Prediction of Anti-inflammatory Activity of Bio Copper Nanoparticle using an Innovative Soft Computing Methodology

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***Abstract*—The objective of this work is to use a novel soft computing approach to predict the anti-inflammatory effect of bio copper nanoparticles. Using a modified technique, various doses of the Musa sapientum extract and copper nanoparticles were examined for their anti-inflammatory capabilities. Protein denaturation was evaluated, and an inhibition percentage was computed. The outcomes demonstrated that the quantity of copper nanoparticles raised the inhibition percentage, indicating a greater anti-inflammatory efficacy. In order to forecast the anti-inflammatory action based on the input variables of contact duration, operating temperature, and beginning concentration, an artificial neural network (ANN) was created. Using experimental data, the ANN model was developed, tested, and its performance assessed. The outcomes showed that the ANN model has a high degree of accuracy in predicting the anti-inflammatory action. In the context of summary, copper nanoparticles produced by Musa sapientum show considerable anti-inflammatory action. The ANN model and the suggested soft computing technique, which included the creation of copper nanoparticles, made an accurate prediction of the anti-inflammatory capabilities. This study aids in creating new methods for estimating the efficacy of bioactive nanoparticles in diverse therapeutic uses, such as the treatment of inflammation.**

***Keywords*—Copper; nanoparticles; green synthesis; prediction; artificial neural network**

I. Introduction

Humans regularly come into contact with natural goods through the foods they eat and the herbal supplements they take. It is challenging to easily determine bioactive natural compounds in complex combinations like plant extracts, which contributes to the slow rate of their discovery [1]. The body's natural protection against damage, infection, or stimulation is fundamentally the inflammation responses, which support tissue homeostasis in hostile settings [2]. Acute and chronic inflammation, are the two main categories used to classify inflammation. An Acute inflammation is a type of innate immune response, but chronic inflammation lasts a extended time and leads to numerous debilitating chronic illnesses, including cancer, autoimmune conditions, cardiovascular disease, also neurological diseases. Thus according to statistics, chronic inflammatory illnesses cause three out of every five deaths worldwide [3]. The production and release of chemical mediators by the cells in the sick, damaged, or injured tissue serve as the catalyst for the inflammatory response. White blood cells also called leukocytes are used at the site of inflammation as just a consequence of additional signals produced by inflamed tissues. Any infectious or toxic agent is destroyed by leukocytes, which also remove cellular waste from injured tissue. This inflammatory response typically promotes the healing process. An unchecked inflammatory reaction, however, could be harmful [4].

One aspect of the body's immunological reaction is inflammation. An inflammatory response is responsible for infections, healing wounds, and any tissue injury. Inflammation is the outcome of numerous defensive system feedbacks in reaction to physical harm or illness. Acute inflammation develops quickly and becomes serious in a short period of while. Its symptoms linger for just a few times although, in some cases, they might persist for several weeks. Acute inflammation is frequently accompanied by swelling, redness, discomfort, immobility, and heat. Acute bronchitis, abrasions or cuts on the skin, sore throat from the flu or even cold, afflicted ingrown toenails, acute appendicitis, dermatitis, tonsillitis, sinusitis, high-intensity workout, infectious meningitis, and physical trauma are a few circumstances and diseases that can result in acute inflammation. Chronic inflammation seems to be a continuous state of tissue injury, active inflammation, and repair that lasts for a long time (months and or years). The harshness and consequences of chronic inflammation characteristically depend on the cause of damage and then how well the body is able to repair and manage the damage. Common signs of chronic inflammation include body aches, fevers, rashes, weight increase or loss, weariness, joint discomfort, and mouth sores. Certain diseases, including diabetes, cancer, cardiovascular conditions, (COPD), rheumatoid arthritis, hepatitis, allergies, Tuberculosis, periodontitis, asthma, and also chronic peptic ulcer, might progress as a result of chronic inflammation [5]. Inflammation was therefore initially described by a collection of clinical symptoms rather than by a particular mechanism. Human disorders that exhibit the five traditional inflammatory symptoms of redness, pain, swelling, heat, and consequent decrease of organ function are caused by inflammation established in Fig. 1 [6].

