



Effect of Microwave and Ultrasonic Disinfecting

Techniques on the Color of Artificial Teeth: A Comparative Study.

ABSTRACT

Aims of the Study: To evaluate the influence of disinfection by microwave and ultrasonic cleaning techniques on the color parameters of different types of artificial teeth used in prosthodontic treatment. **MATERIALS & METHODS:** Three types of artificial teeth were used: Porcelain teeth, RMH acrylic teeth (double cross linked) and Seif acrylic teeth (cross linked). Samples were immersed in distilled water for 48 hours at 37°C before taking measurements. The color parameters (*hue, chroma and value*) of study samples were measured by Easy shade device before treatment, after disinfection by microwave (800 watt for 6 minutes), and lastly after cycle in ultrasonic cleaner (15minutes with effervescent tablet). Data were statistically analyzed by Analysis of Variance (ANOVA) followed by Duncan Multiple Analysis Range Test to determine the level of significance. **RESULTS:** Color of acrylic teeth was affected more than that of porcelain teeth. Results showed significant differences ($P<0.05$) in *chroma* and *value* color parameters before and after disinfection for Acrylic teeth but not for *hue* parameter. **CONCLUSIONS:** Seif teeth colors changed during disinfection more than RMH teeth, while Porcelain teeth the least. Microwave disinfection technique do not affect significantly the color of denture teeth

الخلاصة

الهدف: معرفة تأثير التعقيم باستخدام جهاز الموجات المجهريه وجهاز التعقيم بالموجات فوق الصوتية على صفات اللون لثلاثة أنواع من الأسنان الاصطناعية المستخدمة في التعويضات السنية. **المواد والطرق:** استخدمت ثلاثة أنواع من الأسنان الاصطناعية: أسنان البورسلين، أسنان (أر إم إيج) الاكريلية (ذات تصالب مضعّف) وأسنان سيف الاكريلية (ذات تصالب أحادي). تم غمر جميع العينات قبل قياسها في الماء المقطر لمدة ٤٨ ساعة عند ٣٧ درجة مئوية. تم قياس صفات اللون الثلاثة (التدرج، الكثافة وإشراق اللون) باستخدام جهاز المطياف الرقمي وذلك قبل التعقيم وبعد التعقيم بالموجات المجهريه (عند قوة ٨٠٠ واط ولمدة 6 دقائق) مرة وبعد التعقيم بجهاز الموجات فوق الصوتية (لمدة ١٥ دقيقة بوجود قرص فوار) مرة أخرى. تم تحليل النتائج باستخدام اختبار تحليل التباين متبوعا باختبار دنكن لمعرفة الفروق المعنوية إحصائيا. **النتائج:** لوحظ تأثير الأسنان المصنعة من الاكريل أكثر من أسنان البورسلين. أظهرت الدراسة أيضا وجود فرق معنوي في صفتي اللون (الكثافة وإشراق اللون) قبل التعقيم وبعده لأسنان الاكريل بينما لم يلحظ ذلك في صفة (التدرج). **الاستنتاجات:** أسنان سيف كانت الأكثر تأثرا، في صفات اللون، بالتعقيم من أسنان (أر إم إيج). إن التعقيم بواسطة الموجات المجهريه لا يؤثر معنويا على لون الأسنان الاصطناعية

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The ultimate objective of aesthetics in dentistry is to create a beautiful smile, with teeth of pleasing inherent proportions to one another, and a pleasing tooth arrangement in harmony with the gingiva, lips and face of the patient^(1,2).

Tooth color and natural appearance frequently have a decisive role in distinguishing “aesthetic” from “non-aesthetic” smiles⁽³⁾. Indeed, a number of recent studies have shown that the personal dissatisfaction with tooth color can range from 17% to 53% depending on population under study⁽⁴⁻⁶⁾.

Acrylic resins and porcelains have been used for the fabrication of artificial teeth; however, neither type completely accomplishes the requirements of an ideal prosthetic tooth. For this reason, acrylic resin teeth have been modified to overcome the disadvantages of acrylic resin by using interpenetrating cross-linking agents, different monomers, and the addition of nanofillers⁽⁷⁻⁹⁾.

In dentistry, the HSB (Hue, Saturation or Chroma, Brightness or Value) system is most commonly used for color communication⁽¹⁰⁾.

Hue mostly has no effects on color changes. It was not possible to correlate a linear relationship between *hue* and the thickness of each layer.

