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An Evaluation of color property of Hibiscus Sabdariffa Flowers on Microwave Treated Polymethyl Methacrylate in Vitro and Vivo by 3D Computer Program

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ABSTRACT

Many attempts to improve the properties of poly methyl methacrylate powder. The use of microwave radiation produce an effect on the acrylic powder, and this effect improve the transverse strength and residual monomer concentration but the color property may be affected and the use of natural pigments or coloring agents may improve the color by different shades. The aims of this study to evaluate color improvement of PMMA Vertex™ after the exposure to the microwave energy and reducing particle size with grinding by adding coloring agents (Hibiscus Sabdariffa, Vanillin and Titanium dioxide) with different concentrations. And study the coincidence of prepared color to shade guide (in vivo and in vitro) by computer-aid 3D program prepared specially for this study.

Materials and Methods: PMMA powder was treated with microwave radiation at a power level of 360watt for ½ hr. The obtained PMMA powder and the additives (Hibiscus Sabdariffa, Vanillin and Titanium dioxide) were then grinded using an electrical blender individually. The next step isparticle size reduction of the microwave treated PMMA powder and additives to 80µm individually also. Then mixing the control PMMA powder and the treated PMMA powder with additives in different concentrations (acrylic only, acrylic with microwave, acrylic with H 0.05, acrylic with H 0.04, acrylic with H 0.03, acrylic with H 0.02, acrylic with H 0.01, acrylic with H 0.05/T 10, acrylic with H 0.05/T 5, acrylic with H 0.05/T 0.5, acrylic with H 0.05/T 0.1, acrylic with H 0.05/V 10, acrylic with H 0.05/V 5, acrylic with H 0.05/V 0.5 and acrylic with H 0.05/V 0.1), after making acrylic samples with these different concentrations compared with Vertex™ gingival shade guide and 25 of healthy people respectively by using 3D computer program based on Euclidean metric.

Results: According to the 3D computer program, the experimental groups matched to different shade guides and exclude (acrylic with H 0.05/T 10, acrylic with H 0.05/T 5, acrylic with H 0.05/T 0.5, acrylic with H 0.05/T 0.1and acrylic with H 0.05/V 10) not matched to any shade and when comparing with patients 56% of all patients matched to different shade guides and when compare the patients to the experimental groups 56% of all patients matched to experimental groups except (acrylic with H 0.05/T 10, acrylic with H 0.05/T 5, acrylic with H 0.05/T 0.5 and acrylic with H 0.05/V 10).

Conclusion: The use of Hibiscus Sabdariffa flowers useful in obtaining different shade colors of acrylic resin which considered cheap natural pigment and more economicand we can use the computer programs for more accurate comparison and obtained the right shade of the gingiva that suitable for each patient.

Keywords: 3D Computer Program, Color Property, Euclidean Metric, Microwave, PMMA Powder, Vertex™ Gingival Shade Guide.

INTRODUCTION

Polymethylmethacrylate is most commonly used for fabricatingremovable partial and complete dentures [1] and have three fundamental features have contributed to its success: excellent appearance, simple processing technique and easiness of the repair [2]. To improve their properties Ebraheem[3] approved that the use of microwave radiation produce an effect on the acrylic powder, and this effect improve the transverse strength and residual monomer concentration.

The advantages of curing denture base resin by microwave energy include greatly induced curing time, less cumbersome equipment, a cleaner method of processing and minimal color change in resin base [4].
The researchers showed that the main two factors that have a major role in color property of acrylic resin are residual monomer content and porosity caused by overheating [5] therefore using natural pigments to make different shades of color like Vanilla in different concentrations instead of the Vertex™ synthetic acrylic stains are clinically acceptable compared in relation to patients attached gingival color and Vertex™ gingival shade guide [6] and Hibiscus Sabdariffausing as coloring agent due to containing anthocyanin colourant from roselle[7]. Vanilla is a crop of great commercial importance as the source of natural vanillin, a major component of flavor industry [8].

Titanium oxide (TiO_2) asa coloring agent, Introduction of TiO_2 for preparing acrylicresins allows the production of polymer with both color and surfacemodifications [9].

