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Characterization and Synthesis of Nanoparticle and its Application for Improving Post Harvest Shelf life of a Fruits

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Abstract:

Fruits are key components of a daily meal plan and are in high demand since they are an excellent source of vitamins, minerals, antioxidants, dietary fibre, and flavouring compounds for the majority of the world's population. We describe the MgO nanoparticle in the publication. Magnesium was used as a precursor in this study's sol-gel method to produce magnesium oxide (MgO) nanoparticles. In order to study the morphology of MgO nanoparticles, various methods were employed. X-ray Diffraction reveals the size and crystallinity of MgO nanoparticles (XRD). Fourier transform infrared spectroscopy was used to obtain the sample's infrared spectrum, which discloses the sample's composition and shows that it contains a range of functional groups (FT-IR). When wax is applied to the surface of fruits, MgO nanoparticles with the strongest anti-microbial characteristics inhibit pathogenic attack. The experiment demonstrates that adding paraffin wax to a suspension of citric acid and magnesium oxide nanoparticles and coating it on apples and guavas can extend their shelf lives. The self-life extends by 15 to 20 days compared to the 7 days of uncoated apple and guava fruits.

Keywords: Magnesium, Fruit, Nanoparticles

1. INTRODUCTION:

Fruits are key components of a daily meal plan and are in high demand since they are an excellent source of vitamins, minerals, antioxidants, dietary fibre, and flavouring compounds for the majority of the world's population. Therefore, it is crucial to keep the nutritional value of fruits (for instance, guavas and apples), yet significant changes take place in fruits between harvesting and consumption. There are variations in the production of carbon dioxide and the confluence of oxygen when apples and guavas are harvested. This stage sees an increase in the pace of gas transfer, the cessation of new cell creation, and the onset of metabolic loss. Fruits eventually reach maturity and senescence. Two factors, one internal (for example, cultivar specificity and growth condition) and the other external (for instance, atmospheric composition, such as oxygen, carbon dioxide, and ethylene), affect the quality of fruits (kluge at. al., 2002).

Currently, there are many options for preventing nutrition loss between the time of harvest and the time of consumption in order to prolong one's own life.

When citric acid, magnesium oxide nanoparticles, and paraffin wax are combined, a suspension is created that can be used to coat the surface of apples and guavas. To extend the shelf life, we therefore inhibit microbial growth during the storage stage in order to stop the physical and chemical reactions that occur in apple and guava fruits. and keep the apple fruits' nutritious makeup intact.

The study of materials with very small sizes (1–100 nm) and various crystal structures, such as spherical nanoparticles, flower-shaped particles, nanorods, nanoribbons, and nanoplatelets, is known as nanotechnology. When compared to micro-or nano-sized objects, its high surface-to-volume ratio produces unrivalled physical and chemical characteristics.

There is a lot of interest in the recently developed scientific field of the synthesis of metal nanoparticles with particular features. Because of their distinctive physical and chemical characteristics, such as increased damping property, mechanical stability, and high strength with good thermal conductivity, nanoparticles have garnered a lot of attention in recent years. Due to their applicability in the fields of optical electronics, sensing devices, and nano electronics, metal oxide nanomaterials with high surface area have garnered significant interest from scientists.

For the synthesis of these materials, a number of techniques have been proposed, including chemical vapour condensation, arc discharge, hydrogen plasma-metal reaction, and laser pyrolysis in the vapour phase, microemulsion, hydrothermal, sol-gel, sono chemical, and microbial processes in the liquid phase, and ball milling in the solid phase. Metal nanoparticles' characteristics are greatly influenced by the processes used in their manufacture. There are many different types of metal oxide, and they have a wide range of characteristics and potential uses.

