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Green Synthesis of Chitosan and Cinnamaldehyde Schiff Base and it's Diversified Biological Application

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Abstract:-Chitosan is a biopolymer extracted from the shell chitin of crustaceans with special characteristics such as biocompatibility, biodegradability, and antibacterial activity. Schiff bases are compounds that combine an imine or azomethine group with a carbon-nitrogen double bond to form an organic molecule. Cinnamaldehyde Schiff bases are commonly employed as flavouring ingredients and can kill bacteria, fungi, and viruses. Metal complexes of chitosan and Schiff bases are synthesised by reacting the biopolymer or Schiff base with the metal ion in an appropriate solvent. Metal complexes have different characteristics depending on the metal ion, the ligand, and the production technique.

Keywords:- Schiffbase,Chitosan,Cinnamaldehyde,Metal Complexes,Antioxidant,Antidiabetic,Antiglycation.

I. INTRODUCTION

A series of metabolic conditions known as diabetes mellitus are brought on by aberrant insulin secretion, action, or both.. It is marked by chronic hyperglycemia and metabolic abnormalities of carbohydrates, proteins, and lipids as a result of impaired insulin activity. Both microvascular and cardiovascular complications of diabetes are strong oxidative stress impact. The heart, small and big vessel endothelial cells, and other organs produce too much mitochondrial superoxide due to metabolic problems associated with diabetes and both. This increased production of superoxide activates five critical pathways in the pathogenesis of complications.

These pathways generate cytosolic reactive oxygen species (ROS), which inhibit angiogenesis, activate inflammatory pathways, and result in hyperglycemic memory. In type 2 diabetes, insulin resistance promotes the production of mitochondrial reactive oxygen species (ROS) from saturated lipids and the inactivation of anti-atherosclerosis enzymes. Overexpression of superoxide dismutase prevents the development of diabetic retinopathy, nephropathy, and cardiomyopathy in transgenic diabetic rodents.

Green chemistry involves technology and equipment. It helps chemists and chemical engineers make greener, more productive, and potentially profitable goods. Synthesis requires it. [1]

Schiff bases—imines—have the formula R3R2C=NR1 with an azomethine group (HC=N). Hugo Schiff named them condensed aldehydes or ketones in 1864.

Schiff first outlined how to synthesise Schiff bases by condensing primary amines with carbonyl compounds using azeotrope distillation and eliminating water.[2]

Heat, acid, or base form Schiff bases. Chemists use amine-aldehyde bases. Amino acid-based Schiff base synthesis. Aldehyde or ketone to Schiff base is reversible in acidic, basic, or neutral conditions.

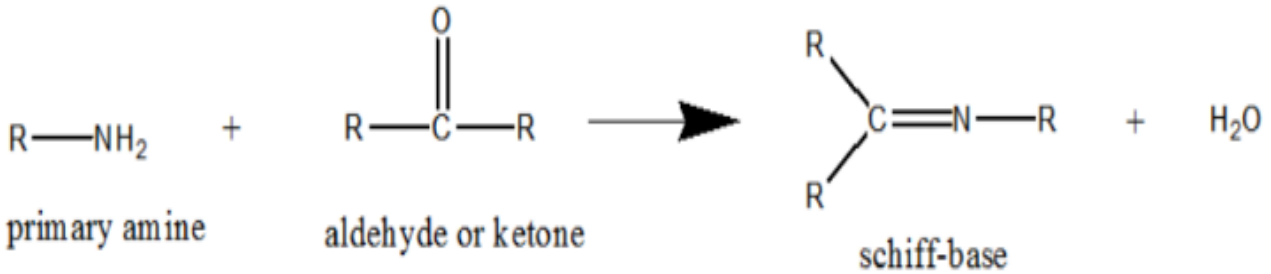

Fig1 Shows the Typical Procedure for Synthesizing a Schiff Base.

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Chitosan cross-links via amino and hydroxyl groups[3].Glucosamine-N-acetylglucosamine copolymers can be used to make chitin from crab shells[4]. Chitin follows cellulose as the most common natural polymer. Waste, food, medicine, and biotechnology use chitosan [5]. Biodegradable, biocompatible, and low-toxic, it is a promising medical substance. Chitosan is an excipient in traditional pharmaceuticals. Literature describes chitosan as an oral enhancer, mucoadhesive, and peptide and gene delivery medium. Chitosan reduces cholesterol and heals wounds. Chitosan, a new chemical, must be standardised for biomedical and pharmaceutical usage. Quality, purity, molecular weight, viscosity, and deacetylationcharacterise chitosan. Chitosan quality can vary with manufacture. Commercial chitosan varies in purity, molecular weight, and deacetylation. Deacetylation may impact chitosan performance in certain applications, according to several studies. Deacetylation distinguishes chitin from chitosan by identifying polysaccharide-free amino groups. Chitosan is 75%-deacetylated chitin [6]. Deacetylation removes acetyl groups from chitin, leaving chitosan with a full amino group (-NH2). Multiple techniques change deacetylation. Increasing temperature or sodium hydroxide solution concentration removes acetyl groups from chitin, creating chitosan molecules with unique characteristics and uses. Since purification and reaction conditions affect chitosan deacetylation, its degree must be determined before employing it in drug delivery systems.

Cinnamaldehyde: Lauraceae spice cinnamon is used worldwide. Cinnamaldehyde, cinnamic acid, and cinnamate are its main ingredients. Cinnamaldehyde ($C_6H_5CH=CHCHO$) is cinnamon's main ingredient. Due to its nontoxicity, fungicidal, and antibacterial qualities, cinnamonaldehyde has several uses[7]. Cinnamonaldehyde inhibits Gram-positive, Gram-negative, and fungal bacteria.

