ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF RESEARCH IN PHARMACEUTICAL SCIENCES

Published by JK Welfare & Pharmascope Foundation   Journal Home Page: www.ijrps.com

The influence of (Mn) Nano - particles on mechanical, physical, and biological properties of (PMMA/PVA-Mn) Nano - composite used for denture base

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Article History:

Received on: 19.08.2019
Revised on: 05.11.2019
Accepted on: 16.11.2019

Keywords:

Nano-composite,
Structural,
Bacterial,
mechanical properties

ABSTRACT

The (PMMA/PVA–Mn) Nano-composites films were prepared via a photopolymerization method with different percentages (0.0%, 0.1%, and 0.2%) Of Mn with (20%PVA /80%PMMA,30%PVA/70%PMMA ad 40%PVA/60% PMMA). The structural, bacterial, and mechanical properties of Nano-composites. Were studied, X-ray properties of Mn nanoparticle which studied. Scanning electron microscopy analysis was employed to evaluate the morphological and structural properties of each thin film Nanocomposite. Moreover, the effect of Streptococcus mutans antibacterial of those materials was analyzed. The morphological studies represented that both non-functionalized and Bio functionalized manganese oxide NPs (MnNPs) formed are of spherical morphology but exhibited with a difference in size about 20 nm and 27-40 nm, respectively. The performance of the antimicrobial activity. The results are revealed that the Bio functionalized MoNPs showed higher antibacterial. Results show that values increase in each of Mn Nanoparticle and with different concentrations of (PVA/PMMA) polymer, then decrease alternately less value of volume fraction of fillers. Young modules values increase alternately by the volume fraction of fillers.

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ISSN: 0975-7538

DOI: https://doi.org/10.26452/ijrps.v11i2.2208

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INTRODUCTION

In recent years, the various size and shape of different Nanomaterials has been realized through UV-irradiation. Polymer Nano-composites homogenized with metal Nanoparticles have become vital of all chemistry, physics, technology, and bioengineering (Lakshmi and Kannan, 2016). Recently, the polymerization of the natural monomer is performed at first and afterward the silver particles, as though the photograph polymerization technique has been accounted for to incorporate metal-polymer Nanocomposites because of its exceptional favorable circumstances (Hilal *et al.*, 2016). In this strategy, the decrease of metal particles and polymerization of monomer can be completed at the same time under the ordinary weight at room temperature without utilizing an unreasonable decrease of operators (Deshmukh and Composto, 2007). This issue incites the arrangement of homogenously dispersed metal nanoparticles in the substance compound network. Thusly numerous papers are uncovered on the radiation-incited combination of metal concoction compound Nanocomposites as far as anyone is concerned; there is no report on the utilization of UV-light to deliver PMMA/PVA-MN Nanocomposite.

In this paper, we employed UV-irradiation to Nanocomposite in which the metallic ions ($Mncl_2O_3$) are reduced, and there is the polymerization of the methyl-methacrylate monomer. Where Nanocomposite exhibits many characteristics as catalytic, electrical, optical, etc. it is often used in various electronic fields and biomedical applications (Akhavan *et al.*, 2010).

In recent years polymers are widely used in the manufacturing of dental materials; this refers to the mechanical properties. The polymer Nanocomposite materials indicated great biocompatibility. The materials having high filler substance indicated progressively unmistakable scaled downscale - hardness differentiated and monetarily open area materials, as well as the Polymer Nano-composites, have the same thermal conductivity as natural teeth (Mutar and Mahdi, 2019).

In most of the dental materials, compressive strength characteristics are considered important, and this is referred to as the mastication, which considers brittle materials scale according to International Organization for Standardization ISO (Hilal *et al.*, 2019).

Theoretical part

The structural properties of denture base the polymer Nanocomposite of (PVA/PMMA-Mn) of difference concentration.

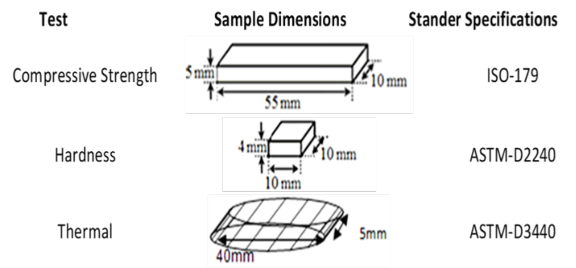

Figure 1: Dimensions and shapes of samples

Mechanical properties

Compressive strength

In Most of the dental materials utilized for denture base, compressive quality considers as significant inspect for a given marker of fragility, so its imply that is a measure of protection from the crack under pressure load. Pressure disappointment in composite material depended upon the properties of the grid, for example, sturdiness, and properties of reinforced such as volume fraction and interface. The shape of tests which test that have measurements