All the composition techniques mentioned above, the sol gel process has many advantages. A single sol gel installation can produce materials at extremely high temperatures, synthesise almost any substance, co-synthesize two or more substances, precisely monitor the microstructure of the end products, and quickly control their physical, mechanical, and chemical properties. It has been noted in numerous academic publications that MgO nanoparticles perform better than bulk MgO. Magnesium is essential for good health, and MgO nanoparticles are well-suited for use with human cells. MgO has just been listed by the FDA (Food and Drug Administration, US A) as a safe material. The goal of this study was to create magnesium oxide with small dimensions, and the size of the particles was evaluated using XRD analysis at the highest peak and FTIR analysis at various peak locations.

After examining several production strategies for nanoparticles, Because of its affordability, simplicity of preparation, and viability, this approach has innovative qualities that are of great interest. Magnesium nitrate is used as a precursor, and H2O2 is reported in the synthesis of MgO nanoparticles using an improved sol-gel process (hydrogen peroxide). Magnesium has varied degrees of antibacterial activity against different types of bacteria. Due to their antibacterial properties, they have been employed in food packaging, wound healing, and surface coatings. However, gram positive and gram negative bacteria species have not yet been compared for these nanomaterials' anti-bacteria properties.

2. Material and Methods

2.1 Synthesis Of MgO Nanoparticles:

It took 15.7 g of magnesium nitrate and 500 ml of double-distilled water to create MgO nanoparticles using the sol-gel method. A continuous magnetic stirrer was used to ensure that the zinc nitrate entirely dissolved. Then, 800 ml of alcohol (ethanol) was gradually added while the mixture was continuously stirred. The solution was then heated to 45°C. Next, add 8 ml of H2O2 to the aforementioned solution drop by drop while stirring with a magnetic stirrer to create a clear solution. Remove the top layer and let the solution settle. Place the gel in centrifuge tubes, and spin them for five minutes at 8,000 rpm. Wash the sample with distilled water after discarding the supernatant liquid. 2-3 times, repeat the preceding step. The sample was annealed for 1 hour at 5000 C after being allowed to dry at 800 C until it was dry.

2.2 Antibacterial activity of MgO and ZnO NP suspension with citric-

Preparation of Coating-

One gramme of magnesium oxide nanoparticles and two grammes of citric acid were combined to create the coating in a bowl. Next, add 100 grammes of wax, and stir continuously for 10 minutes at room temperature. Citric acid and magnesium oxide nanoparticles were provided by the lab of the HD&FS BBAU, Lucknow, food science and technology department. Once the procedure was complete, the coated filmogenic selection was ready for use in the Apple.

1) control treatment
2) wax with citric acid
3) wax with citric acid and MgO NPs

In this experiment, 3 types of sample are selected and which are,

1) Control Apple sample
2) Apple coated with citric acid (2%) and wax
3) Apple coated with citric acid (2%) and (1%) magnesium oxide nanoparticle and wax

In all three condition the coating were applied on Apple as order to prevention of microorganism and the delay the maturation process.

Application of edible coating and storage-

Proper cleaning of Apple before coating and sanitized with sodium hypochloride solution about 10 to 15 minutes. The proper drying of Apple with tissue paper then apple dipped in the solution of wax for 2 minutes then removed from solution and place on a plate at room temperature**.** Each sample stored at room temperature 27℃ for 15 days for microbial detection in each sample.

3 RESULT AND DISCUSSION

3.1 X-Ray Diffraction Analysis:

A crystal structure and size of MgO and ZnO nanoparticles was analysed by XRD. X-Ray Diffraction Analysis or X-Ray Crystallography was used to identify the atomic or molecular structure of particles in which the crystalline atoms cause a beam of incident X-rays to diffract in to many specific directions.

$$D = K\lambda / \beta\cos\theta$$

Where,

D is the crystallite size of the particles,

K is a shape factor (K=0.9 in this work),

λ is the wavelength of the incident1 X-ray (1.54056 A, CuKα),

θ is the diffraction angle and β is the full width half maximum.

The synthesised MgO nanoparticles showed a single phase with clear diffraction peaks according to the information provided by reported data (JCPDS card no 36-1451 Average particle size of the MgO nanoparticles was determined as 21.82 nm at highest peak (36.2476^0) according to the Debye – Scherrer’s equation.