Many research have combined chitosan and cinnamaldehyde.

Traditional medicine and cooking employ cinnamon bark. 250 cinnamon varieties exist. Cinnamonaldehyde (C_9H_8O) has 132.16 g/mol. In excessive amounts, this yellow, oily fluid can irritate the skin. It's a popular root fungicide. It protects alloys against corrosive fluids. [8]

A study found significant cinnamaldehyde levels in Cinnamomumosophloeum.[9] Cinnamonaldehyde's alkene, benzene, and carbonyl groups block glucosidase. Assimilation destroys this molecule, causing harm. Freeze-drying chitosan nanoparticles preserve bioactive chemicals, enhance solubility, and transport them to the target site. Cinnamonaldehyde comprises 74% EE of chitosan nanoparticles. 23.9% of 100 ppm cinnamaldehyde-chitosan nanoparticles inhibited -glucosidase with an IC50 of 134,13. Thus, encapsulated cinnamaldehyde inhibits -glucosidase.

II. MATERIAL & METHODS

A. Cinnamonaldehyde is Extracted from Cinnamon Stalks Via Steam Distillation:

A 250mL three-necked distillation flask was stuffed with 25.5 grammes of freshly pulverised cinnamon sticks. 200mL of distilled water were provided. 100 millilitres of water were poured into a second funnel affixed to one neck. The containers were heated by heaters. The distillate was collected in 100mL-graded cylinders. A hazy distillate was produced by distillation. 100 mL of hazy distillate. The insoluble suspension of cinnamonaldehyde veils the distillate. Thus, cloudiness indicates the concentration of cinnamaldehyde in the distillate. The Erlenmeyer containers were filled with 100mL of distillate. The distillation vessel contains 100 mL of water in order to collect excess distillate.The concentration of cinnamonaldehyde was low in the subsequent distillation volume. Following the mixing and funnelling of the distillates came the steps of mixing and directing. Then, oil extraction occurred.

- *Extracting Oil.*

The Erlenmeyer flask was cleansed with 60mL DCM prior to being placed in the separatory funnel. After vigorous shaking and applying a funnel lid, the layers separated. Due to its high specific gravity, DCM sank in the separator's receptacle. Emptying out a flask. The extraction process proceeded in the subsequent phase. Multiple times. Each phase required 60mL of DCM. After the third stage, the upper aqueous layer contained little cinnamaldehyde. Add cinnamon oil and sodium chloride next.

B. Tests for Cinnamonaldehyde Confirmation

- *Tollen's Test.*

Atedly Using the Tollen’s method, cinnamonaldehyde was extracted. The aldehydes in the Tollen’s reagent initiate two significant chemical reactions. Aldehyde is converted to carboxylic acid by Tollens' reagent.Transforms reagent ions into silver metal. Typically, test containers are clean. On the test tube, silver ions reduced to metallic silver form a silver mirror. The "Silver Mirror test" is actually the Tollens test, which leaves a silver metallic residue on the test tube.[10]

- *Schiff's Test:*

Schiff's reagent is used to quantify aldehydes. Fuchsin hydrochloride is used to designate solutions containing sulphurdioxide.Sulphur dioxide degrades dye. Schiff's Reagent reacts with aldehydes to restore the crimson-purple hue of the dye.

C. Chitosan-Cinnamaldehyde Schiff Base Preparation

Chitosan (1g) that had previously been refined was diluted in 50 ml of 5% acetic acid and agitated for 6 hours at room temperature. The resulting viscous solution was then stirred, 10 ml of ethanol containing a specific amount of cinnamaldehyde was added, and the mixture was then filtered through cheesecloth to eliminate any remaining undissolved particles.At 50°C, this mixture was swirled for 6 hours. The development of a dark yellow gel is a sign that the chitosan Schiff base has formed. A sodium hydroxide solution

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solution in excess of 5% was added to the end result. To remove unreacted cinnamaldehyde, the precipitate was filtered and repewashed with distilled water and ethanol. The finished product was then filtered and dried in a hoover oven at 60°C overnight.[11]

D. Metal Complex Formation using a Schiff Base: [12]

Copper sulphate, zinc acetate, ferrous chloride, and magnesium sulphate were among the different metal complexes from the chitosan-cinnamaldehyde Schiff base (CH-CI SB) that they marged in 2:1 of ligand: metal complex.

➢ *CH-CI SB+CUSo4 metal complex preparation:*

Chitosan-Cinnamaldehyde0.6g Schiff Base was agitated in 300ml acetic acid for one hour. 10ml of ethanol dissolved 0.159g of Cuso4 after an hour of stirring. The solutions are blended after 1.5 hours. Ethanol filtered. Dried green. Made CH-CI+Cu.

➢ *CH-CI SB+ zinc acetate metal complex preparation:*

Chitosan: Cinnamaldehyde 0.6g Schiff Base was agitated in 300ml acetic acid for one hour. After swirling for an hour, 10ml ethanol dissolved 0.183g zinc acetate. The solutions are blended after 1.5 hours. Ethanol filtered. Golden dry. CH-CI SB+Zncomplex.

➢ *CH-CI SB+ Fecl2 metal complex:*

Cinnamaldehyde-chitosan.0.6g Schiff Base was agitated in 300ml acetic acid for one hour. 50ml ethanol dissolved 0.126g ferrous chloride fecl2 after an hour of stirring. The solutions are blended after 1.5 hours. Ethanol filtered. Brown-red solid. CH-CI SB+Fecomplex.

