction in lightness after 14 days of treatment, but when the measurements were taken again in the next 14 days, half of the teeth appears to have a slight increase in L. However, when comparing the average value of L, we can note there is still reduction in L from 45.20 to 25.80. From the average value, the difference in L of teeth treated with flaxseed is 39.80 while teeth treated with fluoride is 19.4. Teeth that were treated with flaxseed exhibited greater reduction when compared with teeth that were treated with fluoride.

Results showed that C value of control group increased from 20.8 to 29.10 and C value for flaxseed group also increased from 21.00 to 29.30. The C values for fluoride group, however, decreased from 21.50 to 18.60 (Figure 9). Results also showed that h value shows reduction in all three groups (Control: from 138.40 to 51.10; Flaxseed: from 75.60 to 48.20; Fluoride: from 87.40 to 53.00) (Figure 10).

IV. Discussion

The present pilot study was conducted to test the efficacy of flaxseed as an organic remineralizing agent, by measuring colorimetric parameters using a spectrophotometer and adjunctive computerized digital imaging software analysis. L, C and h were evaluated pre- and post-treatment with flaxseed and fluoridated tooth paste. Lightness parameters increased after immersion of teeth in carbonated drink, a phenomenon which indicates that demineralization cause an increase in surface lightness. As previously mentioned, demineralization is more likely to occur when the hydroxyapatite crystals in enamel become less closely packed in low pH environment, rendering the enamel more soluble and susceptible to lose its minerals (Hallgren et al., 2015).

Loss of minerals, low fluorescence radiance and white appearance are cardinal characteristics of incipient, demineralized lesions. The mineral loss causes an alteration in the refractive index of enamel and increases light scattering in the WSL (Sundararaj, Venkatachalapathy, Tandon, & Pereira, 2015). To simulate this, the samples in fluoride and flaxseed groups were immersed in carbonated drink prior to treatment to induce WSLs, or at the very least, to leach minerals from the enamel surface. The composition of Coke is carbonated water, high fructose corn syrup, caramel colouring, phosphoric acid, natural flavours and caffeine, among others. The pH recorded is 2.49 (Kitchens & Owens, 2007), which is significantly lower than the critical pH 5.5 at which demineralization starts to occur. Due to the poor aesthetics that come hand in hand with WSL (Kim, Son, Yi, Ahn, & Chang, 2016), vital bleaching is one of the methods employed to restore acceptable clinical appearance (Knosel, Attin, Becker, & Attin, 2007). However, it is important to note that bleaching is used to only lighten the surrounding background colour of the tooth for the WSL to appear indistinct (Greenwall, 2009). Despite the ability to satisfactorily camouflage inactive WSL, bleaching treatments would require supportive remineralization therapy to maintain enamel strength (Kim et al., 2016; Knosel et al., 2007). In addition, reports of dental sensitivity during and post-bleaching treatments are widely circulated (Moghadam, Majidinia, Chasteen, & Ghavamnasiri, 2013). Therefore, we believe it is imperative to find an agent that facilitates remineralization that can aesthetically improve enamel appearance without adverse effects such as sensitivity.

In this study, the decrease in L and C shown across all samples treated with flaxseed, shows that it is capable of reversing demineralization and probably restoring strength and aesthetics of demineralized enamel. This is supported by the theory that when an object's translucency decreases, the amount light passing through it will decrease as well, and the object will seem less saturated (Vieira et al., 2008) [28]. It can be postulated that the high content of calcium and potassium aids in remineralization (Knight, McIntyre, Craig, & Mulyani, 2006; Zhi, Lo, & Kwok, 2013). The spectrophotometric analysis was made the primary data measurement method because it precludes visual perception or environmental lighting as digital imaging analysis could be less accurate due to color deflections, shadows and daylight interference (Peskersoy et al., 2014).

Molecule size will affect the penetrability of the enamel (Jheon, Seidel, Biehs, & Klein, 2013) by chemicals, saliva or even bacteria; hence, it would certainly affect flaxseed paste penetration. Flaxseed paste solubility will also affect the amount of flaxseed minerals penetrating the tooth surface and subsequently influence the colorimetric parameters. In healthy enamel, the percentage of these pores is only 0.1%. In contrast to that, an initial lesion that lies above sound enamel will have 1% of these pores. This is called the translucent zone. These pores or micro-channels have a diameter of 0.5 to 1.5 μm and a depth of 100 μm, which eventually allow bacterial invasion (Barbosa de Sousa, Dias Soares, & Sampaio Vianna, 2013). We anticipate that using flaxseed paste for remineralizing the enamel surface would block these micro-channels and subsequently hinder bacterial invasion, therefore, saving the tooth from further mineral loss and destruction.

Due to flaxseed's remarkable mineral content, especially for calcium, potassium, phosphorus and magnesium; and its effect on the demineralized tooth surface, it would be interesting that future investigation can be implemented to clarify the biochemical mechanism of flaxseed role on the demineralized enamel surface or mineral loss.

V. Conclusion

Flaxseed induces noticeable effect on the tooth surface by reducing the lightness parameters of the demineralised surface. The decreased lightness values of enamel surface after flaxseed application is attributed to the influx of high calcium and potassium minerals content of flaxseed paste into the enamel structure, rendering it less permeable to light, which makes flaxseed a promising complementary organic agent for tooth remineralization.

CONFLICT OF INTEREST

No conflict of interest existed.

ACKNOWLEDGEMENT

We would also like to thank Ms. Izyan Hazwani Baharuddin for her assistance in the statistical analysis of our research results.

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