It is considered a low-cost, clean photocatalyst with chemical stabilityand non toxicity and has been used for a wide variety of environmental applications, including water treatment [10]. Hibiscus sabdariffais an annual herbaceous shrub, cultivated for its flowers although leaves and seeds have also been used in traditional medicine [11].

The three dimensions of color offer a universal language to communicate shades; the color is described with the Munsell terms of Hue, Value, and Chroma [12, 13].

- **Hue:** The attribute of color by means of which a color is perceived to be red, yellow, green, blue, purple, etc [14].
- **Value:** The dimension of a color that denotes relative blackness or whiteness (grayness, brightness) [14].
- **Chroma:** The purity of a color or it's the saturation of the hue [14].

The color range of gingival tissues seems to be even broader than the tooth color range (the lightness and hue range are wider and the chromarange is narrower) [15], therefore computer aided manufacturing procedures will change many aspects of dentistry in the future, particularly in relation to treatment simplicity and production time [16]. Instruments for clinical shade-matching encompass spectrophotometers, colorimeters and imaging systems. Clinical imaging and conventional image processing methods were used such as Adobe Photoshop and Corel Photo-Paint in dentistry [17].

MATERIALS AND METHODS

A 50 gm of PMMA powder (Vertex™-Dental bv Johan) is used as constant weight for preparation of each group of the tested material. PMMA is prepared in wet condition and put in microwave at 360 watt 40 % level of power then removed from microwave and after material exposure to microwave radiation, it removed and crushed immediately by electrical grinder (Clatronic, germany) for 5 minutes or until the most solid pieces are grinding [3], then sieved by the size of 100 µm sieve after that sieved by smaller size sieve (80µm) after grinding of treated PMMA. Hibiscus sabdariffa (from Sudan) is used as dry flowers, these flowers grind in electrical grinder and then sieved by the size of 80 micron sieve.Vanillin also used as crystals powder, this powder grind in electrical grinder for 5± 0.5 min. then sieved by the size of 80 micron sieveand also TiO_2be prepared at the same procedure of grinding and sieving. This procedure occurred in Alhokamaa Company for drug industry and medical supplies in Ninava.ThenHibiscus sabdariffawas mixed with acrylicmonomer that gives the red color in gradual concentrations (0.01-0.05%) alone.

Another additives Vanillin used with concentration (0.1%, 0.5%, 5%, 10%)[6]with additive of Hibiscus sabdariffa (0.05%) in clean dry gar and TiO_2 used with concentrations (10%, 5%, 0.5%, 0.1%) with additive of Hibiscus sabdariffa (0.05%) as seen in figure (1).