➢ *CH-CI SB+Mgso4 metal complex:*

0.6g chitosan-cinnamaldehyde. For one hour, 300ml acetic acid agitated Schiff Base. 10ml ethanol dissolved 0.120g copper Mgso4 after one hour of stirring. The solutions are blended after 1.5 hours. Ethanol filtered. Golden dry. CH-CI SB+Mgcomplex.

E. Characterization Techniques Schiff Base

➢ *Characterization by TLC*

Commercially available silica plate was used as stationary phase, while E.A: Hexane in the ratio of 7:3 was used as mobile phase. Plate was developed by charring of carbon using strong acid.

➢ *Characterization by UV-Visible Analysis*

The synthesized chitosan-cinnamldehyde with the use of a UV-Visible spectrophotometer, complexes are examined. The molar extinction coefficients are computed using the acquired spectral values. The values can be used to foresee transitions.

➢ *Identification by FT-IR Analysis*

FT-IR analysis is used to identify the synthesised chitosan-cinnamaldehyde complexes. IR spectroscopy involves the interaction of infrared radiation and substance, with absorption spectroscopy being the dominant technique. The IR spectrum is represented by a graph of infrared light absorbance (or transmittance) versus frequency or wavelength. The names of the near-, mid-, and far-infrared sections reflect their relationship to the visible spectrum. Wave numbers correspond to micrometres (previously referred to as "micron"), symbol m, which are used to measure wavelength.

F. Biological Applications.

➢ *Antioxidant assay:*

- *DPPH Radical Scavenging Activity.*

Research on Antioxidants scavenging test for DPPH method was used to measure the ability to scavenge the stable free radical, DPPH, as a decrease in absorbance at 517 nm .2,2-Diphenyl-1-picryl hydrazyl (DPPH) reagents in methanol at 90.25 mM in a dark environment.An equivalent volume of ethanolic Rhizome of Cyperusrotundus L (250-1500 g) was added and made up to 1.0 mL with a methanolic DPPH solution (90.25 mM). The control received an equal addition of methanol. The absorbance was measured at 517 nm in a Systronics UV-visible Spectrophotometer after 20 minutes. An industry standard for comparison was ascorbic acid.The following equation was used to determine the percentage (%) by which DPPH inhibited free radicals.

$$\text{Scavenging\%} = \frac{\text{Abs of control - Abs of test}}{\text{Abs of control}} \times 100$$

- *Nitric Oxide Scavenging Activity.*

Griess reagent detected nitric oxide radical scavenging. 500 l of the standard (Vit.C 1 mg/ml) and 50, 100, 150, 200, and 250 l of pure C-PC (2.295 mg/ml, Purity 1.41) were diluted in test tubes with distilled water to 1.5 ml. All tubes received 1.5 ml of 10 mM sodium nitroprusside and were incubated at 25°C for 150 minutes. After 1.5 ml of incubation, each fresh tube received 1.5 ml of Griess reagent (1% Sulphanilamide, 2% Orthophosphoric acid, 0.1% NEDD). OD was 545 nm. A decrease in vitamin C absorption indicated number scavenging action. The % scavenging activity was calculated using this formula in triplicate trials.

$$\text{Scavenging\%} = \frac{\text{Abs of control - Abs of test}}{\text{Abs of control}} \times 100$$

➢ *Antiglycation:*

- *Glycation of Bovine Albumin.*

Mixtures of 6 mg/ml BSA and either 0.5 M glucose or fructose in 0.05 M phosphorus, 0.1 M NaCI (pH 7.0) (PBS) were neutral by via 0.45 p membranes (Acrodisc, Gelman Sciences, Ann Arbour, MI) and incubated at 37 °C for 5-7 days (for fructose) or 15-21 days (for glucose). in a humid environment. Based on the idea that Amadori group fluorescence generation is faster during fructation than it is during glucation, a shorter incubation duration for fructose was selected. Thus further, if saturation levels of fluorescence had been reached after a lengthy first incubation, a potential generation of fluorophores in a later

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incubation without sugars, as was initially expected, would be hidden. The mixes were dialyzed six times at 4°C during a period of 5-7 days following incubation. The PBS used for the dialysis was a tenfold volume excess. This last dialysis stage was proceeded by assays. [13]

- *Fructosamine Determination;*

Frutosamine has antiglycation properties. Fructosamine, an Amadori product, was detected using a nitrobluetetrazolium (NBT) assay in glycated albumin samples and controls (Ahmad et al. 2013b). A 0.75 mM NBT solution in carbonate buffer (0.1 M, pH 10.35) has been prepared. Glycated 40 lL samples were incubated for 30 minutes at 37 C with 0.8 mL of NBT solution. The absorbance was calculated at 530 nm using a Thermo Scientific Genesys 10S UV-Visible. The fructosamine concentration was expressed in lM/mg of protein using the standard 1-deoxy-1-moepholinofructose slope. [14]

- *Congo Red Assay:*

By measuring absorbance at 530 nm, the volume of Congo red dye that was bound to the amyloid cross -structure was measured. For 20 minutes, the glycated sample (50 L) was combined with 50 L of 100 M Congo red dye. Distilled water (1 mL) was added to the volume to make it big enough for spectrophotometric analysis at 530 nm. [15]

