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PREPARATION, OXYGEN PERMEABILITY, OPTICAL TRANSPARENCY,WATER CONTENT,PROTEIN ADSORPTION AND EVALUATION OF BACTERIAL ADHESION PROPERTIES OF NEW SILICONE HYDROGEL THROUGH MODULATING SILICONE AND HYDROPHILIC MONOMER

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ABSTRACT

Silicone Hydrogel (SiHy) contact lenses are extremely fruitful in compare is onto preceding soft lenses; they were established to offer superior oxygen permeability. In the following paper, the hydrogel contact lenses based on silicone were made through the polymerization of 3-(methacryloyloxy) propyltris(trimethylsiloxy) silane (TRIS) with N,N dimethylacryl amide (DMA), Methyl methacrylate (MMA),and 2-hydroxyethyl methacrylate (HEMA). The features of silicone hydrogel lenses were studied depending on the approaches like equilibrium water component, oxygen permeability, optical transparency, protein adsorption, as well as cell toxicity.The outcomes revealed which the TRIS component in all makings rose the oxygen penetrability and decreased the equilibrium water component, while the DMA& HEMA participated the hydrophilicity of the silicon hydrogels and increases the equilibrium water content (EWC)%. The higher worth of oxygen penetrability was 102barrers, conforming to an equilibrium made of water component of 66%. generally, the silicone hydrogels in this work displayed decent oxygen permeability as well as optical transparency and anti protein adsorption. Hence forth, those polymers made of silicone hydrogel might be possible for manufacturing contact lens.

KEYWORDS: Contact lenses, silicone hydrogel, Photopolymaraization, Copolymerization, Protein adsorption, Oxygen permeability.

1. INTRODUCTION

The usages of CLs variety from remedial vision as well as therapeutics to cosmetic presence (Efron *et al.*, 2007), (Efron, 2016). Within these usages arises the needs as of the expiration of the one who use the lenses, containing extent of putting on, ease, durability, practicality of manage, steadiness of vision, etc. This too indicates that in the uses of contact lenses arises the needs from creators, like substantial prices, easiness of manufacture, and depend ability of the CLs, etc. Lastly, the needs on for evolving CL substances.

Regularly, for manufacturers decide the strictures of the substance that scientists should focus their study the classification of "hard" or "soft" are manipulated by means of blanket descriptions of CLs (Efron *et al.*, 2007), (Efron, 2016). Hard CLs are unbending (durable great-water-component substance. Rigid lenses are frequently are, in fact, more elastic), lenses of gas-permeability, while lenient contact lenses are composed of elastic, because of the combination of low-modulus constituents—hence forth, they are too stiff than hard. One more designating feature interchangeably denoted as stiff gas-PMMA lenses permeable lenses (RGPs); nevertheless, it is not firmly true. The beginning might be categorized as stiff, while contemporary RGP lenses is that PMMA solid lenses own no oxygen penetrability, while lenses of RGP type are penetrable.

Moreover, a lenient contact lens (SCL) is a greatly malleable, substance of oxygen-permeable with often great water-component. This suppleness denotes which SCLs apt to the form of a customer's eye abundant quicker than a stiff lens. SCLs could be disposed every day, every week, or every month. Those blanket descriptions of CLs could suggest being its substantial aspects, although not for sure. There is frequently an intersection in substances manipulated amid hard and soft lenses, like silicone hydrogels as well as RGPs. Though both manipulate silicone ingredients, the variance is in aspects like the gel network as well as water component. Byproducts there within could more differentiate the range of likely CLs as well as their features.

Hydrogel is regularly in use in manipulated with biology, medicine, substantial science as well as business of engineering.In specific, hydrogel already used in contact lenses because of imposing role like wettability,biocompatibility, optical a, as well as aspect mechanical strong point (Zhao *et al.*, 2014).However, hydrogel lens restrictions gas permeability, particularly oxygen penetrability. Great oxygen penetrability is too noteworthy to keep the comfort of wearing as well as to limit hypoxia-related problems, like dry eyes as well as corneal edema (Fonn *et al.*, 2006; Awasthi *et al.*, 2013), as hypoxia regularly happens to sick people who put

contact lenses to along eras of time. In order to decrease the lack of oxygen source, the hydrophobic constituent shaving siloxane collections like hydroxyl-terminated polydimethylsiloxane (PDMS) as well as tris-(trimethyl-silyl-propyl-methacrylate) (TRIS)are manipulated to develop the absorptivity of oxygen of contact lenses. The collaboration of 2-metha cryloyloxy ethylphosphoryl choline as well as vinyl ether terminated poly dimethyl siloxane macro-monomer, developed the penetrability of oxygen of contact lenses made from hydrogel (Wang and Liu, 2013).

TRIS is a monomer of hydrophobic containing siloxane collections which could rise the oxygen absorbability of an already existing hydrogel lens. Due to the small chain span, TRIS is lenient as well as shortage strong point likened to PDMS (Awasthi *et al*., 2013). Henceforth, hydrogel lenses that are TRIS-based exhibitinor mechanical strength as well as greater suppleness other than PDMS-dependent lenses made of hydrogel. Though TRIS could develop the oxygen the transmit possibility of contact lenses, greater TRIS component would cause lesser equilibrium of water component(EWC) as well as surface wettability of lens made of hydrogel that are made of silicone (Chekina *et al*., 2006; Tighe, 2013).

Moreover, the process of polymerizing 2-hydroxyethyl methacrylate (HEMA) to gather with using PDMS providing greater oxygen penetrability than hydrogel that is non-silicone (Lai, 1995).

In this study a hydrogel lens made by silicone synthesized through the combination of TRIS with methylmethacrylte (MMA),2-hydroxyethyl methacrylate (HEMA), as well as N,N-dimethyl-acrylamide (DMA) to develop the water absorbability, protein approval, as well as wettability. The chemical constructions of the made silicon hydrogel contact lenses were characterized via FTIR spectrometry. The features, containing water content, oxygen permeability, as well as protein adsorption presentation were later examined. The relationships amid the compositions as well as features were argued over proportional examining of the investigational in formation.

We used optical polymerization in the manufacture of contact lenses instead of thermal, as it gave very fast results in minutes instead of long hours. We also used HDODA, which was not previously used in the manufacture of contact lenses, as it gave excellent results compared to the rest of the crosslinking agents. And the production of new lenses with high oxygen permeability and suitable for human use and drug loading interaction lens.

2. EXPERIMENTAL METHODE

2.1. Materials

1,6 hexandioldiacrylate, Purity(99.99%), (226.27) is the M.Wt. was purchased from ALDRICH, 2-hydroxyethyl methacrylate (HEMA), Purity (99%), M.Wt(130.14),was purchased from MERCK, Methyl methacrylate(MMA)Purity(99%) M.Wt(100.12), was purchased from HIMEDIA, Bovine serum albumin, Yellow granules, was purchased from HIMEDIA, Distilled water Purity(99%), Iraqi local product, N,N dimethyl acrylic amide (DMA), Purity(99.99%) ,M.Wt (73.9), was purchased from HIMEDIA, Silicone (Si) 3-(methacryloyloxy) propyltris (trimethylsiloxy) silane, Purity(99.99%), was obtained fromALDRICH,1-hydroxycyclohexyl phenyl ketone (PI184), Photo initiator Bisphenola dimethacrylate, Purity(99.99%), was bought from ALDRICH, Phosphate buffer saline (PBS), Purity (99.99%), was purchased from HIMEDIA, Ethanol Purity (99.99%) was purchased from MERCK.

2.2. Preparation of Silicone Hydrogels Contact Lenses.

The hydrogels made of silicone were polymerized as of TRIS, DMA,MMA, as well as HEMA monomers with different ratio (10%,20%) (Chien and Kuo, 2019)by free-radical polymerization in the existence of cross-linking mediator HDODA as well as photo creator PI184, as listed in Table 1. The response mixes were emptied of gassed by nitrogen for 30 min to eliminate the oxygen. Then the mix was moved in a dim milieu at room heat for 30min. Afterward being dispensed into polypropylene shapes, the mix was healed below 365 nm UV light for 40 min. After warded molding, the lens substance was filtered through soaking in 50% ethanol for 24 h at 50 °C to eliminate the un-reacted monomers as well as photo originator. Then, the lens was engrossed in refined water for 12 h at 50 °C to wash out the ethanol. Finally, the lens was preserved in PBS (pH 7.4) at room heat. For all constructions, the percentages of HDODA and PI184 were 0.625 wt % as well as0.4 wt %, correspondingly (Tran and Yang, 2019).