Chroma (yellowness) showed that increasing the portion of Base Dentin resulted in a higher chromatic shade, that is a more intensive final color; whereas a greater amount of Transpa Dentin and Enamel reduced the *chroma*.

Lightness (or *Value*), which represents the lightness–darkness of a color. *Value* is the parameter most perceptible to the human eye; an error in this parameter will have the greatest impact on the perception of the final color⁽¹⁰⁾.

The thickness of each layer of tooth and the ratio between the different layers significantly influenced the final color. For example, an increase in the thickness of the Enamel layer resulted in a reduction of the *value* and vice versa⁽¹⁰⁾.

It has been shown that some disinfectant solutions caused changes in the physical and mechanical properties of denture base resins. These solutions may be unintentionally introduced into the oral cavity. In addition, the use of disinfectants has been considered to be time consuming or inappropriate. More recently, microwave energy has proved to be an effective method to disinfect acrylic dentures as an adjunct to the treatment of oral candidiasis^(11,12).

Ultrasonic devices are mechanical aids generally used by professionals. The mechanical cleansing activity of the device is complemented with the concomitant use of a chemical solution. Ultrasound has two mechanisms of action: the first being the movement of liquid resulting from sound waves transferred to the liquid (vibration) and the second, the collapse of bubbles formed by vibration of the unit⁽¹³⁾.

The majority of the color evaluation systems are based on a method quantitatively evaluates *chroma*, *hue*, and *value* of varying substrates⁽¹⁴⁾.

Spectrophotometers generally can provide more systematic and precise measurements than colorimeters because of their ability to measure the amount of light reflected from objects over a full spectral wavelength⁽¹⁵⁾.

The aims of this study are to evaluate the effects of disinfection by microwave or ultrasonic devices on the color parameters of three types of artificial teeth.

MATERIALS AND METHODS

Artificial teeth used in this study are listed in Table (1).

Table(1) Artificial teeth used in the study

Materials	Type	Cross-linking	Shade	Manufacturer	Batch No.
Seif teeth	Acrylic resin	single	A ₂	Syria	----
RMH teeth	Acrylic resin(Two-layer)	double	A ₂	Professional standard of P. R. China	0812, Iso (13485)
Porcelain teeth	Alloy pin porcelain	non	A ₂	Shanghai Co., China	Iso (0123)

For each type of artificial teeth, twelve master models were made by positioning the tooth in the center of a polyvinylchloride (PVC) tube (20*20mm) previously filled with autopolymerizing acrylic resin (Respal, Italy). The ridge lap and collar portions were embedded within the autopolymerizing resin, until the polymerization reaction was completed⁽¹²⁾(Figure 1).

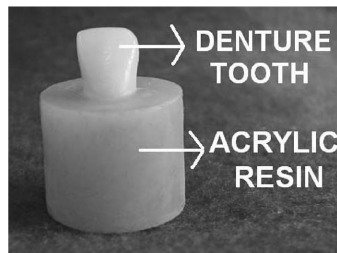


Figure (1) Test Specimen

All samples were kept in distilled water at 37°C for 48 hours to simulate the environments of oral cavity.

For microwave disinfection, specimens were immersed in 200ml of distilled water in beaker and irradiated with 800W for 6 min. in the microwave (Panasonic, Matsushita Electric Industrial Co.Ltd). Specimens were submitted to two cycles(12min.) to simulate when contaminated dentures come from the patient and before being returned to the patient. The selection of this cycle was based on previous studies which demonstrated that higher exposures for few minutes produce consistent sterilization with no harmful effects on dental materials^(12,16,17).

For ultrasonic disinfection, the test group samples were immersed in distilled water with one effervescent tablet (Voco, Germany) then ultrasonic vibration for 15 min. in ultrasonic device (Digital Ultrasonic Cleaner, Model: CD-4820, China)^(13,18).

Easyshade's spectrophotometer (Vita Esayshade, Vita Zahnfabrik, Germany)(Figure 2) .



Figure(2) Easyshade’s spectrophotometer

Measurement technique was utilized to obtain delta information about color represented by the three parameters individually (*hue/chroma /value*)⁽¹⁾.

