Preparation and (TiO2- ZnO) Polyethylene for Food Preservation

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Abstract. The polymer nanocomposite was prepared using low-density polyethylene and each of (titanium oxide and zinc oxide) nanoparticles by casting method. The nanoparticles were synthesized via the UV-irradiation method. Structural properties of TiO2 and ZnO nanoparticles studied by x-ray diffractions so the grain size of nanoparticles ranged between (10-12) nm. Mechanical properties of the nanocomposites improve as the ratio of nanoparticles in polymer increased, compared to pure LDPE. Given that studies show that using this 2.5 Gy of gamma Rayes irradiated of nanocomposites improved that fantastic for use as food packaging. Besides, the polymer nanocomposites proved that antimicrobial properties against the E. coli, since it releases the nanoparticle's cations.

Keywords: Antimicrobial packaging, Polyethylene, TiO2 nanoparticles, ZnO nanoparticles, Mechanical properties.

1. Introduction
Titanium dioxide (TiO2) and zinc oxide (ZnO) nanoparticles are ideal semiconductor materials. That has many attractive features for instance its inexpensive materials, the stability of chemical characteristics, simplicity of preparation, environmentally friendly, in addition, that used in many applications in light-emitting diodes, transparent conductors, UV-shielding, pharmaceutical applications, and as antimicrobial applications, etc[1-3]. Polymer nanocomposites well are defined as the multi-material phases, one of this material with the nanoscale at any form, nanoparticles, nanotubes or nanorods structures[4,5]. Ignumently nanocomposites through using Low-density polyethylene (LDPE) doped with nanoparticles. It has many properties, including the potential barrier, anti-microbial materials in addition to mechanical properties, so Prioritizes to use in the production of special packages for preserving food[6,7].
(TiO2 - ZnO) / LDPE nanocomposites as uniquely antimicrobial agents and discriminate chemical and physical barrier properties can protect foods more efficiently[8-13]. Further, radurization technique Consider as the importance to reduce spoilage losses and improve Enhance food and health quality, as they contribute Protraction one-shelf life for aliments.
2. Experimental:
Titanium dioxide (TiO$_2$) and ZnO nanoparticles were prepared via the UV-irradiation method in use all of the titanium nitrite Ti(NO$_3$)$_4$, and (ZnNO$_3$)$_2$ dissolved in deionized water. It slowly under stirring into a round bottom flask putting in an ice bath about 25 minutes. Afterward, the prepared polymer nanocomposites by thawed polyethylene (LDPE) with 0.5 concentrations and mixing with 0.1% TiO$_2$ and (0.1, 0.2, 0.3)% of ZnO then mixing it well for a homogenous solution then casting the solutions in Petri dishes.

3. Results and Discussions:
Structural Properties: that examined through X-ray diffraction as shown in figure (1): TiO$_2$ X-ray in the 20 range of 10-70°. The diffraction peaks corresponding to the (1 0 1), (0 0 4), (2 0 0), (1 0 5), (2 1 1), and (2 0 4) crystal planes while X-ray of ZnO structural properties have (100) and (002) planes as illustrated in figure (1)[1,14].

3.1 Bacterial effect
For studied the bacterial effects for (TiO$_2$–ZnO) polyethylene (LDPE) nanocomposites against Escherichia coli bacteria that found in the environment, foods, and intestines of people and animals which are frequently occurring foodborne pathogenic microorganisms [8,12]. This effect illustrated in table (1).

Table 1. Statistical analytical results of E. coli counts/mL in examined.