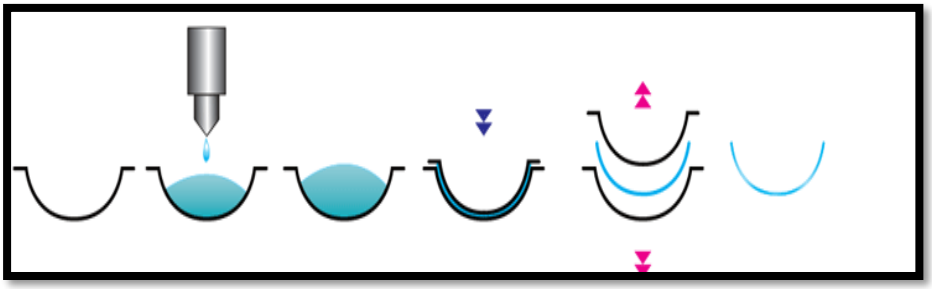

Fig. 1. Making contact lenses.

Table.1. Formulations of silicone hydrogel through copolymerization of TRIS, DMA, MMA, HEMA.

Sample	Feed monomer			TRIS	Time irradiation at min	EWC %	DK
	DMA	MMA	HEMA				
A1	0	90	0	10	10	18	95
B1	45	45	0	10	2	40	89
B2	40	40	0	20	3	33	102
C1	30	30	30	10	9	66	88
C2	26.66	26.66	26.66	20	8	55	90

2.3. Equilibrium Water Content

Dried hydrogel pieces were manipulated to decide the water content, the water component was controlled by submerging the hydrogel (0.1gm) in 100 ml of refine water for lengthy period of time. Extra water was detached from surface through blotting with lens-cleaning tissue immediately before measurements. The equilibrium water component(EWC) in distill water was decided through the ratio of the weight of water found inthe hydrogel toward the whole weight of the equilibrium of hydrogel on hydration (Yang *et al.*, 2016). EWC was measured through manipulating the next equation.

$$EWC = \frac{Ws-Wd}{Ws} \times 100 \quad \text{.....1}$$

Wherever Ws as well as Wd correspond to the weight of the swollen example as well as dried example, correspondingly(Tran and Yang, 2019). The lens that is wet lens underwent the process of rehydration in refined water at chamber heat for 24 hrs.

2.4. Oxygen Penetrability

Oxygen penetrability is fundamentally directed by EWC in hydrogels that are conventional. This happens mean while oxygen is capable of passing within the water rather within the substance itself. Oxygen penetrability is defined as the Dk, where D is the diffusivity of the substance as well as k is the solubility of the substance. The connection amid EWC as well as oxygen penetrability already being established being(Morgan and Efron equation).

$$Dk=1.67e^{0.0397EWC} \quad \text{.....2}$$

Wherever ‘EWC’ is Equilibrium of water component of the substance. The Dkare's units identified as Barrer (Muter, 2015):

$$DK(barrer)= \frac{10^{-11}\ (cm^2 \text{ x } mlO_2)}{sec \text{ x } ml \text{ x } mmHg} \quad \text{……..…….3}$$

2.5 Optical Transparency

The membrane's transparency was studied with the use of UV-visible spectrophotometer, sample were made through cutting to a slight piece (1 cm × 1 cm) after by solvent evaporation method as well as engrossed in refined water for 24 hrs to approaching equilibrium of swelling. The calculations were done from 200 to 700 nm wavelength at chamber heat (Tran and Yang, 2019).

2.6 Protein Deposition

The membranes of hydrogel were engrossed in the solution that is phosphate buffer (PBS, pH 7.4) 5ml for 24 hrs. Afterwards this stage soaking the membranes of hydrogel in lone protein solution of bovine serum albumin for 3hrs at 37 °C the characteristic surface heat of human eye, the attentiveness of protein solution was 0.5mg/ml. Afterwards adsorption the hydrogel membranes were put mildly in to PBS for 5 second to eliminate extra solution adhering to the hydrogel membranes. The membranes were later implanted into a glass tube having 1wt% aqueous solution of sodium dodecyl sulfate (SDS) to eliminate the adsorbed proteins on the membranes. The sum of proteins adsorbed on the membrane surface was calculated from the proteins concentration in the SDS solution manipulating Bradford assesses reagent kit at the end, protein deposition of all specimens was calculated by a UV-Vis spectrophotometer (Tran and Yang, 2019).

2.7 Evaluation of bacterial adhesion

The lenses are made of different types of mixtures consisting of a mixture of silicon and hydrogel. The lenses are kept within a saline solution. The examples were washed with 100 ml of sterile saline three times Examples were saved in 3 ml of PBS solution. Adhesion examination was performed by the method of editing the adherent bacteria by ultrasound, where the lenses were exposed to bacterial isolates by dilution 10^{-4} and 10^{-5} respectively and for each isolation for 30 minutes and 60 minutes, then the lenses were put in sterile vials having 1 ml of PBS solution and then The super waves were shown at a rate of 75 kHz placed in a water bath with a depth of 1 cm at a temperature of 30 m for a period of 15-15 minutes after which the vials were transferred to the vortex vibrator for 1-2 minutes. Then withdraw about 100 ml of the solution containing the free bacteria for the samples and spread on the dishes containers on

TSA incubated the dishes for 24 hours at 37 °C and the cell numbers were calculated with a value of cfu / mm^2 (Alkhozai, 2017).

3. RESULTS AND DISCUSSION

3.1. Synthesis and Characterization

3.1.1. Synthesis and Characterization of (TRIS-co-MMA)

TRIS is profitable monomer made of silicone to sustain great oxygen penetrability in contact lens, whereas (MMA) was chosen for its hydrophobic to provide oxygen transmissibility. In the beginning, only TRIS was copolymerized with(MMA). The hydrogels made of silicone were polymerized from TRIS as well as monomers of (MMA) in the existence of cross-linking mediator 1-6 hexandioldiacrylate and photo motivator,1-hydroxycyclohexyl phenyl ketone, using percentage (10%) of TRIS. The mix was moved in a dim milieu at room heat for 30 min. Afterwards being dispensed in polypropylene shapes, the mix was healed below 365 nm UV light for 10 minutes at 10% of TRIS. In this study TRIS was employed as part of silicone monomers. When TRIS was incorporated in the polymers, the ability of being compatible of hydrophophic monomers might be improved. Those synthesized hydrogels made of silicone display potential to develop the limpidity. As show in Fig. 2.

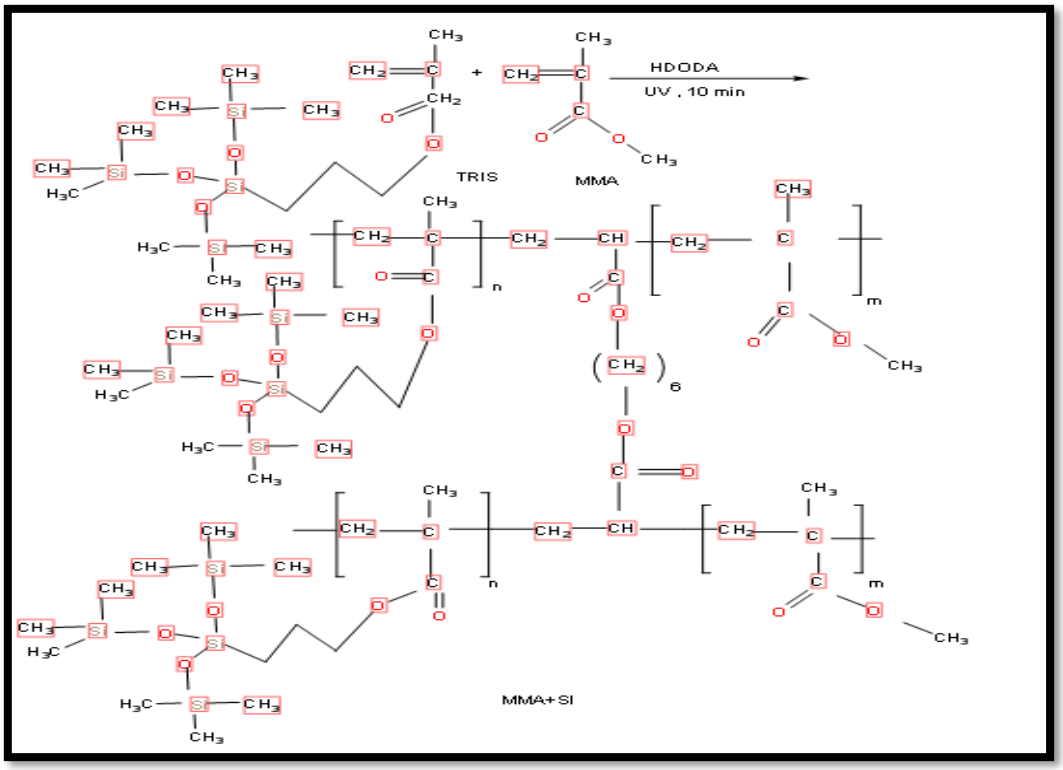

Fig. 2. Copolymerization and Crosslinking of HDODA with TRIS-co-MMA.