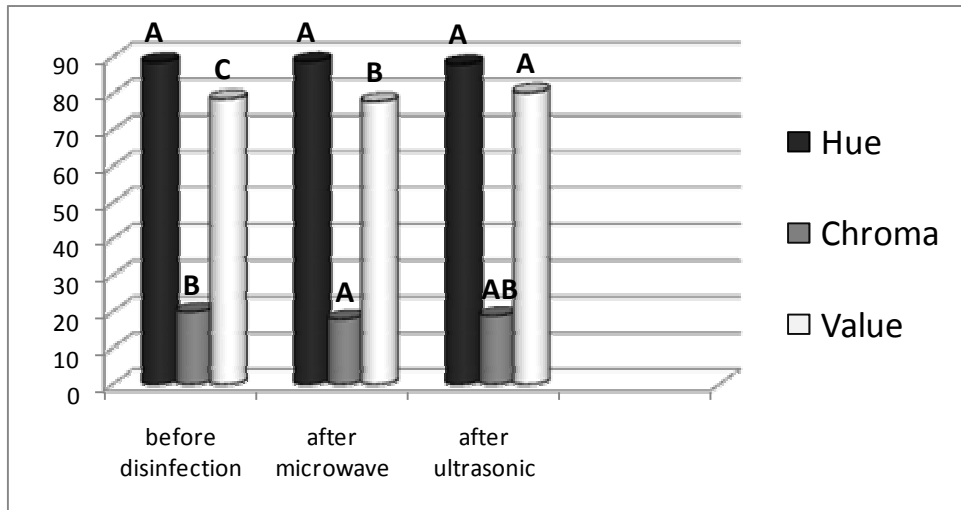
Data of the study were statistically analyzed by Analysis of Variance (ANOVA) followed by Duncan Multiple Analysis Range Test to determine the level of significance.

RESULTS

The results of Seif acrylic teeth showed that there were no significant differences when comparing the *hue* color degree, while there was a significant differences in *chroma* ($P < 0.02$) and *value* ($P < 0.000$) color degrees between samples before and after disinfection techniques, as in Table (2). The level of significance of Seif teeth are drawn in Figure (3).

Table (2) ANOVA test of Seif teeth color parameters before and after disinfections.

Color parameter		Sum of Squares	Df	Mean Square	F	Sig.
Hue	Between Groups	1.801	2	.901	1.054	.373
	Within Groups	12.822	15	.855		
	Total	14.623	17			
Chroma	Between Groups	12.549	2	6.274	4.639	.027
	Within Groups	20.289	15	1.353		
	Total	32.837	17			
Value	Between Groups	19.569	2	9.784	5.686	.000
	Within Groups	25.812	15	1.721		
	Total	45.381	17			



Figure(3) Duncan Multiple Analysis Range Test of Seif teeth.

For RMH acrylic teeth, results showed that there were no significant differences exist between samples in *hue*, *chroma* and *value* before disinfection and after microwave cycle. While *chroma* and *value* showed significant differences ($P<0.05$) and ($P<0.002$) respectively before disinfection compared with that after ultrasonic technique, as in Table (3). The level of significance of RMH teeth are drawn in Figure (4).

Table(3) ANOVA test of RMH teeth color parameters before & after disinfections.

Color Parameter		Sum of Squares	Df	Mean Square	F	Sig.
Hue	Between Groups	.493	2	.247	.996	.393
	Within Groups	3.717	15	.248		
	Total	4.210	17			
Chroma	Between Groups	4.721	2	2.361	.841	.05
	Within Groups	42.127	15	2.808		
	Total	46.848	17			
Value	Between Groups	9.334	2	4.667	10.1 17	.002
	Within Groups	6.920	15	.461		
	Total	16.254	17			