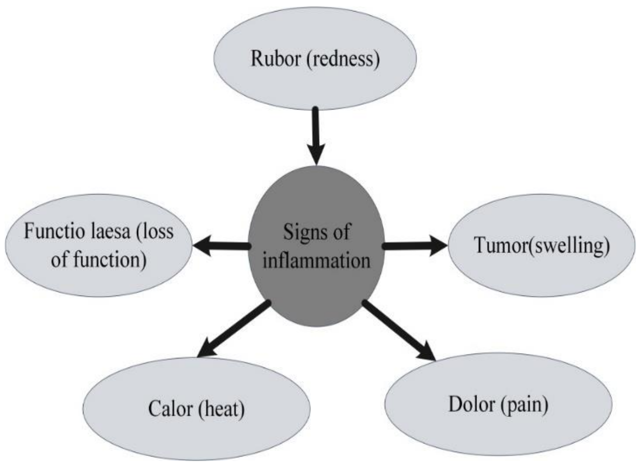

Fig. 1. Signs of inflammation.

Employing nanotechnology in the area of drug administration is a cutting-edge method to deliver medications on the Nano scale to particular organs in a regulated manner to enhance their therapeutic efficacy and minimize negative effects [7]. Among the most active fields of research right now in the fields of materials science, biomedicine, and healthcare is nanotechnology [8]. Metallic nanoparticles seem to be versatile and have stayed utilized in a wide range of industries, therapeutic, as well as medical application, such as wastewater treatment, drug delivery, cancer treatment, and DNA investigation, as well as for antibacterial agents, biosensors, and solar energy generation. It has been claimed that an economical and environmentally responsible alternative to both physical and chemical processes is the green production of metallic nanoparticles. Due to potential uses in business and medicine, copper nanoparticles (CuNPs) have caught the interest of researchers recently. The most efficient method has been determined to involve the biosynthesis of metal oxide nanomaterial's using various plant extracts, including such leaves, stems, cores, and flowers. Numerous phytochemicals found in plant extracts function as stabilizers and retarders of metal oxide nanoparticles. Additionally, the creation of nanoparticles utilizing phytochemical substances is safe for the environment, cheap, straightforward, and may be done at ambient temperature [9]. Additionally, it will aid in reducing the effects of environmental harm brought on by artificial techniques and materials [10].

Nano emulsion, nanoparticles, liposomes, niosomes, and other Nano carriers all have been designed to hold various medications and are meant to deliver them to particular tissues [11]. One of the Nano carriers that facilitate targeting, the delivery, and the controlled release of medications is thought to be niosomes. Niosomes also play an important role in the delivery of naturally occurring medicinal compounds, improving both their physical stability and effectiveness. They are mostly self-assembled bilayer vesicles made of non-ionic surfactants and cholesterol. It has the advantage of encasing and delivering medications that are both hydrophilic as well as hydrophobic. It might be administered via a number of delivery methods, such as parenteral, topical, and oral[12].Metallic nanoparticles are multifunctional and are utilized in a widespread range of applications in science and medicine, involving cancer treatment, drug distribution, wastewater remediation, and DNA analysis. Metallic nanoparticles have newly generated a lot of attention due to their distinctive physical as well as chemical characteristics. Alternatives to chemical and physical processes that are both affordable and environmentally benign include the synthesis and depiction of metallic nanoparticles. Copper Nanoparticles (CuNPs) have received a lot of interest recently from researchers due to their numerous uses in medicine, industries, and other sectors [13].