3.1.2. FTIR Spectrum of MMA-co-TRIS

The FTIR Spectrum of (TRIS-co-MMA),is exposed in Fig. 3; the hydrogel confined with silicone constituents might detect a robust group of –Si–O_3 extending at 636 cm^{-1}, two feeble group of –Si–$(CH_3)_3$extending at 683 as well as 735 cm^{-1}, a feeble group of –CH_3 distortion at 1406 cm^{-1} as well as a robust group of –CH_3extending at 2890 cm^{-1};which designates absorption band at; 2930cm^{-1} ,2820cm^{-1} towards(C-H str. of backbone polymer),1731$cm^{-1}$to(C=O str. ester collection),1250 cm^{-1} ,1200cm^{-1} and 1152cm^{-1} to (C-O-C str.) and 1077cm^{-1} to (-C-O of C-OH str.).Moreover, distinguishing bands at about 900 cm^{-1} and 3100 cm^{-1}agreeing with the vinyl bands of monomers disappeared totally, that designated nonexistence of unreacted monomers (Silverstien, Webster and Kiemle, 2005; Rao, 1963).

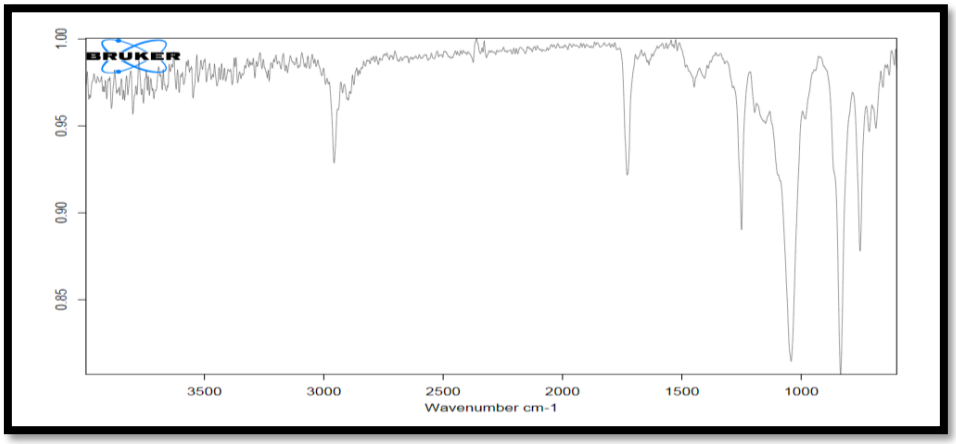

Fig. 3. FTIR spectra for MMA-co-TRIS.

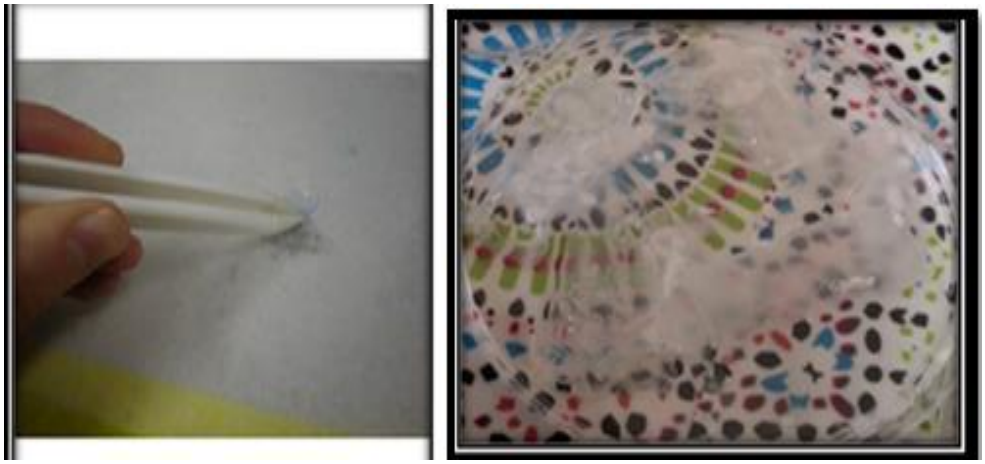

Fig. 4 .Preparation of TRIS-co-MMA contact lens.

3.1.3. Synthesis and Characterization of (TRIS-co-MMA-co-DMA).

TRIS is profitable monomer made of silicone to sustain great oxygen penetrability in contact lens, whereas (MMA) was chosen for its hydrophobic to provide oxygen transmissibility. In the

start, just TRIS was copolymerized with (DMA). The hydrogels made of silicone underwent the process of polymerization out of TRIS and (MMA)&(DMA) monomers in the attendance of cross-linking mediator 1-6 hexandioldiacrylate and photo originator,1-hydroxycyclohexyl phenyl ketone, using different percentages (10%,20%) of TRIS. The mix was moved in a dim milieu at room heat for 30 min. Afterward having dispensed in molds of polypropylene, the mix was preserved below 365 nm UV light for 2 minutes at 10%,3minutes at 20% of TRIS. In this study TRIS was employed to as part of silicone monomers. When TRIS was as similated in the polymers, the compatibility of the monomers made of hydrophilic might be heightened. Those created hydrogels made of silicone display potential to develop the transparence aspect. As show in Fig.5.

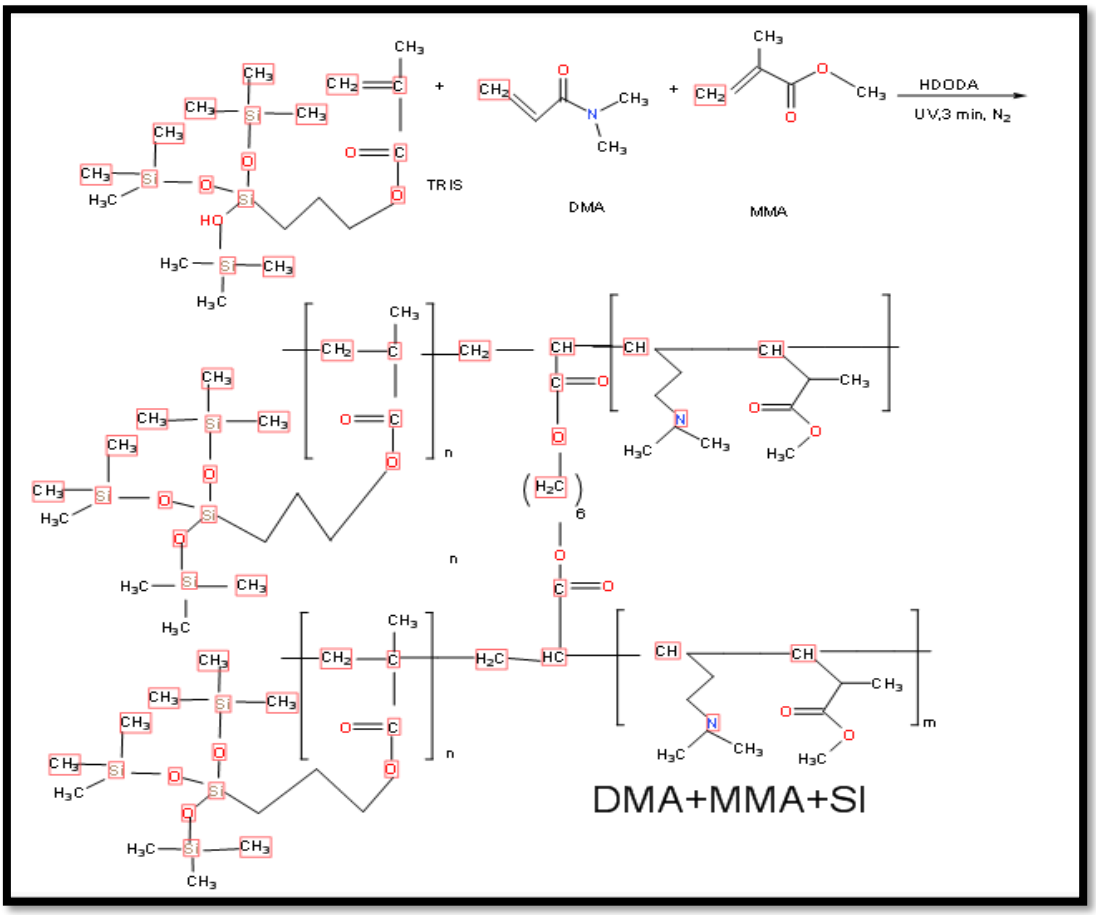

Fig. 5. Copolymerization and Crosslinking of HDODA with TRIS-co- DMA-co-MMA.

