RESEARCH ARTICLE

Synthesis, Characterization of Poly (chitosan nano-particles-co-pyruvic acid) and Substitution with Different Amino Acids

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ABSTRACT

Carriers of bio-degradable nano-particulate are of significant potential applications for nano-particles (NPs) therapeutic range size molecules administration from about 1 to 1000; NPs can be prepared from materials diversity including polysaccharides, metals, and proteins. NPs are beneficial in biodegradability, bioavailability, purity, and relatively small cost. The current study aim was to describe novel bio-degradable NPs characterization and synthesis according to chitosan in this research preparation of chitosan (NP)-co-pyruvic acid) and substitution with different amino acid. These derivatives were characterized by Fourier-transform infrared spectroscopy (FTIR), Scanning electron microscope (SEM), Sodium triphosphate (STPP), thermal stability, and biological activity was studied.

Keywords: Chitosan (NP), Fourier-transform infrared spectroscopy (FTIR), Scanning electron microscope (SEM), Sodium triphosphate, Thermal stability.

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INTRODUCTION

Natural products are vital bio-polymer materials sources such as polyphenols, polysaccharides, polyamides, polyesters, and proteins. They collectively have a vital role in biomedicine and its applications in medicine, such as regenerative engineering of tissues, drug-delivery systems, and biosensors.[1] Chitosan is considered as a polysaccharide being bio-compatible, bio-degradable, and bio-adhesive. Chitosan is of no toxicity and soft tissue compatible in a toxicity tests range.[3] It has widely been utilized in pharmaceutical research and the industry as a carrier for drug delivery and as materials as biomedical.[4] Chitosan (NPs) is gained via the inotropic gelation process according to the relations among the negative groups of (TPP) and the +ve charged chitosan amino groups. A chitosan vital application is the drug delivery systems development along with a regulated release rate of drug and a reduced drug administration frequency[4] because of its gel-forming capability in low pH range.[5] The interactions as ionic and H bonding are responsible for the adhesive of diverse substrates and chitosan characteristics.[6] Gelatin is a biomaterial with the fore-mentioned crucial characteristics. In general, gelatin cross-linking is utilized in several devotions i.e., swelling of gelatin, and gelatin hydrogels as biodegradable implants for delivering drugs as macromolecular and small. Graft co-polymerization is one of many routes to offer synthetic and natural polymers new and combinatorial characteristics.[1-5] The guest monomer, in graft co-polymerization, profits the host polymer of few desired and novel characteristics where the resultant copolymer has characteristic applications and characteristics. The natural polymers modification i.e., cellulose,[2,7] starch[1,4,6] and chitosan[3,8,9] have been finding great attention in the industry and literature because of combinatorial characteristics of both synthetic and natural polymers. Carriers of bio-degradable nano-particulate are of vital potential applications for therapeutic molecules administration. Chitosan-based NP has attracted a high concern regarding their biological characteristics, i.e., biocompatibility, biodegradability, and bio-adhesivity. NPs have vast open advantages in systems of drug delivery improvement that growing efficacy and drugs potency.[1,2] In bio-logical sciences, NPs are particles being submicron. This size as small makes NPs as exclusive promising characteristics in systems of drug delivery terms.[3] Subsequently, from view of drug delivery, NPs are regarded as greater compared to micro-particles.

MATERIALS AND METHODOLOGY

Materials

Chitosan of 200 KD MW and (STPP) were obtained from Aldrich, Canada.

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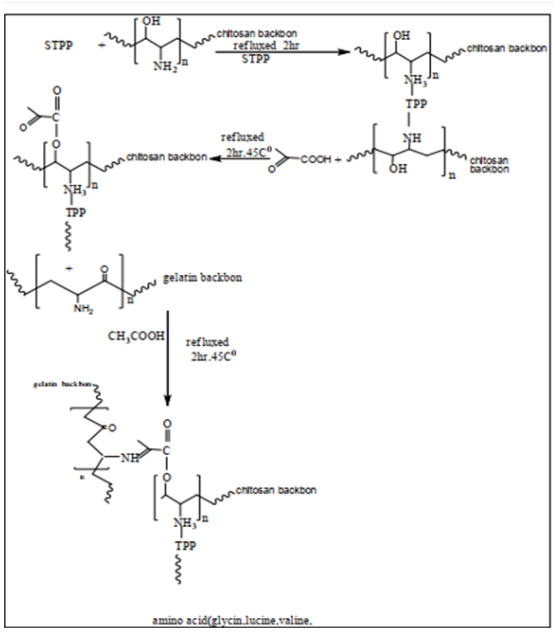
NP preparation