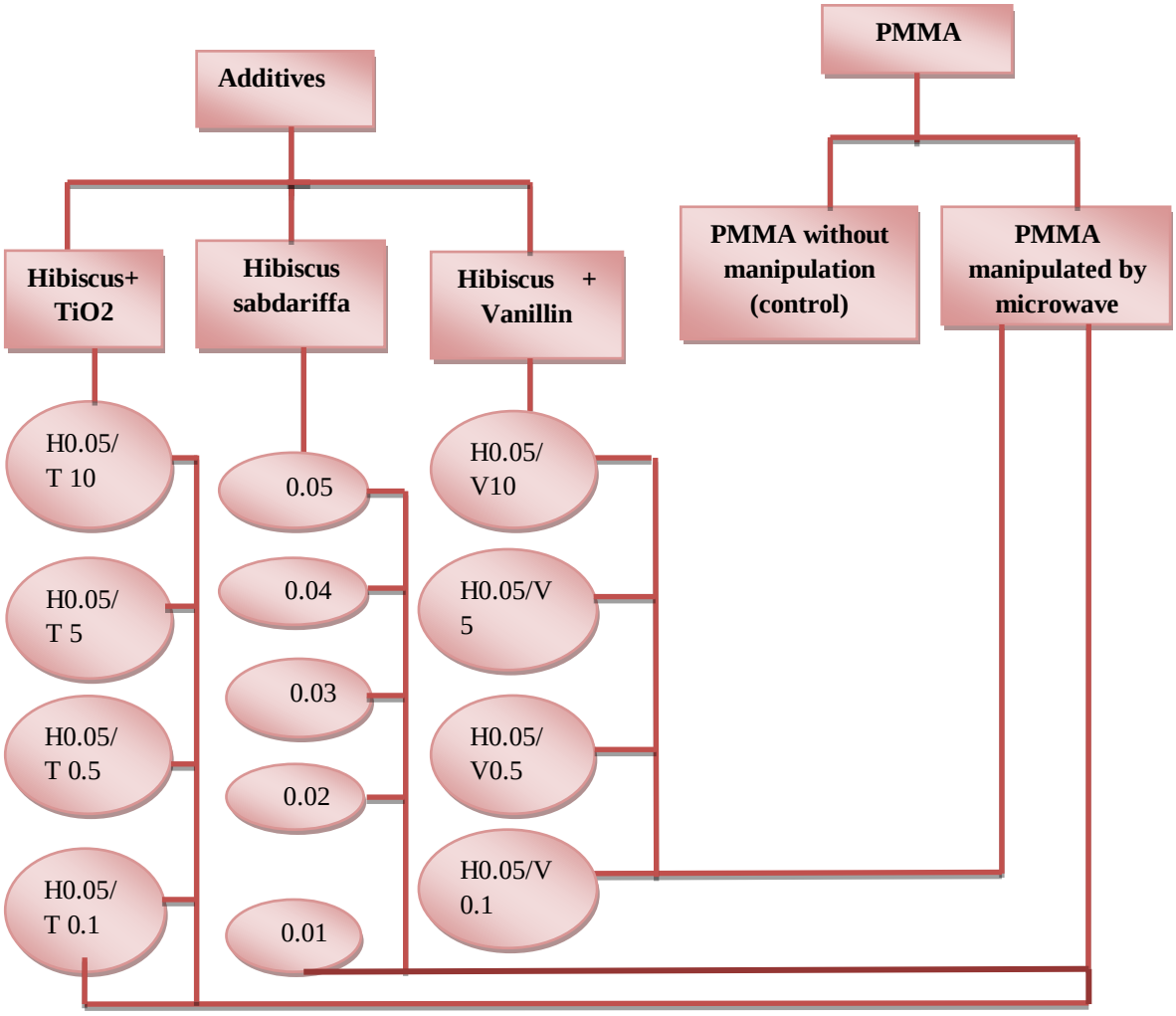

Figure 1: Experimental design of additives to PMMA.

Preparation of the samples

The samples (75 samples) prepared by cutting the Biostar sheet according to the dimensions (30x20x1.5) ±0.03mm (length, width and thickness respectively) [18].Then flasking, packing and curing according to the manufacture instructions. After completing the curing, then the samples were removed, finished, polished with pumice, and stored in containers with non-ionized distilled water in the incubator at 37°C for 48 hour (according to ADA Specification No.12, 2002).

Color property test and 3D Computer Aiding Program (In vivo and in vitro)

Assessment of color properties was performed by using Vita easyshade device (Vita Zahnfabrik, Germany) to measure color of the prepared acrylic samples, gingival color of twenty five humans and Vertex™ gingival shade guide.All prepared color samples and Vertex™ gingival shade guide were measured with the same constant white background.
The color values were measured in the ten tabs of the Vertex™ gingival shade guide (contain ten tabs color grades coded from 1, 2, to 10 shade).Measurement color matching: the Munsell system of Hue, Value, and Chroma.Measurements were done by Vita Easyshade device to obtain the baseline L, C, H values.
On the other side, the measuring gingival color of healthy people (8male, 17 female), 22±1years old (excluded subjects with spontaneous bleeding from their gingiva due to periodontal disease), in the anterior region of attached gingiva (in midpoint between free gingiva and most deepest point of sulcus in central and lateral incisor regions about 2.5 mm apical to the crest of marginal gingiva) was measured [19]. This is because the deposits of pigments are more clear in this area, which may be confirmed by further research investigations [20].