Due to the existence of numerous bioactive chemicals in plants, numerous plant parts or entire plants have been employed for the green production of Cu NPs. Plant extracts were being used successfully for this purpose [4]. Cu Nanoparticles have successfully synthesized utilizing extracts from a variability of plant species, including Musa sapientum stem extract. Bananas (Genus Musa) have indeed been cultivated for a very long period [5]. Pharmacological research demonstrates the nutritional as well as traditional medicinal benefits of all banana parts. Numerous animal model studies, vitro experiments, and clinical studies also support the utilization of various banana portions in the treatment of a variety of illnesses, including cancer, ulcers, diabetes, hypertension, and diarrhoea [14].

The methods utilized to create them and characterize them are constantly being refined. As nanoparticles to be used in a variety of industries, controlling over their shape and size is crucial. Furthermore, because of their large surface energy, these nanomaterials are very unbalanced and aggregate to form raw material. As a result, several stabilizing agents such as surfactants, block copolymers, dendrimers, and microgels are used to stabilize metallic nanoparticles. The hybridization microgels, which include metallic nanoparticles, combine the characteristics of nanomaterials with polymeric microgels. Metallic nanoparticle-loaded hybrid microgels offer application promise in optics, biomedicine, photonics, electronics, and catalysis. Dynamic light scattering (DLS), Scanning electron microscopy, Transmission electron microscopy (TEM), atomic force microscopy, X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and ultraviolet visible spectroscopy (UV/Vis) are used to identify hybridized microgels. Since every approach is intended to collect a particular type of data that can't be gained using the other, it is difficult to evaluate one approach to another because each has its own merits and drawbacks. Among some of the techniques described above, UV/Vis spectroscopy is just one approach that may be utilized to examine the dynamics of bulge as well as deswelling of polymeric microgels as well as hybrid microgels with tiny size of particles. Assessment of hybridized microgels loaded with Plasmonic nanoparticles and research into their usage often includes the use of UV/VIS spectroscopy. According to reports, it is a useful instrument for analyzing and adjusting the optical characteristics of Plasmonic nanoparticles put into polymeric microgels. UV/Vis spectroscopic is another method that may be used to study the catalytic performance of nanomaterials [15].

A quick analytic method for determining light's absorption or transmission is UV-visible spectroscopic. The majority of spectrometers have a functional range of wavelength among 200nm and 1100nm, despite the fact that the visual portion extends up to 800 nm and the UV frequency varies from 100nm to 380nm. Due to the vacuous nature of UV-vis lighting in the spectral area from 100 nm to 200 nm, which is regarded as infrared light exceeding 800 nm, it is of little practical value. The capacity of a substance to gather and emit photons determines its colour, and the human visual system is capable of distinguishing between up to 10 million distinct colours. Transmission is the process by which light travels via medium, reflecting off both transparency and impenetrable surfaces, and is bent by crystalline [16].

The more popular method for tackling this kind of issue is the artificial neural network, essentially mimics the human brain when addressing a problem. As a result, scientists are endeavouring to create an adaptive framework, such as an artificial neural network, to forecast the temperature depended on the results of many elements. Artificial intelligence (AI) is used in artificial neural networks (ANNs). An arithmetic model called an ANN is enthused by the structure and or functionality of neural networks in biology. A neural network utilizes a connectionist style of calculation to interpret the data and consists of a connected group of artificial neurons. Generally speaking, an Artificial Neural Network is a outstanding performance that changes its structure in requital to information passing and through the network even during the learning experience, whether that information is either internal or external. Modern tools for modelling non-linear numerical data comprise neural networks. They are characteristically applied to recognize patterns in data and otherwise model complex associations between inputs and outcomes. ANN has been effectively utilized in a wide range of applications. An artificial neural network (ANN) is a computational system that takes its cues from the biological neural networks that perform actions in the human brain. Neural networks have the ability to "learn" and correlate huge datasets gleaned from simulations or experimentation. The developed neural network is used as an evaluation method to make accurate predictions about the outcomes. They can produce excellent prediction accuracy ratings thanks to effective approaches for both validation and training [17]. The proposed work focuses on the comparison between the experimental and numerical data indicates a close agreement, with the numerical values closely matching the experimental values. This suggests that the soft computing methodology, specifically the Artificial Neural Networks (ANNs) used in this study, effectively predicts the anti-inflammatory activity of CuNPs. The alignment between the experimental and numerical results validates the reliability and accuracy of the soft computing approach in predicting bioactive properties, contributing to its relevance in drug discovery.