CS-TPP (NP) was done based on the previous procedure where chitosan in 1% (w/v) CH_3COOH was dissolved and sonicated before the solution's transparency. One mL of NaOH was added to the STPP solution of (pH=5) and stirred for 2 hours at room temperature. The above produces CS-TPP (NP) formation via mechanism as ionic gelation. For CS-TPP preparation (NPs) overloaded with pyruvic, ten% (w/v) was added to chitosan solution before sodium tripolyphosphate (STPP) solution addition. Around 2 g of gelatin was dissolved in ethanol (30 mL) added to the CS-STTP –co pyruvate. The mixture was refluxed for 2 hours at 45ºC. The products were washed with deionized water store at 25ºC. The same procedure was used to loaded (glycin, lucine, valine) to CS-STTP co pyruvate.

RESULT AND DISCUSSION

This study including preparation poly (chitosan (NP) –co-pyruvate) and then synthesis Schiff base by reaction of different essential chitosan amino acid ability to rapidly gel contacting STPP relies on the inter- and inter- molecular cross-linking formation among phosphate and amino groups. Activating OH groups and establishing chemical-physical electrostatic interfaces and ester bonds in the current work.[10-20] Chitosan–TPP (NP) are chiefly branded via an SEM. Spectroscopy as FT-IR was utilized to obtain the interactions among chitosan-STPP (NPs) samples from 4000–650 cm^{-1} at 1 cm^{-1} resolution (Schemes 1 to 3). In a splitted band of chitosan (3345 and 3290 cm^{-1}) could be noticed that it is flattened via the interaction of tripolyphosphate (3275 cm^{-1}), becoming weak (Schemes 4-12). The beak of FTIR was tabulated in Table 1.



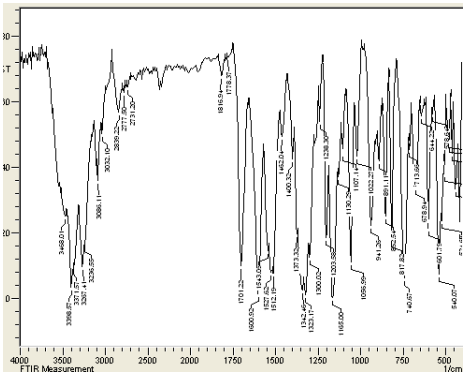
Scheme 1: Mechanism reaction

Table 1: FTIR Spectra of compound

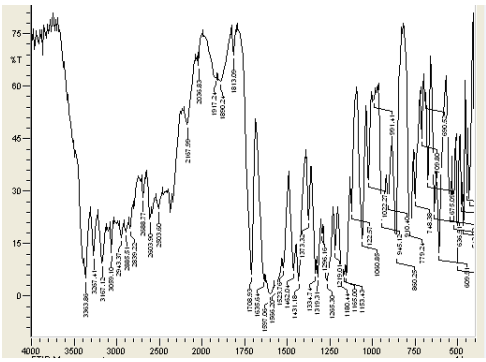
Compound No.	*υ (N-H) amine*	*υ(C=N)*	*υ(C-S)*	*υ(C=C)*
1	3414	1454	671	1616
2	3421	1462	709	1616
3	3448	1496	713	1631
4	3406	1400	605	1712
5	3479	1473	694	1608

Antibacterial Activity

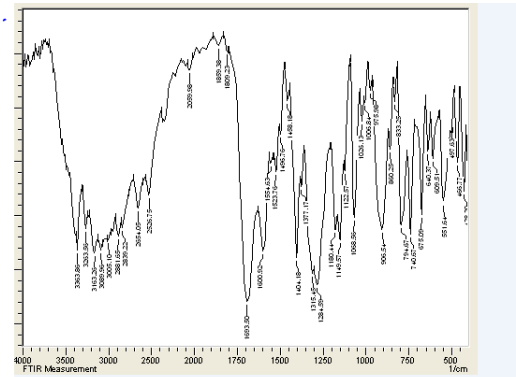
Few synthesized compounds antibacterial activity was assessed via agar diffusion method at 1-mg concentration, DMSO as control was served because of no visible change in bacterial growth, Cephalexin and Amoxicillin (AMX) were utilized as a standard drug where plates were incubated for 24 hours at 37ºC. The inhibition zone is measured in (mm).[21-23]