3.1.4. FTIR Spectrum of (TRIS-co-MMA-co-DMA)

The FTIR Spectrum of (TRIS-co-MMA-co-DMA),is exposed in Fig. 6; the hydrogel founded in silicone constituents might witness a robust group of –Si–O_3 extending at 636 cm^{-1}, two feeble group of –Si–$(CH_3)_3$ extending at 683 and 735 cm^{-1}, a feeble group of –CH_3 distortion at 1406 cm^{-1} as well as a robust group of –CH_3 extending at 2890 cm^{-1};which indicates absorption

band at; 2930cm^{-1} ,2820cm^{-1} to (C-H str. of polymer backbone),1731cm^{-1} to(C=O str. ester band),1250 cm^{-1} ,1200cm^{-1} and 1152cm^{-1} to (C-O-C str.).the amide I group happens in the area of 1620-1670 cm^{-1}for N'N-dialkyl replaced amides (Rogers, 2006). The amide I group at 1629 cm^{-1}is credited essentially to the C=O extending way by certain offerings from the C-N extending ways. The group that is underwent polarization at 1086 cm^{-1} was put here to the symmetric extending ways of the $N(CH_3)_2$ band. Once DMA underwent polymerization process in the hydrogels made of silicones, two novel groups at 1629 as well as1086 cm^{-1}found, that related to the C=O and $N(CH_3)_2$ of the monomers of the acrylamide, correspondingly. The concentration of 1629 cm^{-1} as well as1086 cm^{-1}rise with growing the sums of DMA. The outcomes of robust suggestion of the presence of DMA in the copolymers of silicone hydrogel. Besides, distinguishing bands at about 900 cm^{-1} and 3100 cm^{-1}conforming. to the vinyl bands of monomers vanished totally, that designated nonexistence of unreacted monomers (Silverstien, Webster and Kiemle, 2005; Rao, 1963).

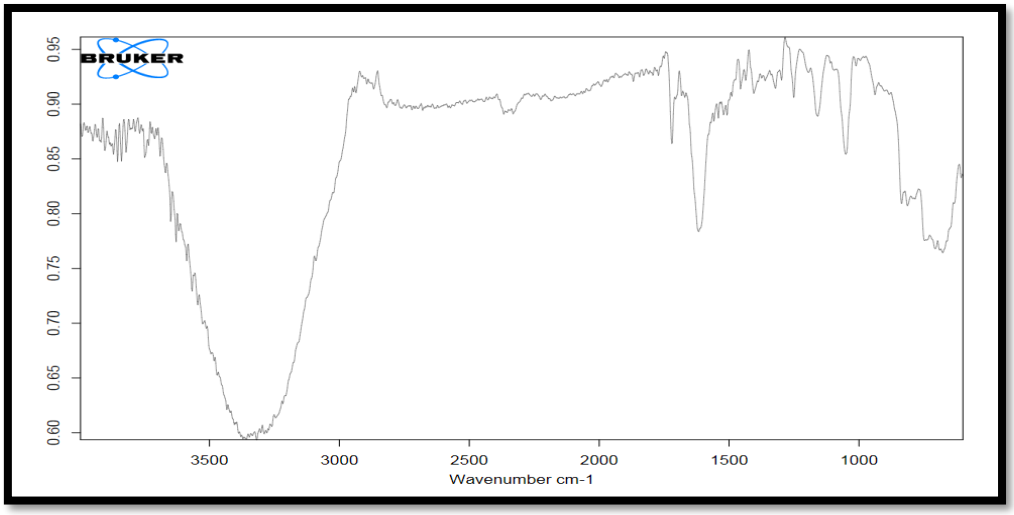

Fig. 6. FTIR spectra for DMA-co-MMA-co-TRIS.

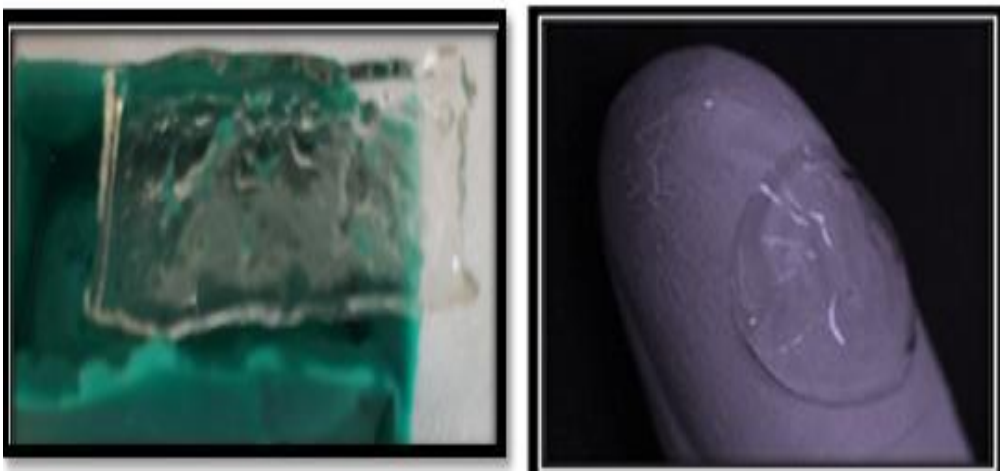

Fig. 7. prepration of TRIS-co-MMA-co-DMA.

3.1.5. Synthesis and Characterization of (TRIS-co-MMA-co-DMA-co-HEMA).

TRIS is profitable monomer of silicone to sustain great oxygen penetrability in contact lens, whereas (MMA) &(HEMA)was selected for its hydrophobic to provide oxygen transmissibility. In the beginning, only TRIS was copolymerized with (MAA). The hydrogels made of silicone were underwent the process of polymerization from TRIS as well as(HEMA),(MMA)&(DMA) monomers in the existence of cross-linking mediator 1-6 hexandioldiacrylate as well as photo initiator,1-hydroxycyclohexyl phenyl ketone, using different percentages (10%,20%) of TRIS. The combination was moved in a dim milieu at chamber heat for 30 min. Later being dispensed into molds of polypropylene, the mix was healed below 365 nm UV light for9 minutes at 10%,8 minutes at 20% of TRIS. In this study, TRIS was employed as portion of monomers made of silicone. When TRIS was included in the polymers, the compatibility of hydrophophic monomers might be enriched. Those manufactured hydrogels made of silicone display potential to develop the limpidity. As show in Fig. 8.

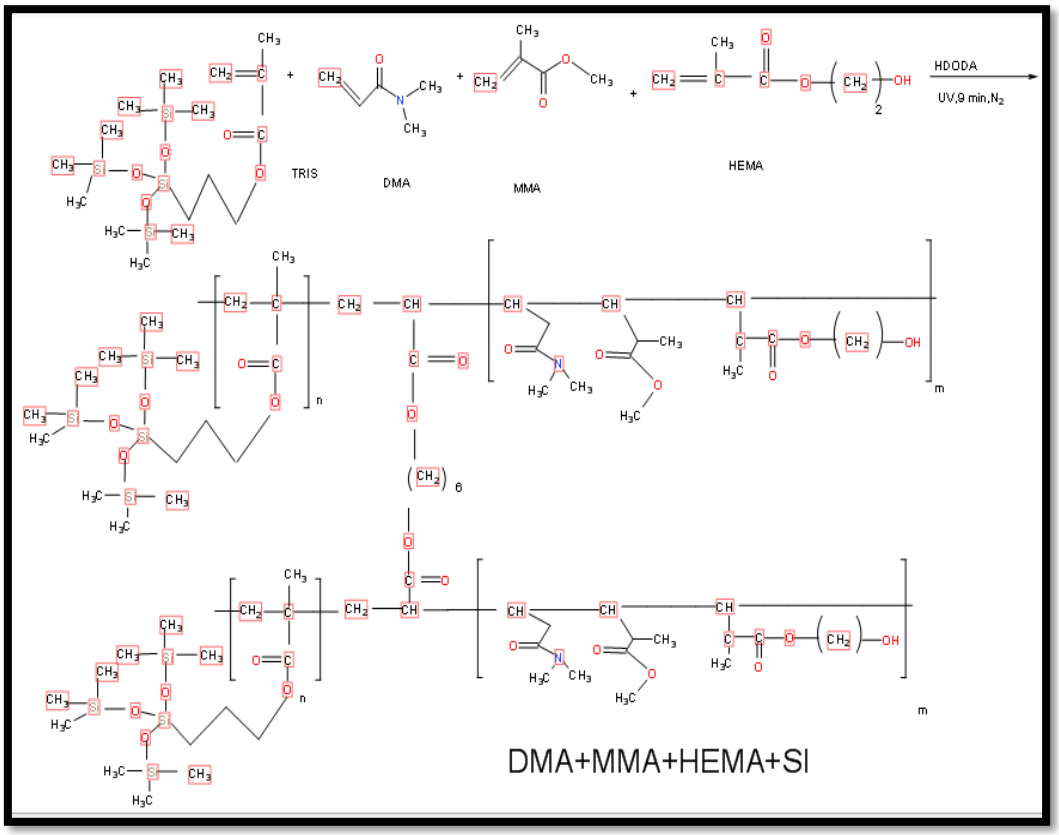

Fig. 8. Copolymerization and Crosslinking of HDODA with TRIS-co- DMA-co-MMA-co-HEMA.