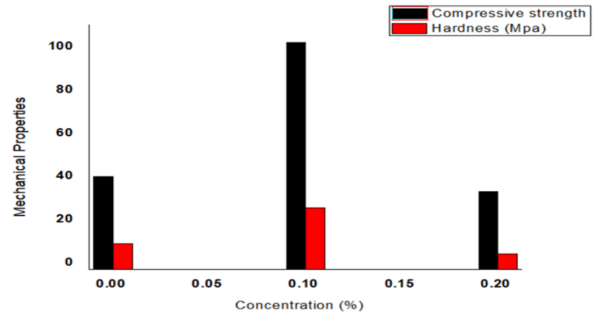

Figure 2: Illustrated difference concentration of Mn nanoparticle effects on mechanical properties

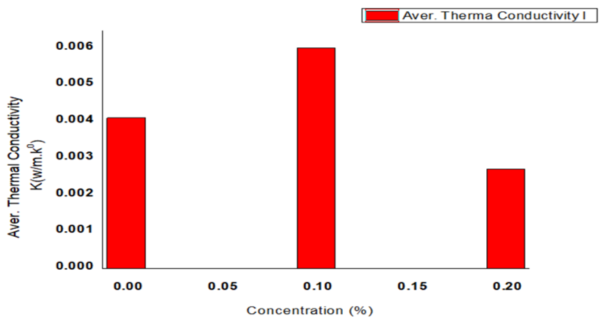

Figure 3: Illustrated difference concentration of Mn nanoparticle effects on average thermal conductivity

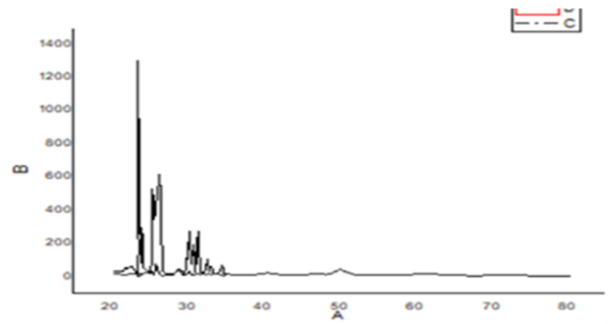

Figure 4: X-Ray of Manganese nanoparticle

breaks even with numerous of the distance across of the cross-segment of tests and connected constraint as appeared within the Equation (1) : (Galvão *et al.*, 2013; Stencel *et al.*, 2018).

$$compressive\ strength = \frac{compressive\ strength\ Max.of\ force\ (MN)}{cross-section\ Area\ (m^2)} \quad (1)$$

Hardness

This most important of mechanical properties, so it considers as the resistance of indentation, and it impossible to consider as the abration or attrition, wear, indentation, penetration, and workability from an applied force of sharp point and as an indication of surface durability. as calculated in Equation (2) : (Stencel *et al.*, 2018; Soares *et al.*, 2015)

$$HV = 1.854\frac{F}{d^2} \quad (2)$$

Thermal conductivity

These properties consider as the most important properties of polymer Nanocomposite, so the aim of this test for denture base and effect of thermal conductivity for all samples using Lee′s Disk, which Collated through British Griffin and Georges factory, To know the types of materials and temperatures suitable for them. The thermal conductivity calculated using Equations (3) and (4), (Dagdiya *et al.*, 2019).

$$K = \left[\frac{T_{a-A}}{d_s}\right] = e\left[T_A + \frac{2}{r}(d_A + \frac{1}{4}d_s)T_A + \frac{1}{2r}d_sT_B\right] \quad (3)$$

$$H = IV = \pi r^2 e(T_A + T_B) + 2\pi re \left[d_AT_A + \frac{1}{2}d_s(T_A + T_B) + d_BT_B + d_cT_c\right] \quad (4)$$

Where T_A , T_B, T_C Temperature of disk A,B,C

d_A, d_B, $d_{C\ Thickness}$ of disk

H: Thermal energy for time

e: The amount of lost heat in one second for the cube centimeter

r: radius of disk

d_s: thickness of samples

MATERIALS AND METHODS

Used MnCl2 for preferred Nano manganese through using UV-irradiation methods, then using casting methods for prepared polymer Nanocomposite, so mixing Nano [MN O] through ultra-sonication. For getting homogeneous dispersion of the Nanoparticles were treated with alcoholic medium (ethanol) in addition that better dispersion of the nanoparticles in PMMA/PV) polymers with different concentration

(*20%PVA /80%PMMA, 30%PVA/70%PMMA ad 40%PVA/60% PMMA).*

The treated particles are then added to the pure resin and solicited for 2 hours at room temperature Mechanical Tests and Thermal conductivity which tested after it designed with dimensions and shapes samples which demonstrated in Figure 1.