➢ *Antidiabetic Assay:*

- *Alpha-Amylase Enzyme Inhibition assay.*

100 ml of 16 mM sodium acetate buffer were mixed with 0.1 g of potato starch to create the starch solution (0.1% w/v). In order to make the enzyme solution, 27.5 mg of -amylase were dissolved in 100 ml of distilled water. The 3,5-dinitro salicylic acid solution and sodium potassium tartrate solution, both in solutions of 96 mM, are combined to create the colorimetric reagent. Both the control and plant extract tubes receive the starch solution, which is then added and allowed to react with the -amylase solution at 25°C in an alkaline environment. Three minutes were given for the reaction. By reducing 3,5-dinitro salicylic acid to 3-amino-5-nitro salicylic acid, the production of maltose was measured. This reaction can be seen at 540 nm.[16]

$$\text{Scavenging\%} = \frac{\text{Abs of control - Abs of test}}{\text{Abs of control}} \times 100$$

III. RESULT & DISCUSSION

Fig 2 Cinnamon

Fig 3 Chitosan

Chitin, a natural polysaccharide found in crustaceans, has been shown to have a number of biological functions, including antidiabetic ones. Chitosan can promote glucose metabolism and prevent the activity of enzymes that are involved in the metabolism of carbohydrate, such as -glucosidase and -amylase. Cinnamaldehyde Schiff base is a product of cinnamaldehyde, a naturally occurring substance present in cinnamon. It has been reported to have antidiabetic benefits, such as boosting insulin sensitivity and raising glucose absorption in cells. It also has antioxidant qualities and can shield pancreatic beta-cells from ros harm, which can aid in the onset of diabetes. More research is needed to understand the mechanisms of action and possible treatment advantage of these substances in the treatment of diabetes.

A. Cinnamaldehyde is Extracted from Cinnamon Sticks using Steam Distillation.

Steam distillation, often referred to as stem distillation, is a gentle technique used to extract volatile and essential oils from plant materials. Cinnamaldehyde, a volatile substance present in cinnamon bark, is recovered as an oily liquid after the steam and volatile chemicals are condensed and separated. Steam distillation is favoured for the extraction of cinnamaldehyde as it does not employ harsh solvents or high temperatures that could harm or change the chemical structure of the substance. It also reduces the extraction of non-volatile substances that may affect the final product's purity and quality.

B. Tests for Cinnamaldehyde Confirmation

It is crucial to provide precise and succinct information on the observations made during the testing when presenting the results of conformed tests for aldehydes such as the Tollen's test and Schiff test.

A reflective silver layer formed on the inside of the test tube, suggesting the presence of an aldehyde. The presence of an aldehyde group was indicated by the solution's transformation to a deep pink or magenta colour. Note that these tests only provide qualitative data, so you won't learn anything about the sample's aldehyde content or quantity.

C. Chitosan-Cinnamaldehyde Schiff Base

Fig 4 CH-CI SB

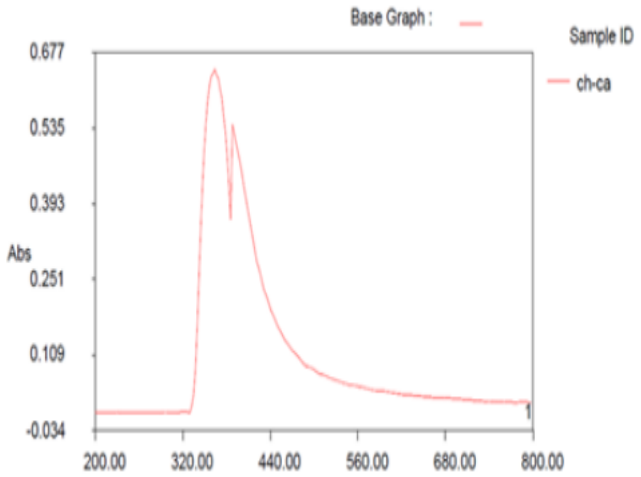
D. Metal Complex Formation using a Schiff Base.

Table 1 Synthesized Compounds Physical And Chemical Characterization:

No.	Compound	C=N(cm-1)	O-H
1	CH-CI SB	1585	1400
2	CH-CI+Cu	1615	-
3	CH-CI+ Zn	1590	-
4	CH-CI+ Fe	1575	-
5	CH-CI+ Mg	1560	-

E. Characterization Techniques Schiff Base:

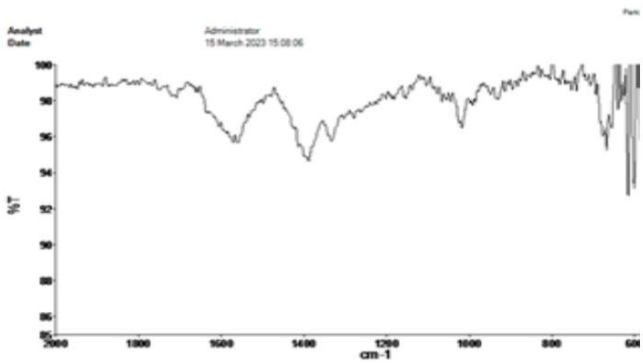
➢ *Characterization by UV-Visible analysis*



Graph 1

UV-VISIBLE spectra of chitosan cinnamaldehyde Schiff base showed absorption peaks at 266 and 350 nm due to the cinnamaldehyde moiety's pi-pi* and imine group's n-pi* transitions. This research sheds light on the properties of chitosan cinnamaldehyde Schiff base.