And we designed a computerized program to make a comparison between the experimental samples and the gingival shade guide and with patients sample by using the Euclidean distance or Euclidean metric. In mathematics, the Euclidean distance or Euclidean metric is the "ordinary" distance between two points that one would measure with a ruler, and is given by the Pythagorean formula. By using this formula as distance, Euclidean space becomes a metric space. The associated norm is called the Euclidean norm. Older literature refers to the metric as Pythagorean metric. The Euclidean distance between points **p** and **q** is the length of the line segment connecting them ($\overline{\mathbf{pq}}$) [21].

RESULTS

In this study we designed a computerized program to make a comparison between the experimental samples which include fifteen groups (acrylic with Hibiscus Sabdariffa 0.05%- 0.01%, acrylic with Hibiscus Sabdariffa 0.05% + Titanium dioxide 10%, 5%, 0.5%, 0.1%, acrylic with Hibiscus Sabdariffa 0.05% + Vanilla 10%, 5%, 0.5%, 0.1%, cured acrylic only and acrylic with microwave) and the gingival shade guide and with patients sample by using the Euclidean distance or Euclidean metric as shown in figures (2-4):

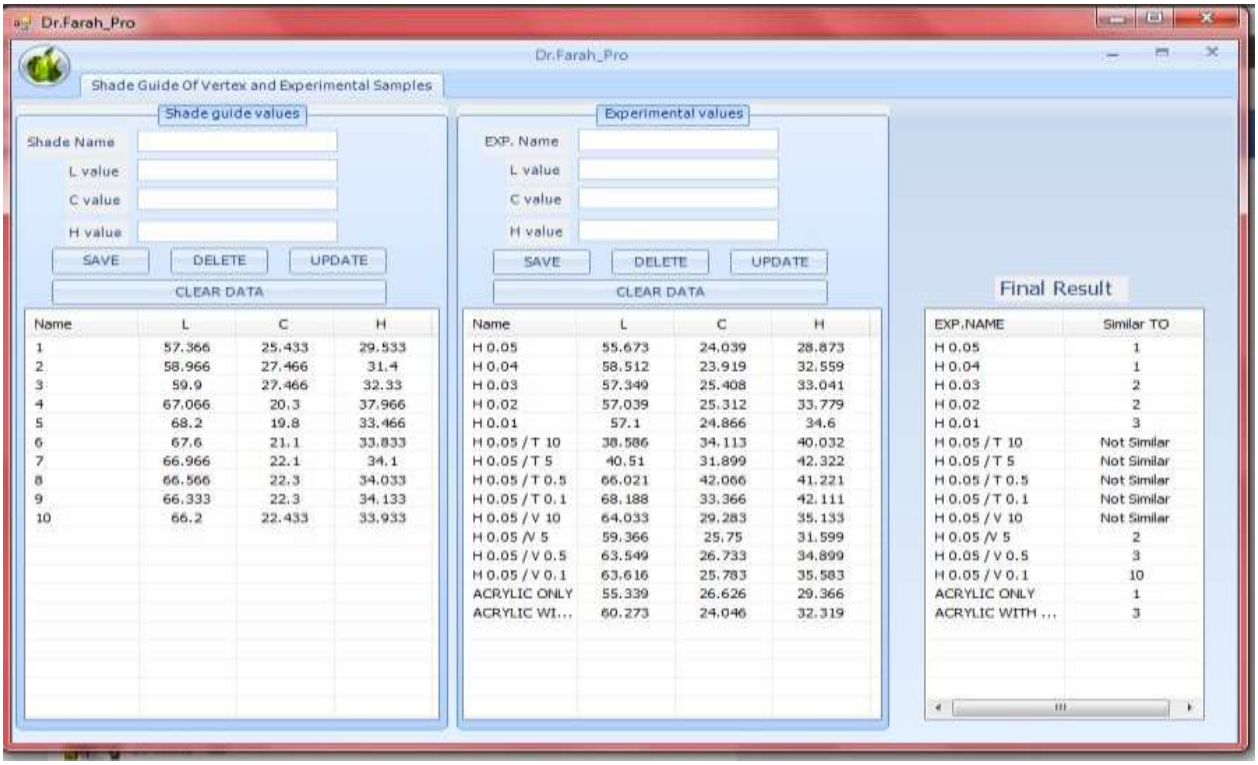

Figure 2: The comparison between gingival shade guide and the experimental samples by using Euclidean metric during programing. H: Hibiscus Sabdariffa, T: Titanium dioxide, V: Vanilla.