3.1.6. FTIR Spectrum (TRIS-co-MMA-co-DMA-co-HEMA)

The FTIR Spectrum of (Si-co-MMA-co-DMA-co-HEMA),is exposed in Fig. 9; the hydrogel founded with silicone constituents might witness a robust group of –Si–O_3extending at 636 cm^{-1}, two feeble groups of –Si–$(CH3)_3$extending at 683 as well as735 cm^{-1}, a feeble group of –CH_3 distortion at 1406 cm^{-1} as well as a robust group of –CH_3 extending at 2890 cm^{-1};that designates absorption group at 3400-3420cm^{-1}because of(-OHstr.group in polymer),2940cm^{-1},2830$cm^{-1}$to (C-H str. aliphatic backbone of polymer), 1758cm^{-1}(C=Ostr,ester group),1152cm^{-1} to (C-O-C str.) as well as 1085 $cm^{-1}$to (-C-O of C-OH str.), 1731cm^{-1} to(C=O str. ester group),1250 cm^{-1} ,1200cm^{-1} and 1152cm^{-1} to (C-O-C str.), 1728 cm^{-1} to (C=O str. ,ester group of EHMA),the amide I group happens in the area of 1620-1670 $cm^{-1}$for N'N-dialkyl replaced amides (Rogers, 2006).The amide I group at 1629 $cm^{-1}$is credited essentially to the C=O extending way by means of certain participated in the C-N stretching way. The polarized group at 1086 $cm^{-1}$was put at this time to the symmetric extending ways of the $N(CH_3)_2$ band. When DMA was to underwent the process of polymerization in the hydrogels made of silicone, two novel groups at 1629 as well as 1086 cm^{-1}founded, that is related to the C=O as well as $N(CH_3)_2$ of the monomers made of acrylamide, correspondingly. The concentration of 1629 cm^{-1} as well as1086 cm^{-1}rise with growing the sums of DMA. The outcomes deliver robust indication of the presence of DMA in the silicone copolymers of hydrogel. Besides, distinguishing bands at around 900 cm^{-1} and 3100 cm^{-1} corresponding. to the vinyl groups of monomers vanished totally, that is designated as non existence of unreacted monomers (Silverstien, Webster and Kiemle, 2005; Rao, 1963).

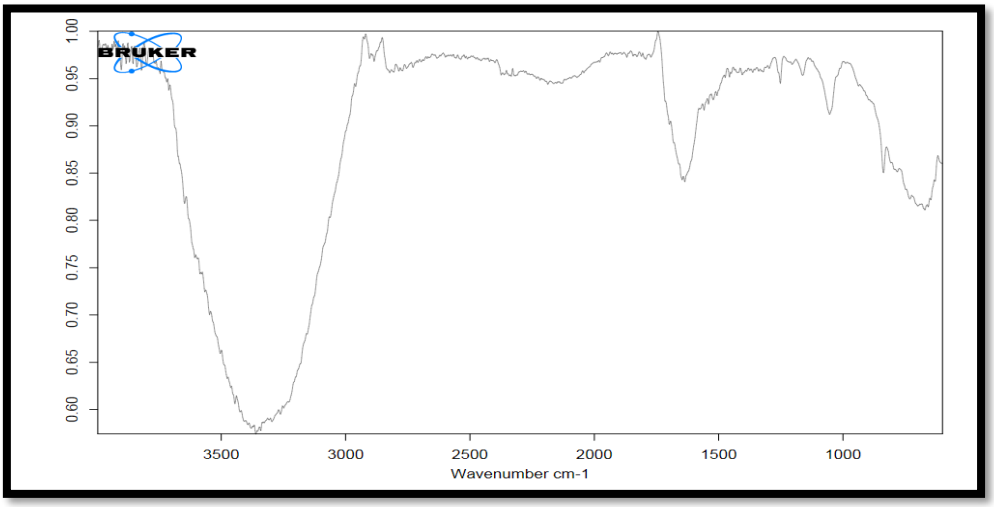

Fig. 9. FTIR spectra for TRIS-co-DMA-co-HEMA-co-MMA.

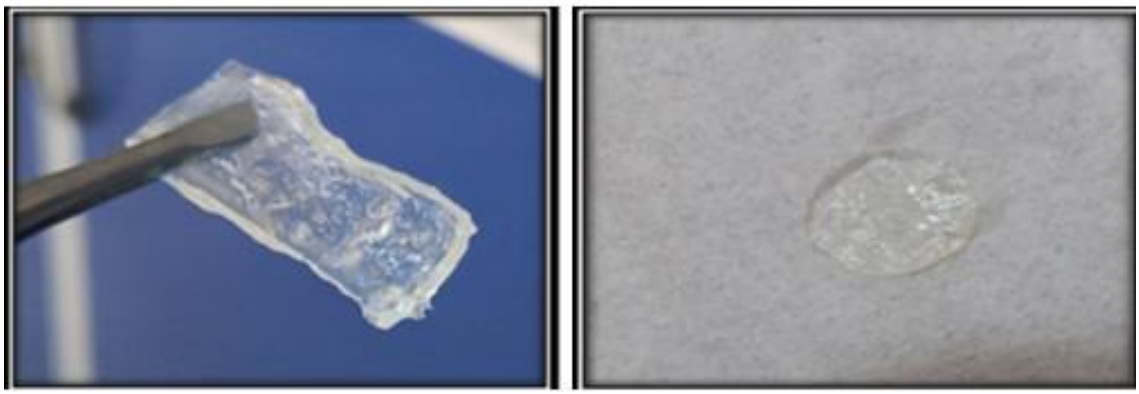

Fig. 10. Preparation of TRIS-co-MMA-co-DMA-co-HEMA.

3.2. Equilibrium Water Content

Fig. 11 signifies the equilibrium water content to time for diverse percentages of TRIS. The water component of the methyl methacrylate can be decreased by increasing the amount of methyl methacrylate due to the these hydrophobic monomers have many methyl group which create swelling performance as well as the expansion water of the polymer network too poorer as well as kept its chain stiff in resulting silicon hydrogel (HOLLY, 1981).

DMA is more hydrophilic than MMA represents. The water content of the methyl methacrylate can be decreased by increasing the amount of methyl methacrylate due to the these hydrophobic monomers have a lot of methyl group which cause swelling conduct as well as the expansion water of the polymer net too poorer as well as reserved its chain stiff in resulting silicon hydrogel (HOLLY, 1981). As predictable, the amide band of DMA offers more hydrogen connecting sites for water in assessment to MMA; consequently, greater kinship for water was established in the hydrogels made of silicone by a further DMA component. Greater component of monomer of the zwitterionic sulfobetaine that is in showed a greater EWC due to sulfobetaine unit might interact with water thru equally electrostatic forces and hydrogen groups, that providing a stouter water kinship than MMA (Omali, 2012). As anticipated, the amide band of DMA delivers extra hydrogen connection sites for water in assessment to MMA; consequently, a greater similarity for water was originated in the hydrogels made of silicone by another DMA component.

For the sake of rising the water content of contact lenses through copolymerization of polar monomers such as DMA and HEMA are polymerized with Silicone into silicone hydrogels, which increases the water content due to the hydrophilic of the co monomers that employed to rise the aptitude of the hydrogels to have more water, but when adding hydrophobic monomer methyl methacrylate (MMA) the water content decreases. The results show that higher

hydrophilic monomers gives higher water content in the hydrogel contact lenses, on other hand the tripolymer (TRIS + MMA +DMA+HEMA),show lower water content because of the increase in hydrophobic monomer (MMA) in comparison with the hydrophilic monomer of DMA, and HEMA that is used.