Table 1: Calculated Diffraction angle at highest peak and crystallite size of MgO and ZnO

Sample	Diffraction angle at highest peak	Average size
MgO	32.4014^0	55.25nm

3.2 Fourier Transform Infrared Spectroscopy (FT-IR):

FT-IR spectroscopy analysis has been done to observe the chemical and structural nature of the particles. The Infrared absorption band identifies the various functional group of the molecule. Synthesized nanoparticles Mg have been scanned from 4000 cm^{-1} to $400cm^{-1}$. The region from 4000 to $1500cm^{-1}$ is functional group region and region from 1500 to $667cm^{-1}$ is fingerprint region.

The analysis of FTIR spectrum of MgO shows peaks at 602.09, 678.39, and $730.19cm^{-1}$ which refer to the formation of MgO as shown. A broad absorption peak noticed at 3308.2 cm^{-1} attributed to O–H stretching of the moisture content. FTIR measurement of MgO nanoparticles shows different peaks at different levels which corresponds to particular functional group and stretch present in it.

Antibacterial activity of citric acid

Antibacterial properties of.5, 1, 1.5 and 2% citric acid were measured in line with the inhibition region method against E. Coli, salmonella and staphylococcus. In table 1, different concentrations of citric acid shows different inhibition region. According to result when increase the concentration of citric acid increase the inhibition region. Inhibition region diameter of citric acid

Table 1: Detection and antibacterial activity of MgO nanoparticles suspension containing citric acid

Concentration of acetic acid.	Staphylococcus.	E coli
.5% citric acid	8.0±0	6.0±0.5
1% citric acid.	17.0±5	10.0±.5
1.5 citric acid.	16.5±0	18.0±.5
2% citric acid.	19.5±.5	18.5±.5

MgO NP suspension with citric acid reduce the microbial growth rate when increasing the concentration of MgO NPs then decreased the growth rate of staphylococcus, salmonella and E.coli as compared to control in guava and Apple simultaneously. In this study there is no growth of staphylococcus, salmonella and E.coli in the sample of guava and Apple juice which are treated with MgO suspension with citric acid with in 24hr. at 30℃.

In fig.1, cell counts of staphylococcus, salmonella and E.coli in guava and apple which are treated MgO nanoparticles suspension with citric acid (.5%), shown no microbial growth rate within 24h. But in Control sample of guava and apple juice having very dense colony of E.coli and staphylococcus will appears In fig.2

In this study when MgO was combined with.5% concentration of citric acid then this suspension perform synergistic effects, shown strong antibacterial activities against food born pathogens staphylococcus, salmonella and E.coli. because MgO and citric acid both have antibacterial properties against pathogens.