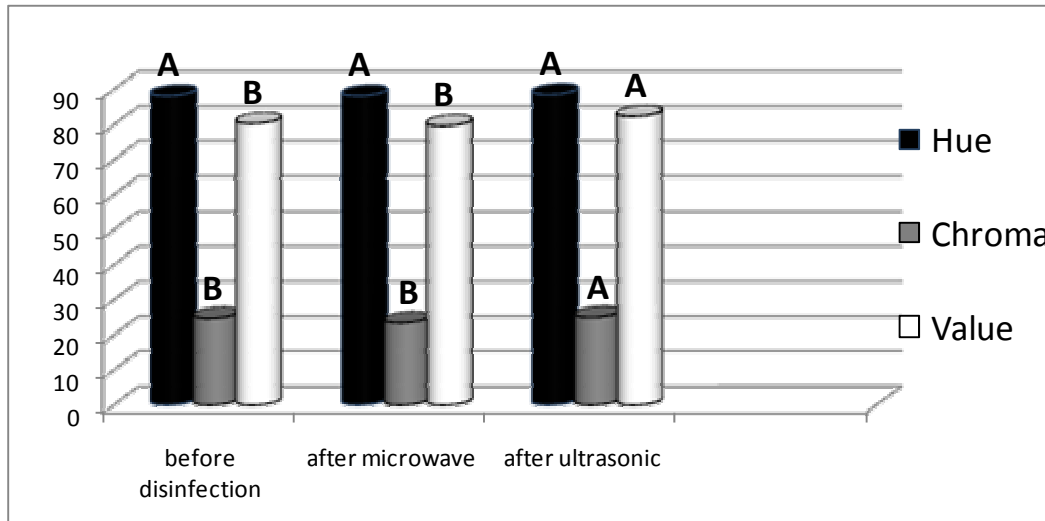
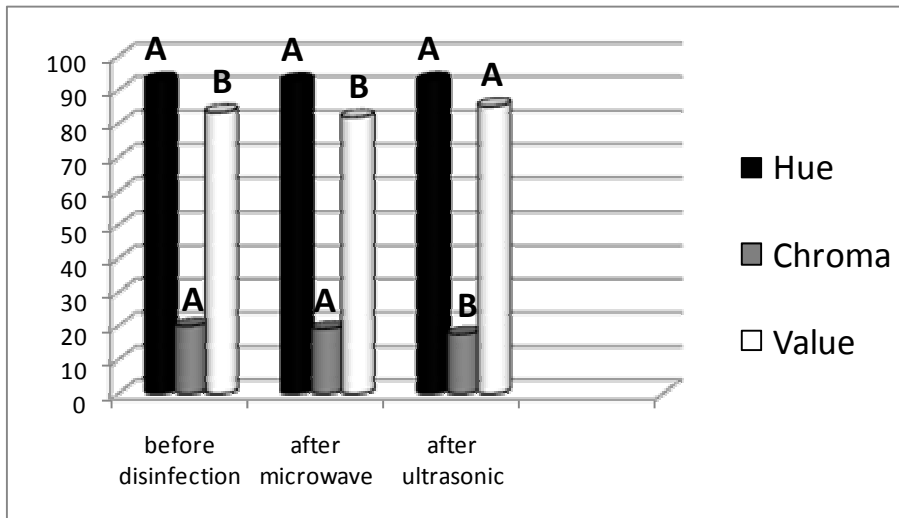


Figure (4) Duncan Multiple Analysis Range Test of RMH teeth.

Results of Porcelain teeth were shown in Table (4), *hue* color degree showed no significant dereferences between samples before and after disinfections. While a significant differences presented between samples before disinfection compared with that after ultrasonic cleansing in *chroma* ($P < 0.003$) and *value* ($P < 0.001$) color degree. The level of significance of Porcelain teeth were drawn in Figure (5).

Table(4) ANOVA test of Porcelain teeth color parameter before & after disinfections.

Color Parameter		Sum of Squares	Df	Mean Square	F	Sig.
Hue	Between Groups	.205	2	.103	.514	.608
	Within Groups	2.997	15	.200		
	Total	3.202	17			
Chroma	Between Groups	20.021	2	10.011	9.038	.003
	Within Groups	16.615	15	1.108		
	Total	36.636	17			
Value	Between Groups	31.464	2	15.732	10.366	.001
	Within Groups	22.764	15	1.518		
	Total	54.227	17			