The primary contributions using required establishing the study are as follows:

- The extract is made from Musa Sapientum powder.
- Using the extract, it was previously created, Cu nanoparticles are created.
- Cu nanoparticles were characterised using UV-visible spectroscopy in step three.
- Anti-inflammatory is discovered through calculation of inhibition.
- The effectiveness of the suggested methodology is proven by validating its function and evaluating it against alternative approaches.

This report's remaining sections are organized as follows: Section II presents the relevant works and provides a comprehensive analysis of them. Information on the problem statement is included in Section III. In Section IV, the proposed soft computing Artificial Neural Network topologies are thoroughly examined. The results of the experiment are given, examined, and thoroughly analysed in Section V, along with comparisons to current best practises. Discussion is given in Section VI. The conclusion of the paper is found in Section VII.

II. Related Works

Metabolomics evaluation of the chosen sponge would be followed by molecular docking research to discover and expect the subordinate metabolites that capacity contributes to its capacity of constraining cancer. This investigation will look at the anti-inflammatory as well as anti-cancer possibility of the Red Sea sponges having own mass and silver nanostructure. Silver nanoparticles made from the Red Sea sponge Phyllospongia lamellosa are extracted using chloroform (CE) and ethyl acetate (EE). UV-visible spectrophotometric, Transmission electron microscopy, and Fourier-transform infrared spectroscopy (FTIR) studies were used to evaluate the produced silver nanoparticles. Cells from the MCF-7, MDB-231, and MCF-10A tumour types were used to test the compounds' anti-cancer properties. COX-1 and COX-2 anti-inflammatory activity was evaluated. Molecular docking as well as metabolomics examines constructed on liquid chromatography-mass spectrometry (LC-MS) also were employed. To determine whether such a formulation is applicable as an anti-cancer therapeutic agent in the study, further separation and decontamination of the active ingredients from the sample crude extract of the sponge are required, and in vivo tests are needed in the study [18].

The research used a dependable and ecologically friendly method to create silver nanoparticles from leaf extract of Brachychiton populneus (BP-AgNPs) in an aqueous solution.

FTIR, energy dispersive X-ray analysis, scanning electron microscopy, and UV-Vis spectroscopy were utillized to analyse the silver nanoparticles generated from the Brachychiton populneus (EDX). Ag Nanoparticles' antioxidant, ant diabetic, anti-inflammatory, and cytotoxic properties were also revealed. By using a UV-Visible spectrum, the creation of BP-Ag Nanoparticles was confirmed at 453 nm. According to the FTIR study, functional groups including such as nitro, alkane, phenol, alkene, alcohol, fluoro, and flavones that are contained in plant extract are responsible for the stability, synthesis, and capping of Ag Nanoparticles. Nanoparticles with a cubical shape were evenly dispersed, according to the SEM examination. Ag Nanoparticles had an average diameter of 12 nm, as determined from SEM images using ImageJ software. Silver at 3 keV and also additional trace elements including oxygen and also chlorine were confirmed by the EDX spectrum. In compared to conventional pharmaceuticals, the biologically synthesized silver nanoparticles showed demonstrated ant diabetic (alpha amylase assay), antioxidant (DPPH assay), cytotoxic (MTT assay) and anti-inflammatory (albumin denaturation assay), properties against U87 and HEK293 cell lines. BP-AgNPs have shown inhibition in these assays in a concentration reliant on way and had minor IC50 values than standards. These findings all point to the potential biological benefits of silver nanoparticles. The key characteristics of silver nanoparticles biologically synthesized suggest potential uses for them in the biomedical field. Additionally, the production of silver nanoparticles by plant-mediated processes uses less energy, is advantageous to living things, generates little waste, and is environmentally friendly [19].