Scheme 2: FTIR of compound 6



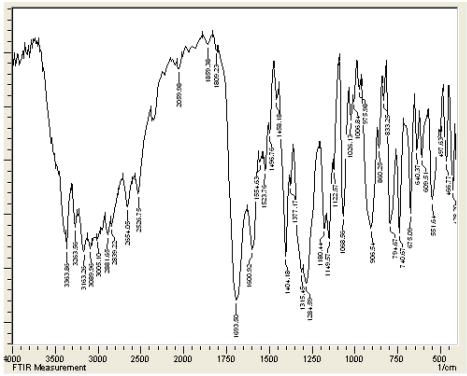
Scheme 3: FTIR of compound 5



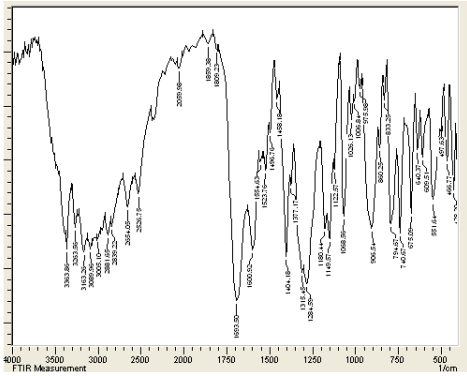
Scheme 4: FTIR of compound 4

Table 2: H-NMR spectra of compound

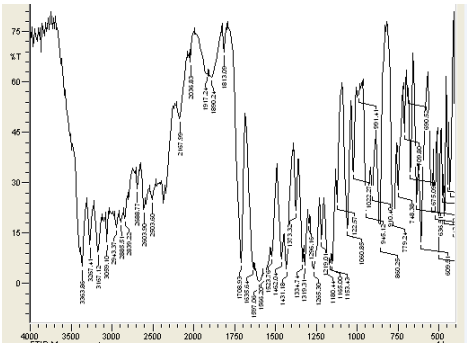
Compound No.	*^{1}H-NMR spectral data ($^\delta$ppm)*
C1	δ(1.7-1.8)(s,2H,CH_2-N), δ(3.3-3.4)(s,2H,CH_2-O), δ(6.9)(s,1H,NH), δ (7.6)(s,2H,CH_2C=O), δ(7.3-7.4)(s,3H,aromatic), δ(10.0-10.6)(s,1H,OH)
C3	δ(1.4-2.4)(s,2H,CH2-N), δ(3.0-3.3)(s,2H,CH2-O), δ(7.1)(s,1H,NH), δ(7.2)(s,2H,CH2C=O), δ(7.3) (s,3H,aromatic)
C4	δ(1.3)(s,2H,CH_2-N), δ(3.2-3.6)(s,2H,CH_2-O), δ(7.7-8.0)(s,1H,NH), δ(7.6) (s,2H,CH_2C=O), δ(7.7)(s,3H,aromatic), δ(12.19-13.53)(s,1H,OH)
C5	δ(2.9)(s,2H,CH2-N), δ(3.1)(s,2H,CH2-O), δ(8.0)(s,1H,NH), δ (3.5) (t,3H,CH3), δ(7.7) (s,3H,aromatic)
C2	δ(1.5),(s,1H,CH-N),δ(1.5-1.6)(t,2H,CH2-C=O), δ(7.1)(s,2H,aromatic), δ(8.1)(s,1H, NH), δ(8.1-8.8) (s,1H,NH)