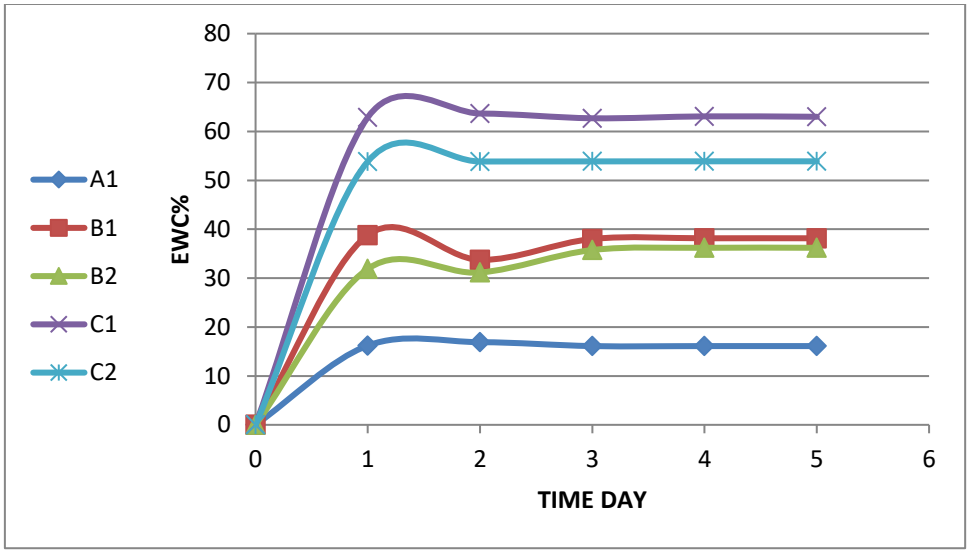

Fig. 11. EWC% for different ratio of monomers.

3.3. Oxygen Permeability

Conventional contact lenses depend on water to transmit oxygen over the lens. Dk bounds Unlike traditional hydrogels, oxygen can be transported. Through the silicon constituent in the silicone hydrogel substances, which leads to a great distance increased oxygen permeability. Investigate Dk as well as water component of diverse hydrogel made of silicone lenses on the market also establish an opposite connection amid Dk as well as water component equally, some preceding readings designated opposite association amid Dk and EWC due to silicon hydrogel lenses water is the preventive aspect in the permeability of oxygen (Chien and Kuo, 2019).

Generally, the silicon–oxygen bonds as well as free water being two chief paths to oxygen transport within hydrogel made of silicone network. Due to the ability of oxygen to absorb siloxane band is 10 times higher other of that of free water, the ability of oxygen to transmit is mainly by the silicone of hydrophobic stage, that is controlled by means of TRIS in this paper. Away from the siloxane bands, oxygen could too carriage by free water presence in the phase of silicone. In matrix of silicone a of hydrogel, water is found as free water as well as well as water that is bound. The bound water is straightly linked to unceasing hydrophilic stage composed of non-freezable as well as formulas that can be freezable. Further, the water stuck

in phase of hydrophobic silicone is generally free water. Being an outcome, in the silicone stage, pores that are small will look as if with too little water component, as well as oxygen could be absorbed over this channel (Tran and Yang, 2019).

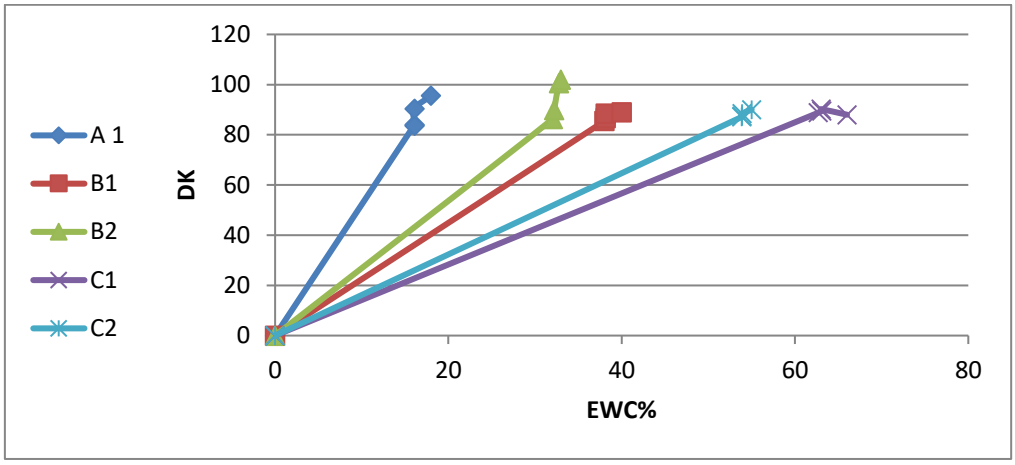

Fig. 12. The correlation between Dk and EWC.

3.4. Transmittance

In the hydrogel contact lenses could efficiently decrease the light scattering as well as cause a great light transmittance. The absorbance for UV light is critical aimed at perfect artificial cornea in term of preventing the damage of UV to internal eye tissue (Harris *et al.*, 2000).

The synthesized polymer should be transparent for the sake of being appropriate to contact lenses. The transmittance of monomers used in contact lenses must be as compatible as conceivable to escape stage of separation. There might be a serious problem with hybridization of theses organic substances due to the different in hydrophobic and hydrophilic monomers, such compounds that are incompatible may lead to micro phase parting as well as form opaque substances. The solution to this problem a network that is interpenetrating (IPN) construction ,has been showed to be a hopeful method (Nicolson and Vogt, 2001).The results showed that the whitest cole contact lenses permitted comparatively uniform range of light transmission of about 95-98.8%,at wavelengths between 400-700 nm and below at wave lengths 240 nm the transmittance less than 1% for all contact lenses.

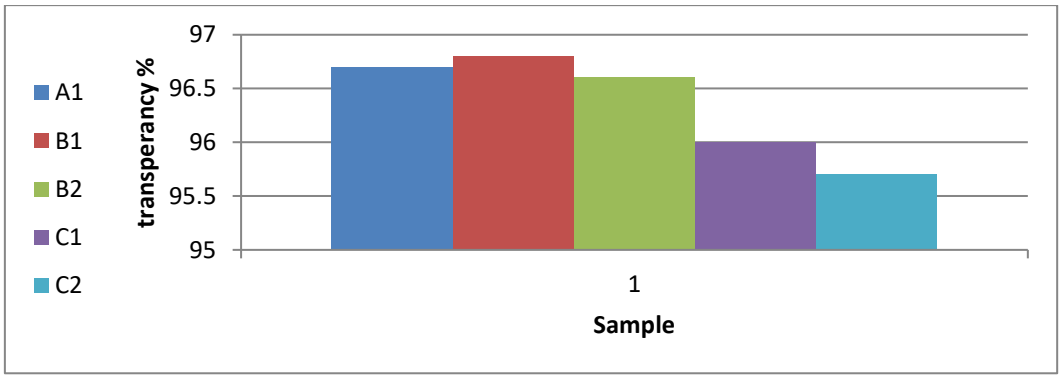

Fig. 13. Light transmission of hydrated modified silicone hydrogel samples.

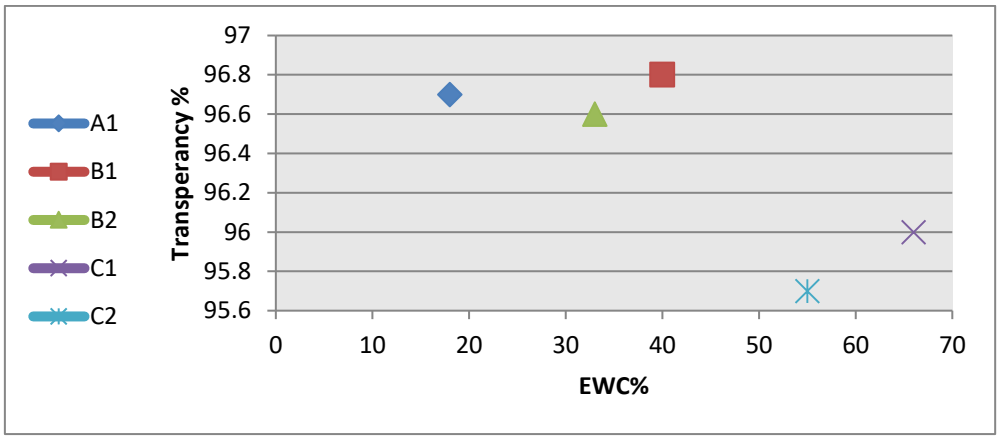

Fig. 14. Worth of transparency by way of a function related to the percentage of EWC in silicone hydrogels.