RESULTS AND DISCUSSION

The preparation of nine samples of the denture base and the measurement of both compression and hardness were completed for all samples. Results were included in Table 1.

Through the results in Table 1 and Figure 2, the results proved that the addition of Nanomaterials by the addition to the difference in the proportion of (PMMA / PVA).

It leads to different compressive strength and hardness values when the Nanomateriall concentration increases to 0.1 Mn Nanoparticles. Conversely, their values began to decrease at concentration 0.2 as a result of the increased aggregation of Nano -material molecules, which leads to a decrease in the values of mechanical and thermal properties PVA The concentration decreases PMMA

From results in Figure 3 and Table 2 reached to the thermal conductivity is an important property for the denture base materials; several additives were added to resin denture base to improve this property.

Thermal conductivity mean values of Nanocomposite are higher than the control group (insignificant increase), this could be attributed to the overlapping of the randomly oriented fiber mixture in some areas within the resin specimen that form pathways and facilitate the transmission of heat, therefore, increase the thermal conductivity, another reason could be related to the presence of salinized fibers acting as thermal conductors as a result of cross-linking that allows heat transmission through atoms in covalent bonds (Deshmukh and Composto, 2007; Akhavan *et al.*, 2010).

Structural properties

X-Ray of Manganese Nanoparticle

The Nanoparticles prepared were characterized by X-ray diffract meter (XRD, as shown in Figure 4. The XRD patterns of the powdered samples were recorded by Rigaku X-ray diffract meter with a CuK radiation (l =1.5418 A^0) in a range of 2Θ.

Scan electron Microscopy (SEM)

The SEM micrographs of each percent of PMMA / PVA with different concentration of MN Nanoparticle, each polymer Nanocomposite are shown in Figure 5. A different surface morphology for all samples is observed. Particles are large and have a homogeneous dispersion of particle sizes. Spherical morphology but exhibited with a difference in size about 20 nm and 27-40 nm, respectively.

The biological properties

The effected of Streptococcus mutans bacteria, which studied on the polymer Nanocomposites PMMA / PVA –MN Nanoparticle results of bacterial effect showed in Table 3.