In this program we enter the mean value of all lightness(L), chroma(C), hue(H) of all groups (gingival shade guide 1-10 and fifteen groups of experimental samples) and make comparison between each one and the results show the groups of adding Titanium dioxide to the acrylic and Vanilla 10% not matched to any one of gingival shade guideso the Titanium dioxide coloring agent was excluded from the following comparison but ten groups matched to different shade guidesas listed below:

- Acrylic with Hibiscus Sabdariffa 0.05% matched to no.1 gingival shade guide.
- Acrylic with Hibiscus Sabdariffa 0.04% matched to no.1 gingival shade guide.
- Acrylic with Hibiscus Sabdariffa 0.03% matched to no.2 gingival shade guide.
- Acrylic with Hibiscus Sabdariffa 0.02% matched to no.2 gingival shade guide.
- Acrylic with Hibiscus Sabdariffa 0.01% matched to no.3 gingival shade guide.
- Acrylic with Hibiscus Sabdariffa 0.05% + Vanilla 5% matched to no.2 gingival shade guide.
- Acrylic with Hibiscus Sabdariffa 0.05% + Vanilla 0.5% matched to no.3 gingival shade guide.
- Acrylic with Hibiscus Sabdariffa 0.05% + Vanilla 0.1% matched to no.10 gingival shade guide.
- Cured acrylic only matched to no.1 gingival shade guide.
- Acrylic with microwave matched to no.3 gingival shade guide.

And in case of comparison between gingival shade guide and healthy people, we select 25 patients (17 females and 8 males) and measuring gingival color in the anterior region of attached gingiva to document how many people will matched to the gingival shade guide and the results seen in the figure (3).