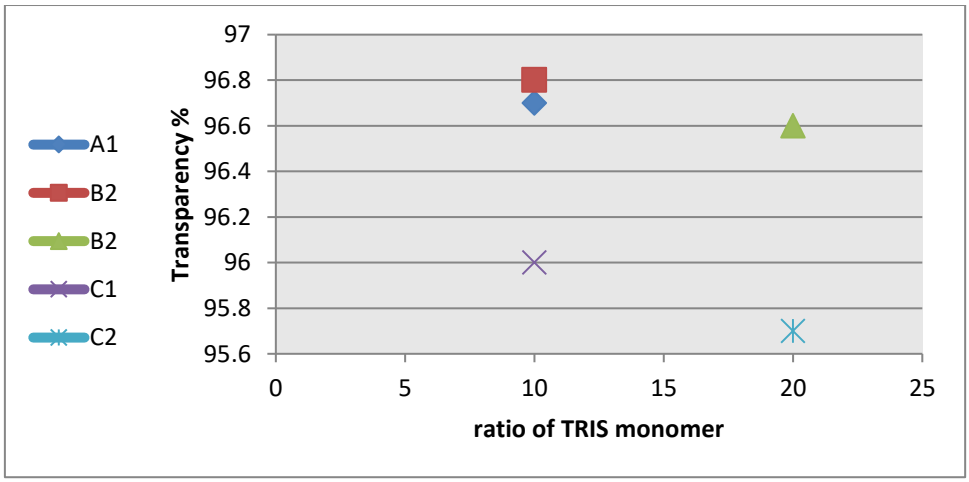

Fig. 15. The worth of transparency as functions of silicone monomer.

3.5. Protein Deposition

Contact lenses signify a great precise sort of interface that is biomaterial, in way of the substance is showing to equally the tear film as well as numerous ecological elements. Although the stage of protein deposition on contact lenses is powerfully affected thru the tear conformation, it is

also altered according to the features that are chemical of the lens substance (Willcox *et al.*, 2002; Lord *et al.*, 2006). It is shown that substantial on formation (Luensmann, 2009) as well as features like water content (Keith, Hong and Christensen, 1997) and pore size (Garrett *et al.*, 1998) roughness of the surface (Castillo, Koenig and Anderson, 1986) hydrophobicity (Luensmann, 2009) and charge (Soltys-Robitaille *et al.*, 2001; Bajpai and Mishra, 2004) all play a title role in adsorption of protein, in addition to tear film pH as well as ionic strong point (Moradi, Modarress and Noroozi, 2004; Demirel *et al.*, 2005). Lastly, protein features likesize, charge, as well as time of material revelation to the protein are all significant elements to examine (Jones *et al.*, 2003).

In the present paper Bovine serum albumin was used because the BSA are very similar in the shape as well as physicochemical properties to human serum albumin, because of the resemblance of HSA as well as BSA, as well as the related availability as well as lesser cost of BSA, many in vitro studies have used BSA being a substitute to HSA (Tighe, 2000; Michnik *et al.*, 2006).

Table 2. Comparison in Structure Amid HSA as well as BSA.

	M.Wt	**Isotonic point**	**Number of fatty acid**
Human HAS	66.438	5.16	585
Bovine BSA	66.411	5.15	583

BSA deposited as well as experienced conformational alterations on poly highly hydrophobic polymer, there are too diverse adsorption conduct for the protein. Conformational alterations of BSA resulting powerfully by means of the sum of protein adsorbed up to the surface, notwithstanding of soaking period or BSA focus in the aqueous solution. Throughout the first 15 minutes, BSA adsorption was almost thorough, with lone a slight increase happening over the subsequent 10 hours, while lysozyme build-up increased considerably done in the 10 hour time period (Ishiguro *et al.*, 2005).

There are too diverse adsorption conduct for the protein. Conformational alterations of BSA resulting powerfully from the sum of protein adsorbed to the surface, regardless of soaking time or BSA attentiveness in the aqueous solution. Throughout the first 15 minutes, BSA adsorption was almost thorough, with only a minor increase occurring over the following 10 hours, while albumin build-up rose considerably in excess of the 10 hour time period. Fundamentally, the process of adsorption happened to the protein is connected to the ability of being wet of the lens. The consequence of connection angle on the adsorption of the protein of altogether examples created in the present study (Tran and Yang, 2019). For BSA, after the TRIS content

rose from 10 to 30 %, the adsorption of protein reduced from 0.851 to 0.205µg/cm^2.The deposition of protein of silicones-dependent hydrogel lens substance was fewer than that of HEMA as well as reduced with reducing water content (Subbaraman *et al.*, 2006). The protein deposition of contact lens is too affected through means of extra elements like pH of milieu, dimension of protein, charge of protein, lens substance, water content, coarseness of lens surface, and substantial factors (Moradi, Modarress and Noroozi, 2004; Demirel *et al.*, 2005). In preceding study, protein adsorption was in a straight line relative to the rise of hydrophobic substances and TRIS component, that caused declining water content (Kim and Somorjai, 2003; Paterson *et al.*, 2015). Nevertheless, yet another study shows that growing BSA adsorption was affected by means of loading hydrophilic constituents, particularly NVP (Garrett, Laycock and Garrett, 2000; Luensmann and Jones, 2012; Silva *et al.*, 2015).

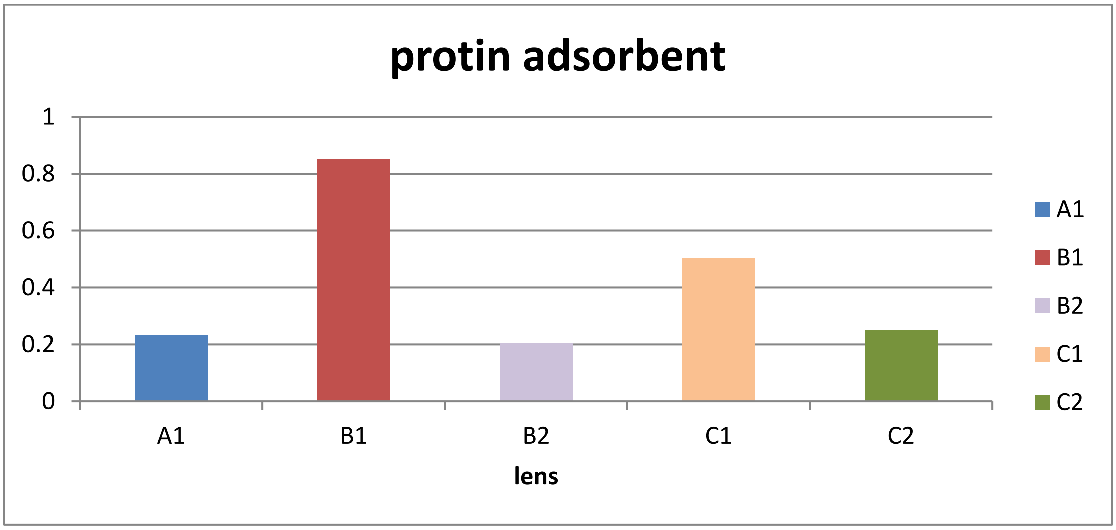

Fig. 16. Effect of Albumin Deposition on Lens Material.

3.5.1. Finding the reaction order for protein albumin adsorption on contact lenses:

The degree of reaction was tested from (zero, first, second order) and by drawing we found it to be second order

Zero order:

$$[\mathrm{CAt}] = -\mathrm{kt} + [\mathrm{CA0}] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

The curve not liner

First order:

$$\mathrm{Ln}[\mathrm{CAt}] = -\mathrm{kt} + \ln[\mathrm{CA0}] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

Second order

$$\frac{1}{[CAt]} = kt + \frac{1}{[CA0]} \quad \ldots\ldots 6$$

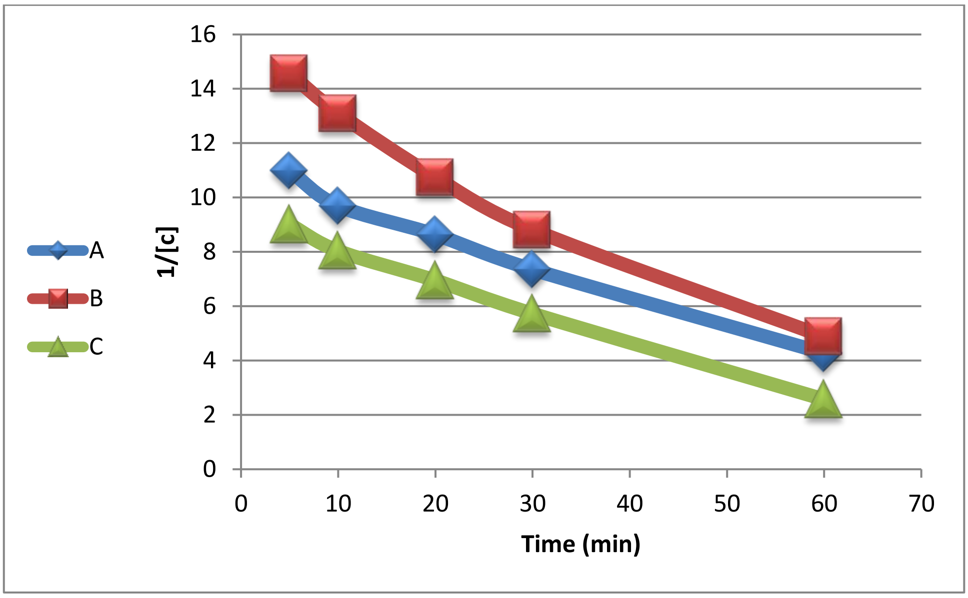

Fig. 17. Proof the order of reaction to the adsorption of Albumin A mono monomer, B di monomer tri monomer.