➢ *Identification by FT-IR Analysis.*



Graph 2

Table 2 IR Spectral Data

NO	COMPOUND	COLOR	MELTING POINT	YIELD
1	CH-CI SB	Yellow	82°C	92%
2	CH-CI +Cu	Green	90°C	75%
3	CH-CI + Zn	Yellow	85°C	78%
4	CH-CI + Fe	Brown	96°C	82%
5	CH-CI + Mg	Yellow	92°C	74%

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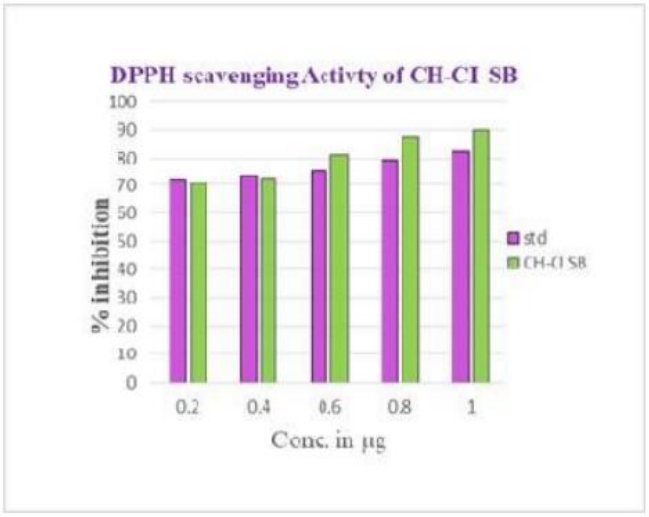
Schiff base's C=N stretching frequency caused an IR spectra band at 1580-1680. Chitosan-cinnamaldehyde bands at 1590.15 cm-1 and 3345.15 cm-1 were attributed to v(C=N) and -(O-H) stretching vibrations. FT-IR spectra of the CSB metal complex showed a change in the C=N stretching frequency to a lower wave number. M-O and M-N stretching vibrations confirmed the coordination of schiff bases to metal ions.

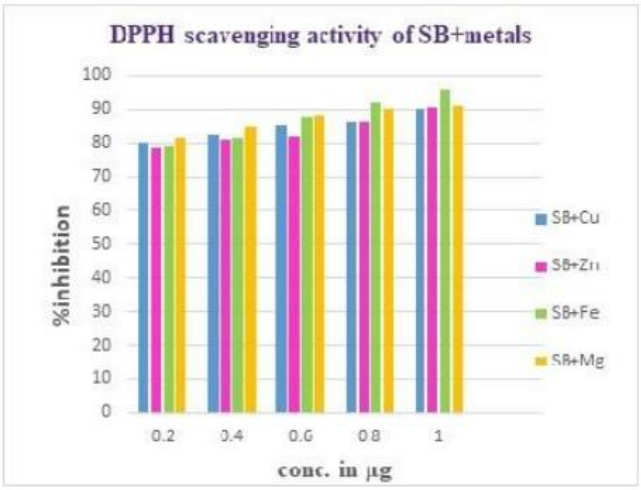
F. Biological applications

➢ *Antioxidant Assay:*

- *DPPH Radical Scavenging Activity*



Graph 3 DPPH Assay CH-CI SB

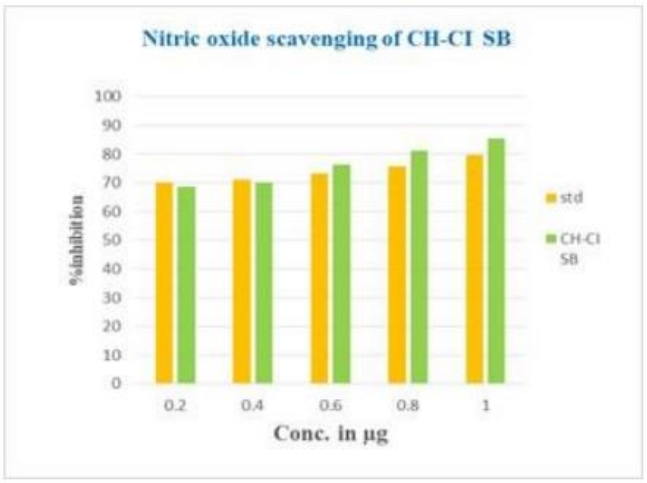


Graph 4 CH-CI+ Metals

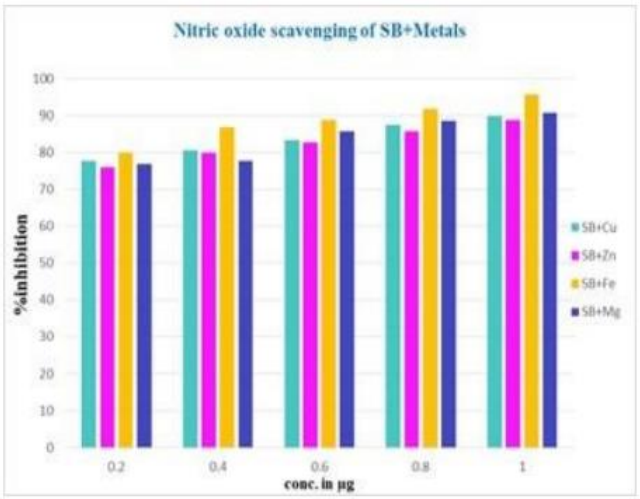
Chitosan and cinnamaldehyde Schiff base can be evaluated for their antioxidant properties using the DPPH assay, a common method for measuring antioxidant activity. When combined, chitosan and cinnamaldehyde form a Schiff base compound that exhibits stronger antioxidant capabilities compared to each individual substance. Furthermore, by coordinating with metal ions, chitosan-cinnamaldehyde Schiff base metal complexes can potentially enhance their antioxidant activity.