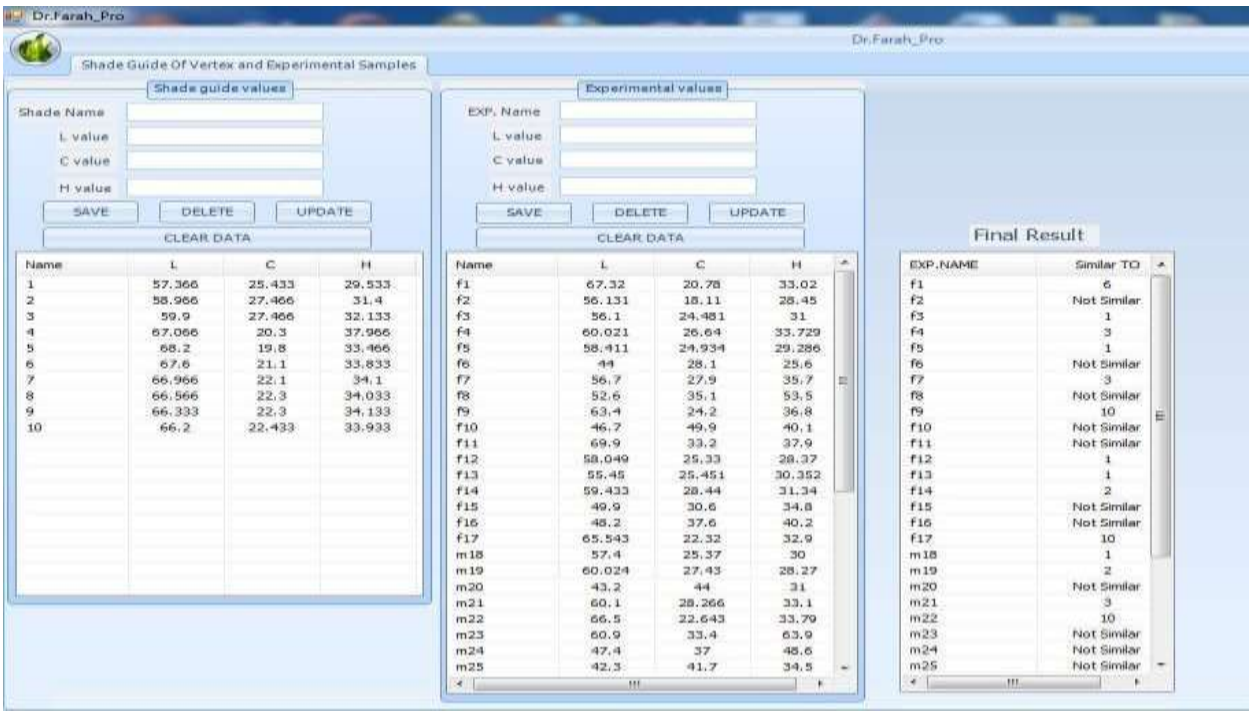

Figure 3: The comparison between gingival shade guide and the patients by using Euclidean metric during programing. f: female, m: male.

In this figure seen 14 patients (10 females, 4 males) of total no.(25) matched to different gingival shade guide and 11 patients (7 females, 4 males) not matched to the shade guide, that means 56% of all patients matched, 58.82% females and 50% males matched to the gingival shade guide.And when compared the experimental samples with the patients as seen in figure (4), 14 patients matched to different experimental groups of the study (56% of patients matched to the groups of this study) .

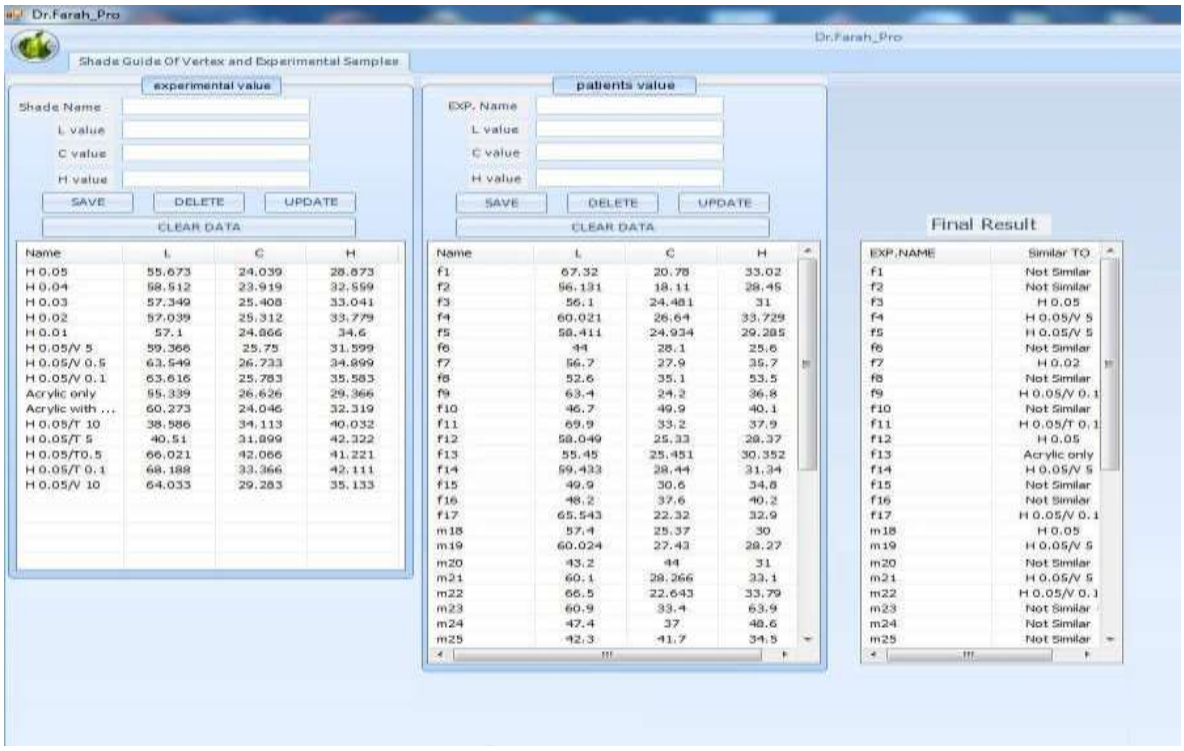

Figure 4. The comparison between experimental samples and the patients by using Euclidean metric during programing. H: Hibiscus Sabdariffa, V: Vanilla. f: female, m: male.