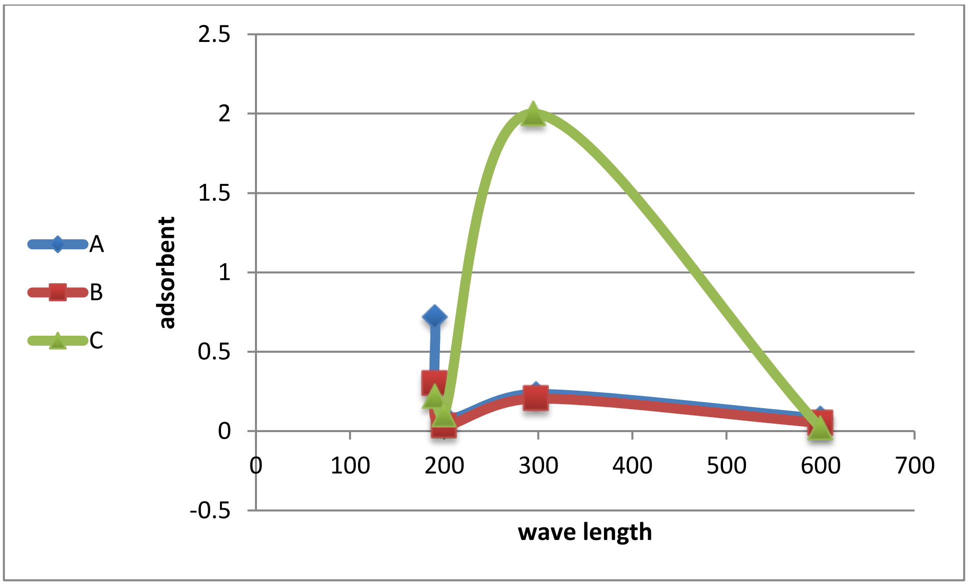

Fig. 18. The correlation between the wave length and adsorbent, A mono monomer, B di monomer tri monomer.

3.6. Evaluation of bacterial adhesion

Corneal bacterial inflammation (transparent tissue at the front of the eye), caused by germs, is a disease that threatens vision, and can appear in children and adults. Most germs do not have access to a complete and healthy cornea, but when the cornea is exposed, for example, after eye damage or a foreign object entering it, the germs can enter into it and lead to inflammation. The common bacteria that lead to bacterial infection of the cornea are Staphylococcus, which

includes the Pseudomonas In our research, we performed an assay on pseudomonas bacteria. On ophthalmic features, cellular conduct is important in influencing the biocompatibility of cells (Lin *et al.*, 2014).A cytotoxicity examination was showed to witness the alteration of morphology cellular through putting the remove middle of hydrogel lens to a cell culture. The contact lenses' surface is liable to adhesion of microbial pathogens that causes ocular contagions (Stapleton *et al.*, 2006). Staphylococcus aurous is among the species existed regularly in human eyes, were also seen in contact lenses of people (Xiao *et al.*, 2018). At this time, we use aurous of Staphylococcus like a bacterial example to experiment the adhesion that is bacterial of the lens substances. The average sum of bacteria add-on on the hydrogels made of silicone were around 10^4CFU/mL. Moreover, bacterial connection for numerous mingling ratios of HEMA. MMA, as well as monomers of DMA hydrophilic in hydrogels made of silicone were examined. The adding of hydrophilic monomers greater than 35% considerably reduced the adhesion that is bacterial to around10^3 CFU/mL. After the lenses have been exposed to bacteria (Pseudomonas) and incubated for 24 hours, we notice that the highest adhesion rate for bacteria on the lenses is after one and a half to two hours. Dilution There are different types of it, but we use Decamitigation. That is, we take one ml of bacterial growth at a certain concentration and dilute it in a ratio of 1 to 10.We repeat the process and each time we reduce it becomes ten to the negative one and the twelfth to the negative to the second negative, and so on the more bacteria the concentration, the more cells are attached the third dilution, for example, bacteria B more than the sixth Thus sticking more. As for the acceptable limits for the presence of bacteria on the lens. It is assumed to be a parameter, but of course it is present. Here the type of bacteria plays a role. There are dangerous bacteria as soon as they exist we refuse to use the lens. Of course there is no specific number.. Here comes the role of the control group and we compare with it where we compared the results with a search (Alkhozai, 2017). Overall, a coarser surface is prone to more bacterial adhesion as in adequacies on the surface area where infections deposits are probably to compose (Tam, 2013). The constructive association was too stated thru (Giraldez, Resua, *et al.*, 2010) (Giraldez et al.2010) that the further silicone of hydrophobic of contact lenses display higher vulnerability to adhesion of Staphylococcus epidermidis other than the conventional lenient contact lenses (Giraldez, Serra, *et al.*, 2010).The present study's remark is reliable to their study. Conferring to researchers' outcomes, we propose that the hydrophobicity of the surface related to the lens is one of decisive elements for adhesion of bacterial.

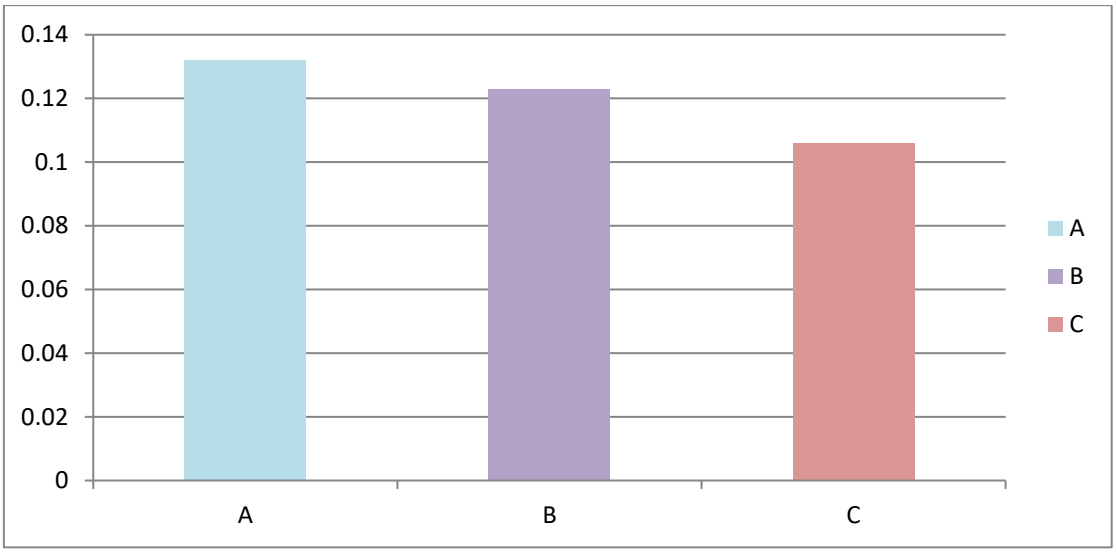

Fig. 19. The value of adhered cells, A mono monomer, B di monomer tri monomer.

4. CONCLUSIONS

By means of what is established in the present paper, the hydrogels made of silicone were polymerized as of TRIS, DMA, MMA, as well as monomers of HEMA. Through altering the structures, the hydrophilicity of the resulting silicone hydrogel lenses could be familiar. An experimental association was got overnumerous regression for the equipoise water component. The EWC rose with the components of DMA as well as HEMA while reducing with the growth of TRIS and MMA. In addition, the oxygen penetrability, the contact viewpoint as well as Young's modulus showed linear dependence on EWC. The outcomes too displayed that the Dk worth decreased first as then as well as increased when the EWC was from 18 to 66%. For biological feature, the sum of bacteria involved to the silicone hydrogels drops. The adsorption of protein decreased with the contact angle. Generally, all examples offered great light transparency, realistic moduli, and non-cytotoxicity.According to overall experimental results, the hydrogels made of silicon are greatly appropriate for the application in contact lenses due to the optimized mechanical features as well as low adhesion of bacteria. The study will aid people for scheming a hydrogel made of silicone with better properties as well as wider use in contact lenses or drug packing contact lens.

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