To determine the potential of these compounds as natural antioxidants for various applications, the DPPH assay is employed. The results indicate that the chitosan-cinnamaldehyde Schiff base demonstrates reduced inhibitin of DPPH scavenging activity at lower concentrations, but exhibits greater inhibition at higher concentrations, indicating a concentration-dependent effect. Moreover, metal complexes formed by chitosan and cinnamaldehyde exhibit even stronger antioxidant activity than the chitosan-cinnamaldehyde Schiff base alone. Notably, the iron metal complex has shown highly promising results, indicating its potential as a potent antioxidant.

- *Nitric Oxide Scavenging Activity.*



Graph 5 Nitric Oxide Scavenging of CH-CI SB



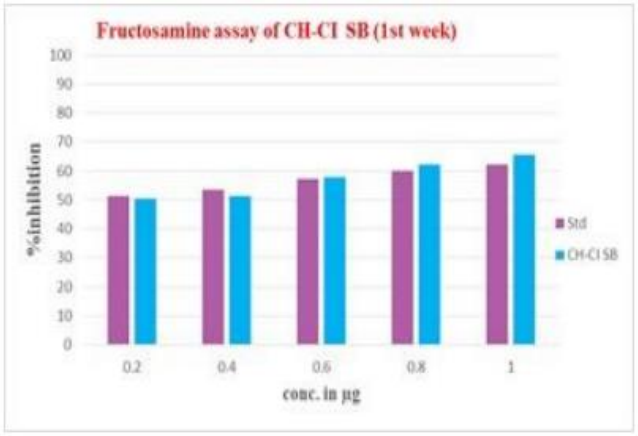
Graph 6 Nitric Oxide Scavenging of CH-CI +Metals

The NO test is a laboratory technique utilized to quantify the ability of a substance to hinder the production of nitric oxide (NO) by cells. Scientists can evaluate the antioxidant properties and potential applications of chitosan and cinnamaldehyde Schiff base by subjecting them to the NO assay. It has been observed that when chitosan and cinnamaldehyde Schiff base form complexes with metals, their antioxidant activity is enhanced. These metal complexes exhibit a reduced suppression of NO scavenging action at lower concentrations, while displaying greater inhibition at

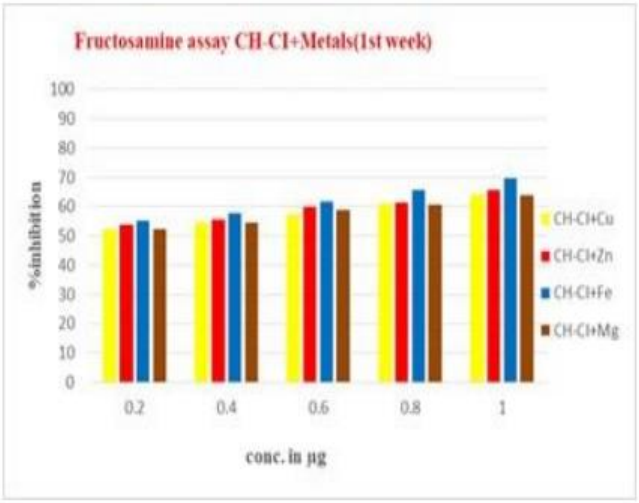
higher concentrations. Moreover, the antioxidant effectiveness of the metal complexes of chitosan and cinnamaldehyde surpasses that of the chitosan-cinnamaldehyde Schiff base alone.

➢ *Antiglycation*

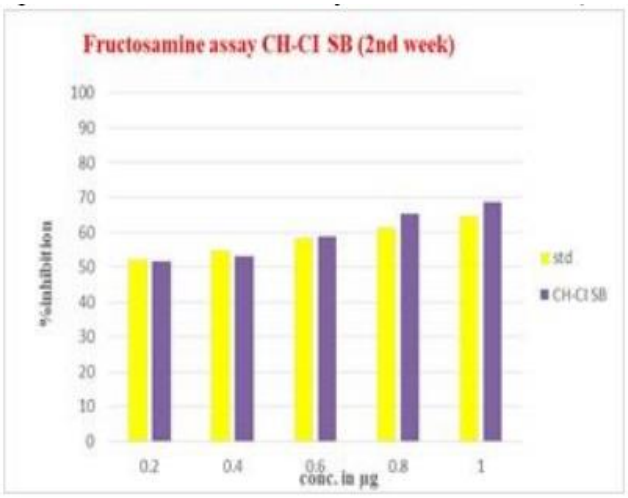
- *Fructosamine Determination.*



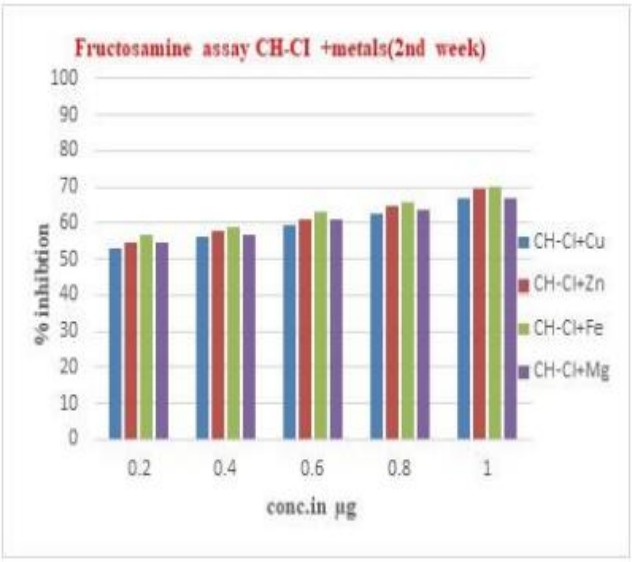
Graph 7a Fructosamine Assay of CH-CI SB (1st week)