DISCUSSION

The color of the healthy gingiva is variable, ranging from a pale pinkto a deep bluish purple. The color range of gingival tissuesseems to be even broader than thetooth color range (the lightness andhue range are wider and the chromarange is narrower) [22]**.** The resin should exhibit sufficient translucencyand transparency (hue, chroma and value) tomatch the adjacent structures and tissues. Itshould be capable of being pigmented or tintedto camouflage the surroundings. Oncefabricated, it should maintain the appearanceand color and not change subsequently [23] andfailure or success of any esthetic material mainly depends on color match and the color stability of material in long term use [24].

In this study we use the main additive Hibiscus Sabdariffa due to containing Anthocyanin which consider a major pigment present in this plant concentrated in regions such as flowers and fruits. It is responsible for a variety of colors in plant, from red to blue [7] and used Vanilla due to giving brightness to the acrylic and matched to different shade guides in different concentrations but exclude the Titanium dioxide which not matched to the gingival shade guides in different concentrations when comparing the gingival shade guides to the experimental samples.

According to the figure (2) which listed the results of gingival shade guides and the experimental groups by comparing L (lightness), C (chroma) and H (hue). H (hue) the main color, presented in region of pink to red area of HSL (hue-saturation-lightness) cylindrical geometry (from 0° to 120° of red area) and all mean value of hue of samples and shade guides ranging from (28 to 35) and when comparing the control group (cured acrylic) with acrylic exposed to microwave will see the acrylic with microwave more pale and lighter in color due to increase the lightness value (L) than control group, also control group matched to no.(1) shade guide and acrylic with microwave matched to no.(3) shade guide due to L, C and H value similar to each other when comparing by Euclidean metric during programing, but when adding the Hibiscus Sabdariffa powder (The pigments (anthocyanins), which responsible primarily for red color, were delphinidine-3-glucoside and cyaniding-3-glucoside [25]) to the acrylic with microwave which have pale and lighter color in 0.05% concentration the lightness value decreased and also in 0.04% concentration of Hibiscus Sabdariffa which have slight increase of lightness value and both of them similar to no.(1) shade guide and the groups with concentrations 0.03% and 0.02% of Hibiscus Sabdariffa show increase in lightness value and resemble to no.(2) shade guide but the group with concentration 0.01%of Hibiscus Sabdariffa have increased lightness value and resemble the microwave group and matched to no.(3) gingival shade guide. This increase of lightness value due to decrease in concentration of red pigments (Hibiscus Sabdariffa) which is responsible for the saturated red color. Groups with Hibiscus Sabdariffa 0.05% and different concentrations of Vanilla (5%, 0.5% and 0.1%) have different lightness value but the effect of hue value will change the reading, acrylic with Hibiscus Sabdariffa 0.05%+ Vanilla 5% matched to no.(2) shade guide when compared with it's value, acrylic with Hibiscus Sabdariffa 0.05%+ Vanilla 0.5% matched to no.(3) shade guide and acrylic with Hibiscus Sabdariffa 0.05%+ Vanilla 0.1% matched to no.(10) gingival shade guide, this results due to the effect of red pigments of Hibiscus Sabdariffa which played an important role in giving brilliant red color of samples [26].

And when comparing the gingival color of the patients to the gingival shade guide and to the experimental samples, concluded that 14 patient of total no.25 matched to different shade guide (56% of patients) and when comparing to the experimental groups 14 patients of total no. 25 matched to different groups of acrylic, acrylic with microwave, acrylic with Hibiscus Sabdariffa and acrylic with Hibiscus Sabdariffa and Vanilla that means these groups will be effective in the clinical applications and this agree with the study of Azeez [27] when using natural stain vanilla modify the lightness value and matched clinically, Hibiscus Sabdariffa also played an important role in giving brilliant red color of samples and responsible for hue value (H) (themain color).

CONCLUSIONS

The use of Hibiscus Sabdariffa flowers useful in obtaining different shade colors of acrylic resin which considered cheap natural pigment and more economic and we can use the computer programs for more accurate comparison and obtained the right shade of the gingiva that suitable for each patient.

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