| Polymer nanocomposite | Examining samples | Total No. of samples | Positive samples | Mean ± S.E.M. |
|-----------------------|-------------------|----------------------|------------------|--------------|
|                       | Chicken           | 12                   | 4                | 30.0         |
| 0.1(TiO$_2$/ZnO) -   |                   |                      |                  | 1.9 x 10$^4$ |
| LDPE                  |                   |                      |                  | 0.24 x 10$^4$|
| 0.1TiO$_2$/0.2ZnO) - |                   |                      |                  | 2.09 x 10$^4$|
| LDPE                  |                   |                      |                  | 0.29 x 10$^4$|
| (0.1TiO$_2$/0.3ZnO) -|                   |                      |                  | 2.89 x 10$^4$|
| LDPE                  |                   |                      |                  | 0.34 x 10$^4$|
| 0.1(TiO$_2$/ZnO) -   | Mutton            | 12                   | 9                | 61.0         |
| LDPE                  |                   |                      |                  | 4.8 x 10$^4$ |
| 0.1TiO$_2$/0.2ZnO) - |                   |                      |                  | 0.9 x 10$^4$ |
| LDPE                  |                   |                      |                  | 4.99 x 10$^4$|
| (0.1TiO$_2$/0.3ZnO) -|                   |                      |                  | 1.9 x 10$^4$ |
| LDPE                  |                   |                      |                  | 5.08 x 10$^4$|

Figure 1. X-ray of TiO$_2$ and ZnO nanoparticles.
Fecal pollution, caused by E. Coli has contributed to the food-borne epidemic disease and a beneficial or detrimental role have been assigned to foods Enterococci can survive heat processing and spoil the products and cause food infection.[15,16].

3.2 Gamma Effects on Polymer Nanocomposite

The food package that illustrated in table (2) demonstrated that the E. Lower percentage of E was mentioned in isolated coli stains. Coli in any form of meat used in testing.

| Irradiation level (Mrad) | Storge time (day) | 6 C percentage spoiled in Chicken | 20C percentage spoiled in Chicken | 6C percentage spoiled in Mutton | 20C percentage spoiled in Mutton |
|-------------------------|-------------------|----------------------------------|----------------------------------|-------------------------------|----------------------------------|
| 5                       | 19                | 35                               | 18                               | 20                            | 90                               |
| 10                      | 19                | 100                              | 20                               | 90                            | 0                               |
| 1                       | 15                | 0                                | 0                                | 0                             | 0                               |
| 20                      | 0                 | 0                                | 0                                | 0                             | 0                               |
| 1.5                     | 15                | 0                                | 0                                | 0                             | 0                               |
| 2                       | 12                | 12                               | 1                                | 9                             | 3                               |
| 20                      | 12                | 19                               | 20                               | 18                            | 18                               |
| 2.5                     | 38                | 54                               | 30                               | 24                            | 30                               |
|                         |                   |                                  |                                  |                               | 22                               |

From table (2) results illustrated that in normal refrigeration temperatures (6 C). Fresh carcasses were found to be organoleptically acceptable for periods as long as 5 to 9 days At this time, the bacterial load had, in general, increased by 4 logs above the initial number figure (2). Irradiation at both (2 and 2.5) Gy Mrad resulted in an immediate reduction in bacterial numbers. Upon storage, the surviving organisms multiplied, the rate being faster on 2 Mrad- than on 2.5 Mrad-irradiated of Chicken and Mutton .results are similar to [17,18].

Figure 2. Gamma irradiation affects the on-shelf life of chicken and mutton.
3.3 Mechanical properties of food package

Table 3. Illustrated effects of addition nanoparticles ratio on hardness and impact factors

| Polymer Nanocomposite          | Impact factor (KJ/M²) | Hardness |
|-------------------------------|-----------------------|----------|
| LDPE                          | 50                    | 40.3     |
| 0.1(TiO₂/ZnO) - LDPE          | 85                    | 45       |
| 0.1TiO₂/0.2ZnO - LDPE         | 76                    | 59.7     |
| (0.1TiO₂/0.3ZnO) - LDPE       | 60                    | 76.6     |

Results from the above, obvious impact factor is increasing as their nanoparticles concentrations increase due to the stresses minutes on material consolidation. While hardness values decreased with an increase nanoparticle ratio of polymer.

4. Conclusions

The mechanical and microbiological properties of thin films prepared from (TiO₂ and ZnO) nanoparticles a little mixing ratio with PLED polymer have been enhanced. In addition, the effect of Radurization on thin films increased the validity of the storage for each chicken and mutton.

5. References

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