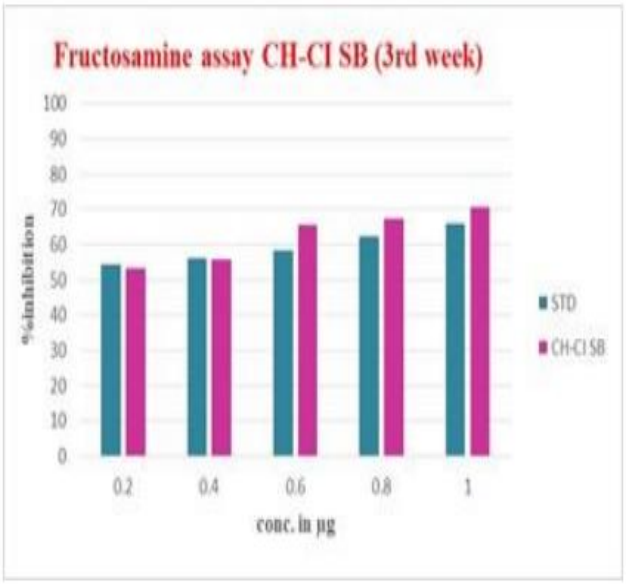
Graph 7b Fructosamine Assay of CH-CI + metals (1st week)



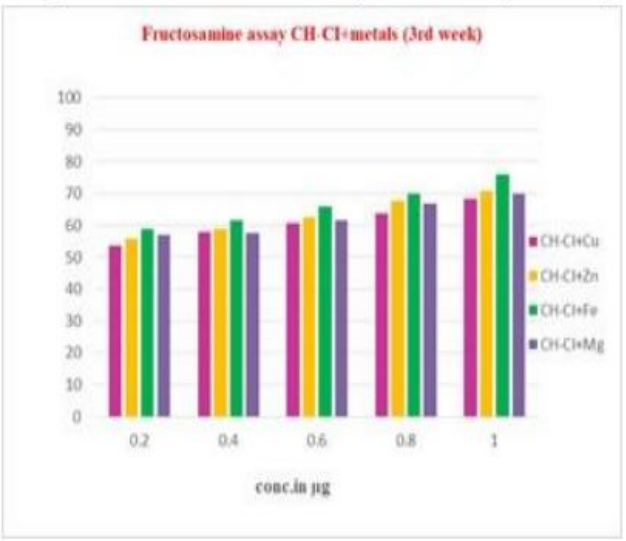
Graph 7c Fructosamine Assay CH-CI SB (2nd week)



Graph 7d Fructosamine Assay CH-CI+ Metals (2nd week)



Graph 7e Fructosamine Assay CH-CI SB (3rd week)



Graph 7f Fructosamine Assay CH-CI +Metals (3rd week)

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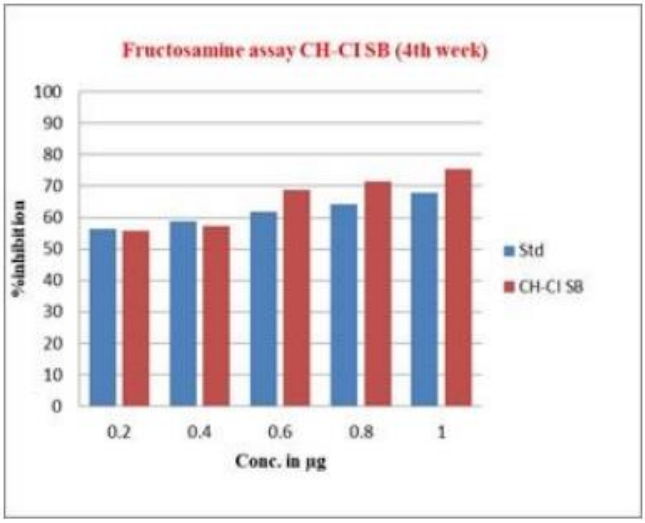
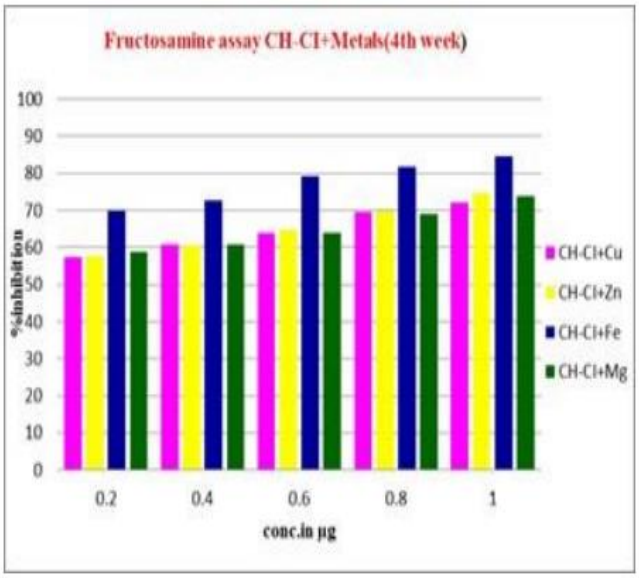