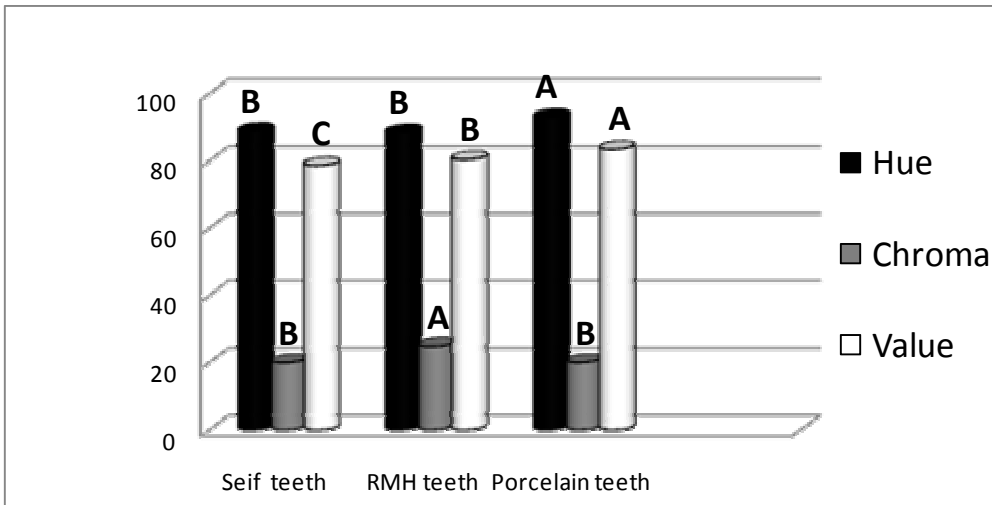


Figure(5) Duncan Multiple Analysis Range Test of Porcelain teeth.

Another comparisons were done between all variables before and after treatments. In Table (5), results showed significant differences between samples before disinfection in *hue*, *chroma* and *value* color parameters ($P < 0.001$) when compared either acrylic teeth (Seif or RMH) with Porcelain teeth. *Hue* and *value* higher in Porcelain teeth, *chroma* higher in RMH teeth than the others The level of significance of teeth before disinfection was drawn in Figure (6).

Table (5) ANOVA of all teeth color parameters before disinfections.

Color parameters		Sum of Squares	Df	Mean Square	F	Sig.
Hue	Between Groups	78.214	2	39.107	216.959	.000
	Within Groups	2.704	15	.180		
	Total	80.917	17			
Chroma	Between Groups	93.930	2	46.965	53.415	.000
	Within Groups	13.189	15	.879		
	Total	107.119	17			
Value	Between Groups	72.454	2	36.227	92.744	.000
	Within Groups	5.859	15	.391		
	Total	78.313	17			



Figure(6) Duncan Multiple Analysis Range Test of all teeth before disinfection.

In Table (6), the results after microwave disinfection showed no significant differences when compared with that results before disinfection. The level of significance of teeth was drawn in Figure (7).

Table: (6) ANOVA of all teeth color parameters after microwave disinfection.

Color parameters		Sum of Squares	Df	Mean Square	F	Sig.
Hue	Between Groups	70.188	2	35.094	56.341	.000
	Within Groups	9.343	15	.623		
	Total	79.531	17			
Chroma	Between Groups	106.990	2	53.495	17.516	.000
	Within Groups	45.810	15	3.054		
	Total	152.800	17			
Value	Between Groups	51.388	2	25.694	61.748	.000
	Within Groups	6.242	15	.416		
	Total	57.629	17			

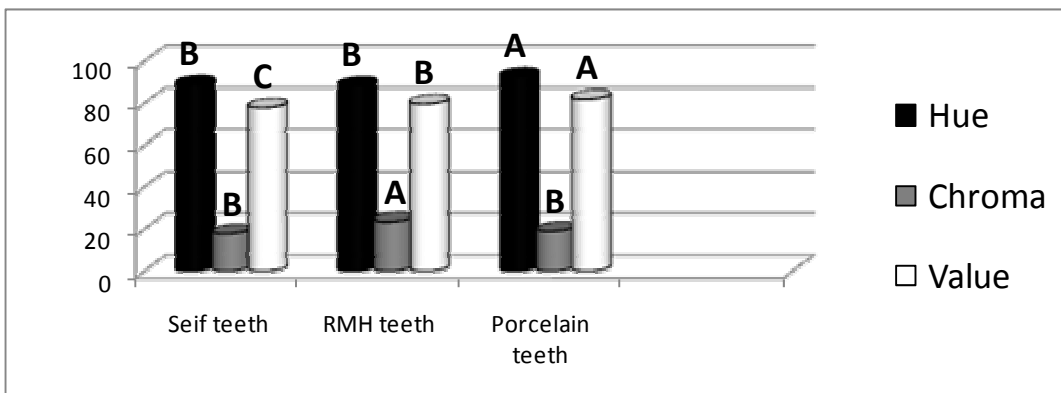
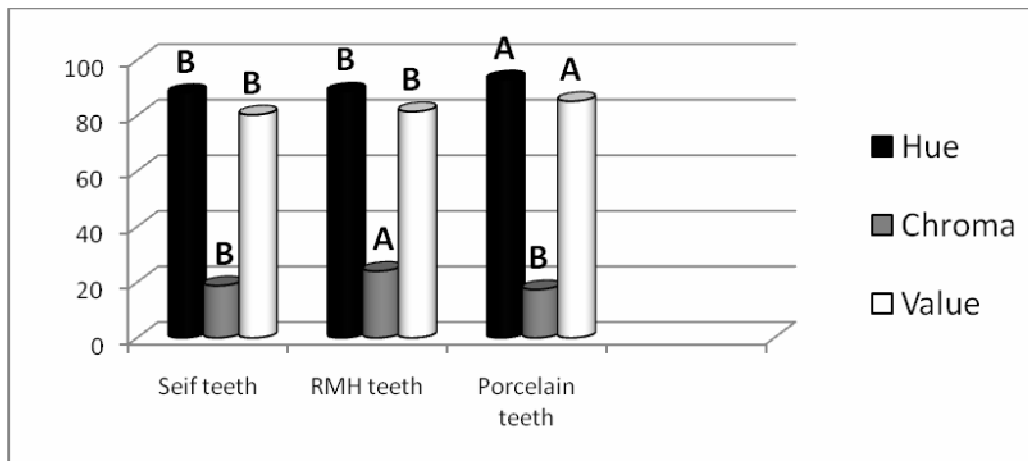