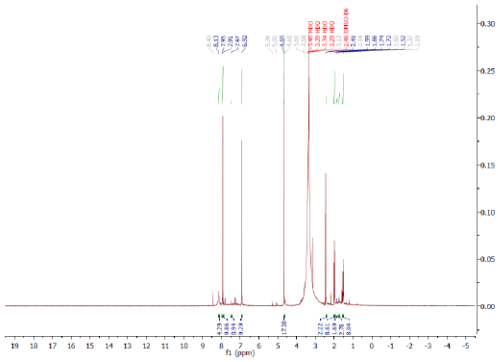
Scheme 5: FTIR of compound 3



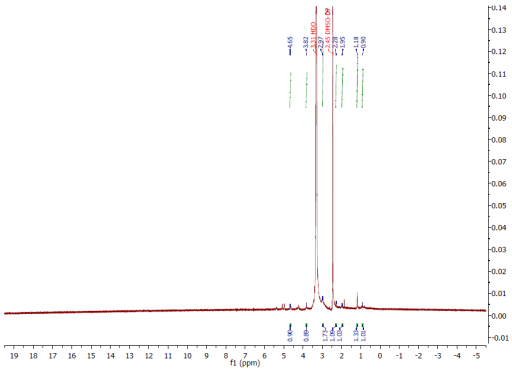
Scheme 6: FTIR of compound 2



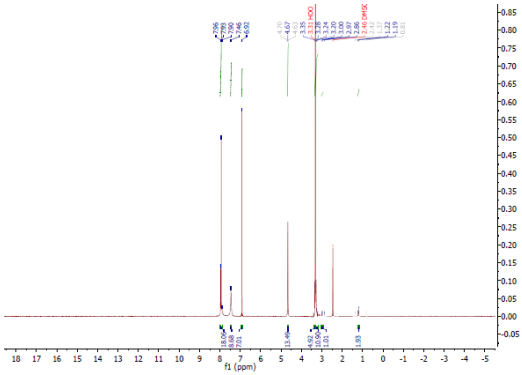
Scheme 7: FTIR of compound 1



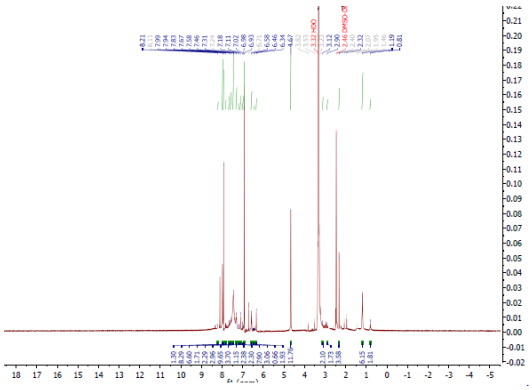
Scheme 8: HNMR of compound 1



Scheme 9: HNMR of compound 2

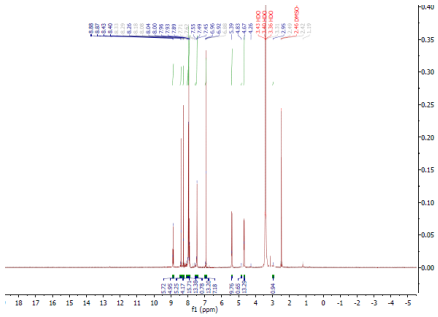


Scheme 10: HNMR of compound 3



Scheme 11: HNMR of compound 4

Figures 1 to 8 illustrate the effect of compounds selected on some bacterial isolate types.