In order to encapsulate diosmin as well as address its physicochemical problems, nanostructured lipid carriers (NLCs) suitable for ocular deliver optimized were optimised using the response surface methodology (RSM). A straightforward and scalable process was used to create NLCs: melt emulsification, accompanied by ultra-sonication. Four different independent variables comprised the research designs (liquid lipid concentration, surfactant concentration, solid lipid concentration, and kind of solid lipid). By using a variance analysis of variance, the factors' impact on the NLC size and PDI (responses) was evaluated (ANOVA). The desirability function was used to choose the optimal formulation (0.993). Diosmin was incorporated into NLCs at two distinct concentrations (80 as well as 160 M). A physical and chemical and technical investigation of drug-loaded nanocarriers (D-NLCs) revealed mean particle sizes of 83.5 nm as well as 82.21 nm for formulations made with diosmin at concentrations of 80.0 mM otherwise 160 mM, respectively, and a net negative surface charge of 18.5 nm and 18.0 nm, respectively, for the two batches. The constructions were examined for viscosity, pH (6.5), and osmolarity adjustments to make them more ocular environment friendly. Stability experiments were subsequently conducted to evaluate D-NLC behaviour beneath various storing circumstances for up to 60 days, revealing that NLC samples are well-stabilized at room temperature. NLCs are cytocompatible with retinal epithelium, according to in-vitro research on ARPE-19 cells. D-NLCs were also tested in-vitro for their impact on a framework of retinal inflammation, confirming their cytoprotective properties at different doses. It was discovered that RSM is a trustworthy model for enhancing NLCs for diosmin encapsulation. Additional research is being conducted to evaluate and verify the anti-inflammatory efficacy of D-NLCs in order to achieve this goal. Furthermore, the antioxidant activity of loaded NLCs is not assessed because the improved manufacture of reactive oxygen species (ROS) represents a different feature of ocular degenerative disorders [20].

The Se Nanoparticles were examined for physicochemical characteristics and also anti-inflammatory activity in vivo in the research. Kluyveromyces lactis GG799 (K. lactis GG799) was used to synthesize SeNPs in a sustainable and environmentally, effective, and inexpensive manner. Sodium selenite was successfully converted by K. lactis GG799 producing bright red Se Nanoparticles with particle diameters between 80 as well as 150 nm, and the nanoparticles were collected inside the cells. Following isolation, component findings indicate that the SeNPs were primarily capped by protein and polysaccharides. By reducing oxidative stress as well as intestinal inflammation, dietetic supplementation containing 0.6 mg kg-1 Selinium (in the procedure of biogenic SeNPs) significantly reduced dextran sulphate sodium (Would seem ulcerative colitis. These results indicated that Se Nanoparticles produced by K. lactis GG799 might represent a auspicious and secure Selinium supplement again for the management of IBD. However, to improve preventive and therapeutic properties and lessen the negative consequences, high bioactivity nanoparticles and low toxicity, are still required [21].