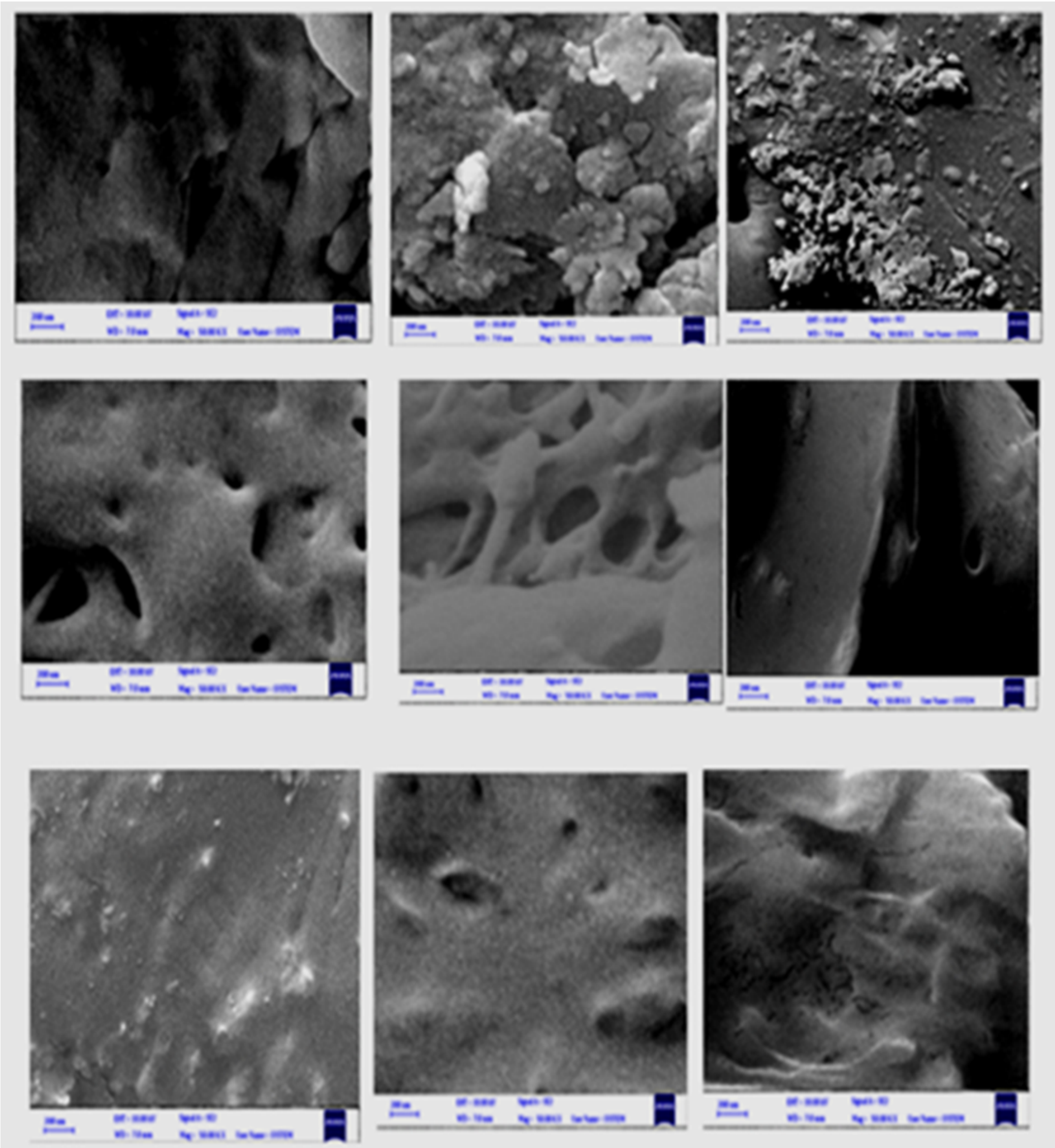

Figure 5: SEM Polymer Nanocomposites

Table 1: Results of the test of the Compressive strength and Hardness of all samples

Sample Concentration	Compressive Strength	Hardness (MPa)
20%PMMA/80%PVA (0%)Mn Nps.	34	7.4
30%PMMA/70%PVA (0%)Mn Nps.	38	9.1
40%PMMA/60%PVA (0%)Mn Nps.	43	11.8
20%PMMA/80%PVA (0.1%)Mn Nps.	65	16.01
30%PMMA/70%PVA (0.1%)Mn Nps.	87	19.6
40%PMMA/60%PVA (0.1%)Mn Nps.	105	28.5
20%PMMA/80%PVA (0.2%)Mn Nps.	23	6.5
30%PMMA/70%PVA (0.2%)Mn Nps.	31	5.4
40%PMMA/60%PVA (0.2%)Mn Nps.	36	7.1

Table 2: Results of the test of Average Thermal Conductivity of all samples

Sample Concentration	Average Thermal Conductivity K(w/m.k°)
20%PMMA/80%PVA (0%)Mn Nps.	0.0034
30%PMMA/70%PVA (0%)Mn Nps.	0.0039
40%PMMA/60%PVA (0%)Mn Nps.	0.0041
20%PMMA/80%PVA (0.1%)Mn Nps.	0.0052
30%PMMA/70%PVA (0.1%)Mn Nps.	0.0055
40%PMMA/60%PVA (0.1%)Mn Nps.	0.0060
20%PMMA/80%PVA (0.2%)Mn Nps.	0.0012
30%PMMA/70%PVA (0.2%)Mn Nps.	0.0020
40%PMMA/60%PVA (0.2%)Mn Nps.	0.0027

Table 3: Results of the biological effect

Sample Concentration	Inhabitation zones (mm)
20%PMMA/80%PVA (0%)Mn Nps.	2 .5
30%PMMA/70%PVA (0%)Mn Nps.	3
40%PMMA/60%PVA (0%)Mn Nps.	3.2
20%PMMA/80%PVA (0.1%)Mn Nps.	5
30%PMMA/70%PVA (0.1%)Mn Nps.	5.8
40%PMMA/60%PVA (0.1%)Mn Nps.	6.5
20%PMMA/80%PVA (0.2%)Mn Nps.	7.5
30%PMMA/70%PVA (0.2%)Mn Nps.	11
40%PMMA/60%PVA (0.2%)Mn Nps.	13

CONCLUSIONS

Tests of hardness and compression of dental bases manufactured from polymer Nano composites - The samples were found to increase the hardness, and compression value as the manganese Nanoparticles increased from (0 -0.1)%, and then the values began to decrease as a result of the aggregation of the particles at concentration (0.2)% until we get the highest value of hardness. Spherical only.

Microstructure and X-ray diffraction tests - We were able to determine through the structure of the minutes of the rules of the teeth, and first, determine the shape of the minutes and secondly the proportion of spherical minutes and irregular minutes for each sample and thirdly the size of the ball minutes, and we found that it ranges between (20-40) nm for all samples

Whenever the concentration of Nano - Mn increased in the PMMA/ PVA polymer leads to increase the zone inhibition.

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