Graph 7g Fructosamine Assay CH-CI SB (4th week)



Graph 7h Fructosamine Assay CH-CI + Metals (4th week)

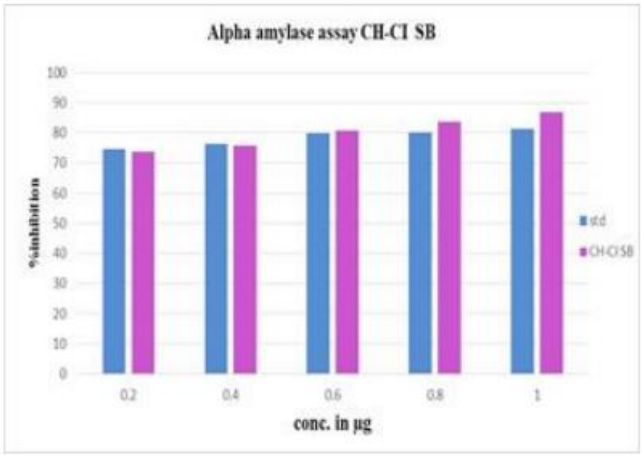
The fructosamine assay can be utilized to assess the ability of chitosan cinnamaldehyde Schiff base products to inhibit the formation of fructosamine, which is produced when glucose reacts with serum proteins. This assay can be used to evaluate the effectiveness of these products in preventing glycation. If the chitosan cinnamaldehyde Schiff base products exhibit antiglycation properties, a decrease in fructosamine levels would indicate a reduction in glycation activity. The chitosan-cinnamaldehyde metal complexes displayed greater activity compared to the CH-CI SB, with the iron complex showing particularly promising results.

- *Congo Red Assay.*

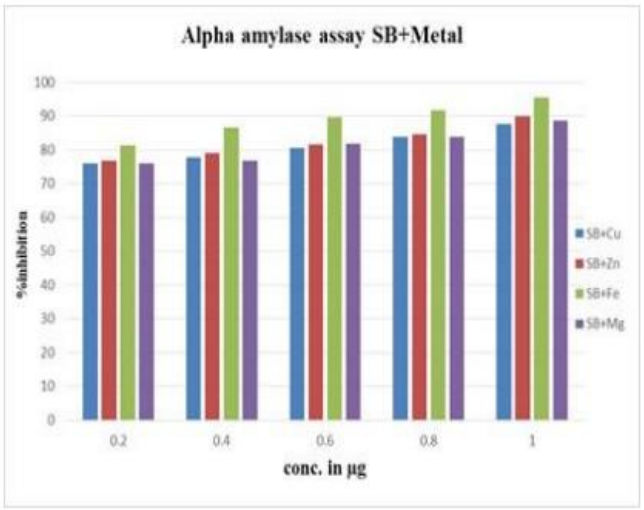
The Congo red assay is a method used to evaluate the ability of a substance to prevent the formation of harmful protein aggregates called amyloid fibrils, which are formed through a process called glycation. Glycation is linked to the development of chronic diseases. Chitosan, a natural biopolymer known for its biological effects, can produce compounds called Schiff bases that have increased biological activity. In our study, we found that the chitosan cinnamaldehyde Schiff base effectively prevented the formation of amyloid fibrils, and the degree of inhibition was dependent on the concentration of the compound. Higher concentrations of the chitosan cinnamaldehyde Schiff base almost completely prevented fibril formation. Additionally, positive results were observed when chitosan cinnamaldehyde formed complexes with metals.

➢ *Antidiabetic Assay:*

- *Alpha-Amylase Enzyme Inhibition assay.*



Graph 8 Alpha Amylase Assay of CH-CI SB



Graph 9 Alpha Amylase Assay of CH-CI + Metals

Alpha amylase plays a crucial role in breaking down and metabolizing carbohydrates, and inhibiting its activity can be a useful approach for managing blood glucose levels. In this experiment, we investigated the potential of chitosan cinnamaldehyde Schiff base products to suppress the activity of alpha amylase. The ability of these products to regulate blood sugar levels was assessed through their impact on alpha amylase enzyme activity. The results demonstrated that both the chitosan-cinnamaldehyde Schiff base and its metal complexes exhibited concentration-dependent inhibition of alpha amylase. Among the four metals tested, the iron metal complex showed the most pronounced inhibitory effect.

IV. CONCLUSION

In conclusion, the research aimed to extract cinnamaldehyde from cinnamon sticks and use it in the manufacture of Schiff bases from chitosan, all while adhering to green chemistry's strict environmental guidelines. These Schiff bases were also studied for their antioxidant, anti-diabetic, and anti-glycation effects after their metal complexes were formed with iron, copper, zinc, and magnesium.

The synthesised Schiff bases and their metal complexes were found to have potent antioxidative, antidiabetic, and antiglycation properties, according to the study's findings. These results suggest that these compounds may play a role in the development of novel therapeutic agents for the treatment of various diseases. Another important reason why green chemistry is used in chemical synthesis is that it highlights the importance of using sustainable and ecologically friendly methods in the manufacturing of these compounds.

More research is needed to learn about the ways in which these chemicals work and how they might be applied to disease treatment and prevention. Overall, the results of this study contribute to the growing body of knowledge about the potential health benefits of cinnamaldehyde and its derivatives. Additionally, the study highlights the significance of using eco-friendly methods during chemical synthesis.

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