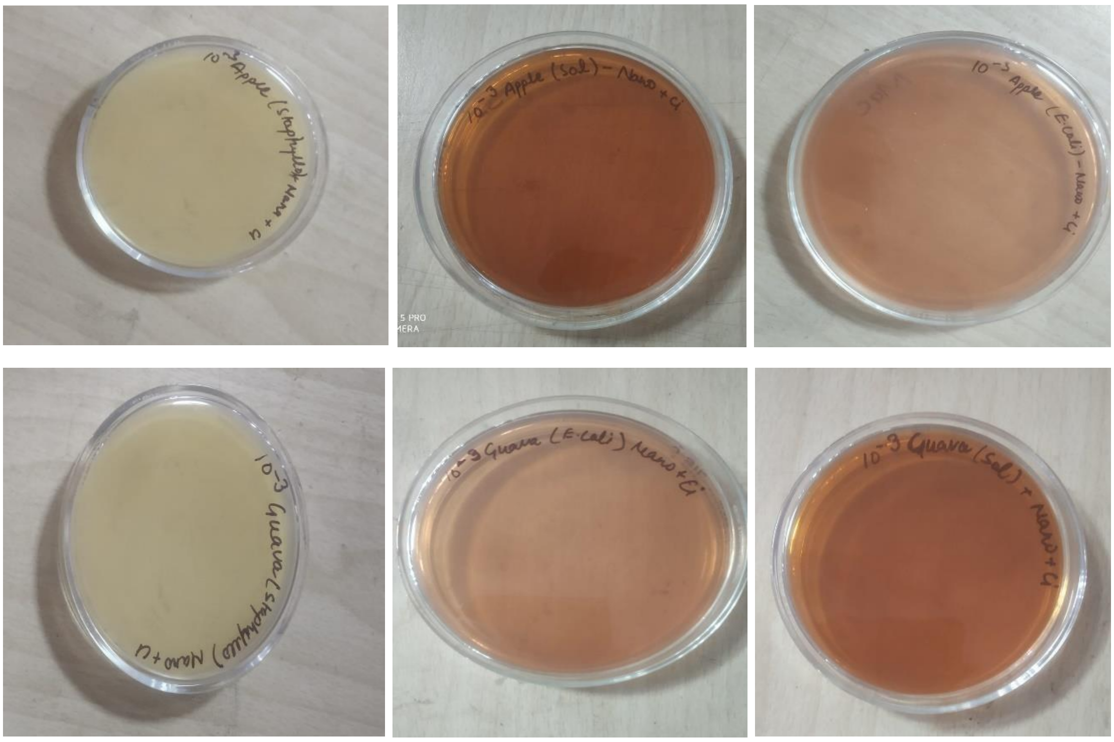

Figure 1: There is no growth of staphylococcus, salmonella and E.coli after the mixing of MgO NPs and citric acid in the guava and apple juices.

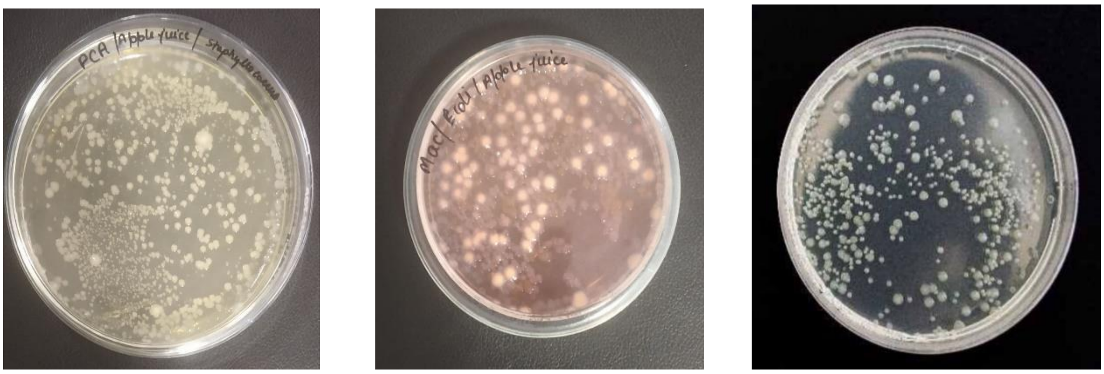

Figure 2: Growth of Staphylococcus and E. Coli before adding the MgO NPs and citric acid in Apple and guava juices.

CONCLUSION:

MgO oxide can be synthesized by using sol-gel methods that were very efficient in producing small sized nanostructures (less than100nm). MgO nanoparticles have been successfully synthesized by simple Sol-Gel method. The prepared MgO nanoparticles were characterized using XRD and FT-IR techniques. In this research, MgO NP suspension containing with citric acid has shown strong antibacterial activity against staphylococcus, salmonella and E. Coli. MgO synergistically enhance the antibacterial effect when they combine with citric acid. It is non-toxic material and there is no harmful effects against human. This study shows that the MgO nanoparticles combines with citric acid then they are more effective against food borne pathogens and increase the shelf life of apple and guava juices

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