Scheme 12: HNMR of compound 5

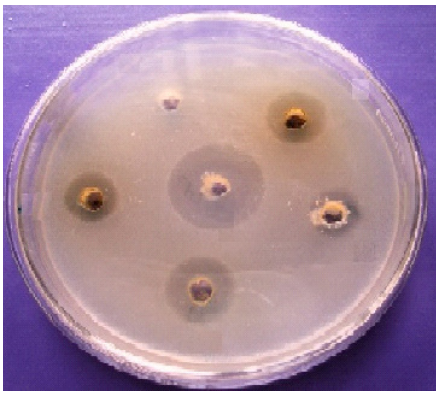


Figure 1: Compounds effect on *S. aureus*

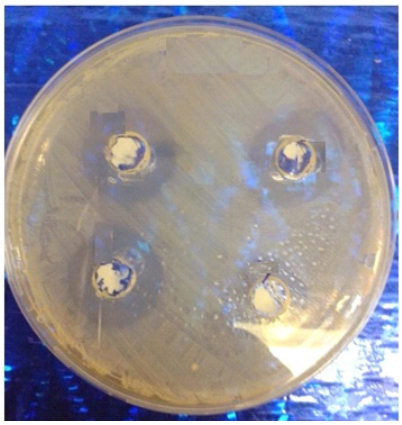


Figure 2: Compounds effect on *B. subtilis*

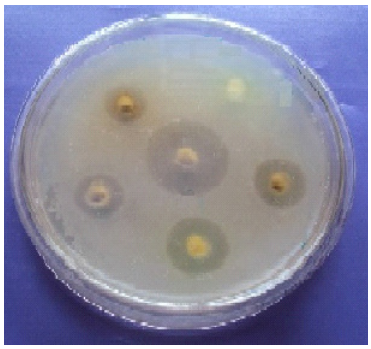


Figure 3: Compounds effect on *E. coli*

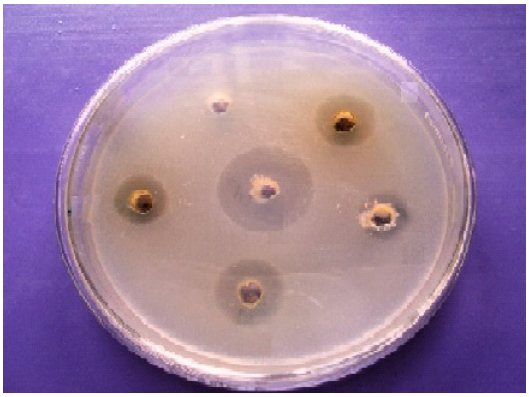


Figure 4: Compounds effect on *P. aeruginos*

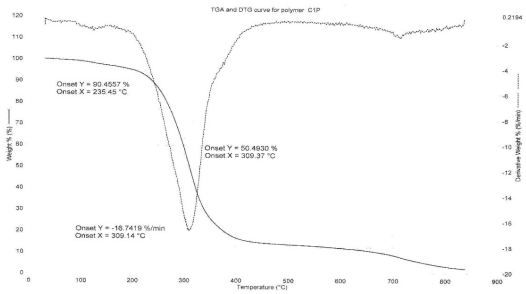


Figure 5: Thermal stability of Chitosan–TPP (NP)

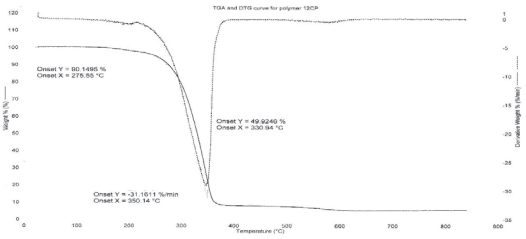


Figure 6: Thermal stability of Chitosan–TPP (NP)

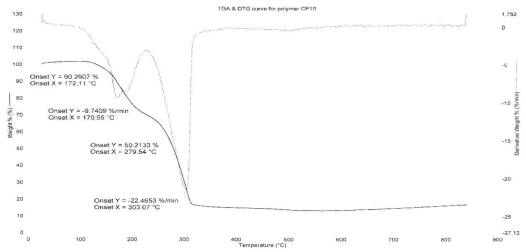


Figure 7: Thermal stability of Chitosan–TPP (NP)

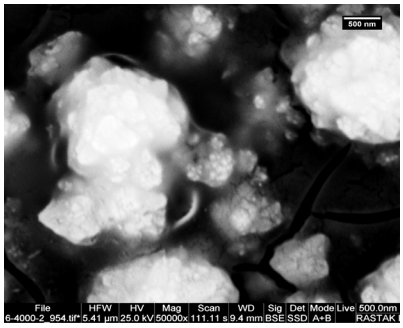


Figure 8: SEM of Chitosan–TPP (NP)

Table 3: Antibacterial of prepared compounds activity

	Zone diameter inhibition (mm)			
Comp. #	*Staphylococcus aureus*	*Bacillus subtiles'*	*Escherichia coli*	*Pseudomonas Aeruginosa*
1	15	11	9	5
2	14	12	8	-
3	15	11	9	4
4	14	12	8	-
Amoxicillin [A]	14	11	5	-
Cephalexin [C]	12	9	5	-
DMSO	-	-	-	-

Antibacterial Screening Compounds l.: Were assessed for antibacterial activity versus diverse strains of bacterial i.e., G^+ bacteria: *Staphylococcus aureus, Bacillus subtilis*, and G^- bacteria: *Escherichia coli*, *Pseudomonas aeruginosa* at 1-mg/mL concentration.

Zones of inhibition for these compounds are assessed and showed in Table 3.

CONCLUSION

The present study aims to achieving synthesis , Synthesis, Characterization of Poly (chitosan nano-particles-co-pyruvic acid) and Substitution with Different Amino Acids Some of the synthesized compounds gave acceptable FT-IR, 1H-NMR that matched data reported in the construct to references. The biological activity for synthesized polymers were estimated to recognize if these compounds will have medical application.

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