Figure (7) Duncan Multiple Analysis Range Test of all teeth after microwave disinfection.

Finally, analysis of the results of the three types of teeth after ultrasonic technique showed no significant differences in *hue*, and *value* between both acrylic teeth, but significant differences existed between acrylic and Porcelain teeth in these parameters, Table (7). The level of significance of teeth was drawn in Figure (8).

Table (7) ANOVA of all teeth color parameters after ultrasonic disinfection.

Color parameters		Sum of Squares	df	Mean Square	F	Sig.
Hue	Between Groups	85.134	2	42.567	85.267	.000
	Within Groups	7.488	15	.499		
	Total	92.623	17			
Chroma	Between Groups	148.284	2	74.142	55.519	.000
	Within Groups	20.032	15	1.335		
	Total	168.316	17			
Value	Between Groups	78.214	2	39.107	13.518	.000
	Within Groups	43.395	15	2.893		
	Total	121.609	17			



Figure(8) Duncan Multiple Analysis Range Test of all teeth after ultrasonic disinfection.

DISCUSSION

The use of microwave energy as a disinfection method is based on two distinct mechanisms: the first considers that the thermal aspects of heating environment promoted by microwave energy leads to microorganism inactivation. The second mechanism considers cell inactivation by selective intracellular heating with membrane changes and internal destruction⁽¹⁹⁾.

The results showed that acrylic teeth affected more than Porcelain teeth during cleansing procedures, Figures(5-7). Conventional acrylic resin and cross-linked acrylic resin artificial teeth consisted primarily of 2-layered structure; however, porcelain resin artificial teeth were primarily 3- or 4-layered structures. This why porcelain teeth were affected less than the others which belongs to the effects of its inorganic fillers like silicon dioxide, glass, or ceramic unlike resin matrix^(7,9).

Water sorption causes water mobility among resin molecules, cross linking agents increases resistance to solvents, decreasing solubility and water sorption rates^(20,12).

Thus, it may be speculated that microwave disinfection produced a plasticizing effect on polymeric chains of polymethyl methacrylate with low cross-linking⁽²¹⁾, so very low apparent deformation or color change was observed on the microwaved prostheses⁽²²⁾, as in the results of seif teeth.

The higher degree of cross- linking agents presents in RMH teeth may prevent the diffusion of disinfectants into the polymer network and change its color unlike Seif teeth^(23,24).

Values were influenced by changes in *chroma* nearly three times more than by changes in *lightness*, while *hue* changes had almost no influence on color change⁽²⁵⁾.

Ultrasonic devices have been advocated for the removal of denture plaque. They convert electrical energy into mechanical energy at the frequency of sound waves. The application of ultrasound has been also used to improve the disinfectant solutions effectiveness. It increases the *value* or *lightness* degree of acrylic teeth, as shown in Figures (3-5); because of its surface porosity unlike porcelain teeth, due to the effects of cleansing ions emitted from the effervescent tablets⁽²⁶⁾.

CONCLUSIONS

Microwave disinfection could be used to disinfect complete dentures without significant effects on their teeth color. Ultrasonic cleaner with effervescent tablets affect the *value* color degree of Seif teeth more than RMH teeth with no effect seen in Porcelain teeth. *Hue* color parameter is not affected during disinfection techniques.

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