The extracts as of several edible portions of Parkia Timoriana exhibited considerable 2, 2 diphenyl 1 picrylhydrazyl (DPPH), 2,2' azino bis (3 ethylbenzothiazoline 6 sulfonic acid (ABTS), as well as Phosphomolybdate rummaging action in line with high antioxidant aptitudes. P. timoriana extract significantly decreased the growth of Escherichia coli, Bacillus subtillis, Bacillus pumilus, as well as Pseudomonas aeruginosa. The functional groups, as well as bioactive chemicals found in the various edible sections of the plant were identified by analysis of the extracts utilizing gas chromatography mass-mass spectrometry (GC-MS) and then Fourier transform infrared spectroscopy. Phenols, alkenes, carboxylic acids, glycogen, aliphatic amines, alkyl halides, primary amines, secondary amines, ether, esters, lipids, aromatics, halogen, nitro compounds, triglycerides, with anti-cancer, antimicrobial, as well as anti-inflammatory characteristics, among other substances, showed characteristic peaks. Additionally, 49 bioactive chemicals that are recognized to have a range of pharmacological actions were found by the GC-MS study. The found bioactive compounds were then subjected to and in silico molecular docking investigations, which suggested potential anti-inflammatory as well as anticancer activities. This is, as far as we are aware, the first publication on the bioactive components of P. timoriana extracts that have significant pharmacological, antibacterial, and antioxidant belongings. The research may result in the growth of new herbal treatments for a variety of disorders using P. timoriana, as well as maybe new drugs. Formulations are not examined, despite the fact that their bioactivity as well as clinical studies are essential for the creation of novel medications [22].

Many substances, including phenolic compounds, flavones, flavanones, triterpenoid acids, chalcones, sugars, and fatty acids, amongst many others, have really been extracted from the Eysenhardtia platycarpa plant. In the study, computational screening for anti-inflammatory action was conducted using Molinspiration® as well as PASS Online on natural flavanone 1 (retrieved from Eysenhardtia platycarpa) as the main chemical as well as flavanones 1a–1d by way of its structural counterparts. Utilizing two investigational designs, a rat ear edoema caused by arachidonic acid and even a mouse ear lobe edoema caused by 12-O-tetradecanoylphorbol acetate, the hydroalcoholic solutions of flavanones 1, 1a-1d (FS1, FS1a-FS1d) also were assayed to evaluate their in vivo anti-inflammatory cutaneous impact. TNF-, IL-1, and IL-6 pro-inflammatory cytokines too were analyzed histologically in rat ear tissue that had been irritated by AA. The outcomes demonstrated that edoema inhibition was brought about by the solutions of flavanone hydro alcoholic in both tested mice. According to this study, the evaluated flavanones would be useful in the treatment of inflammatory skin disorders in the coming [23].

Antiviral and anti-inflammatory drugs may therefore be essential in the treatment of COVID-19 patients. Pimenta dioica leaves contains ethyl acetate extract, four bioactive substances were extracted and recognized using spectroscopic data: gallic acid 3, ferulic acid 1, rutin 2, as well as chlorogenic acid 4. Additionally, as a possible mechanism of action, molecular docking but also dynamics calculations for the separated and revealed compounds (1-4) in contradiction of SARS-CoV-2 major protease (Mpro) were carried out. Additionally, the half-maximal cytotoxicity (CC50) and SARSCoV-2 inhibitory doses of each substance were evaluated (IC50). The consequences of cure with P. dioca aqueous extract, gallic acid 3, ferulic acid 1, rutin 2, and chlorogenic acid 4 were observed by measurement of TNF-, IL-1, G-CSF, IL-2, IL-10, and gene function of miRNA 21-3P as well as miRNA-155 stages to evaluate the anti-inflammatory impacts crucial for COVID-19 affected ones. Likewise, lung toxic effects were stimulated in rats by mercuric chloride. Promising anti-SARS-CoV-2 properties were demonstrated by gallic acid 3, rutin 2, and chlorogenic acid 4, with IC50 ideals of 31 g/mL, 108 g/mL, and then 360 g/mL, correspondingly. Additionally, ferulic acid 1 as well as rutin 2 conducts was found to have stronger anti-inflammatory impacts. The outcomes could be encouraging for further preclinical and also clinical research, particularly on rutin 2 individually or in conjunction with the other separates for the treatment of COVID-19. These substances have not been studied separately or in conjunction with other organic or synthetic items as natural products [24].

The primary protein found in quinoa seeds, chenopodin, is described in this research for the first time in terms of its possible immunomodulatory properties. The study was capable of distinguishing two distinct types of chenopodin, denoted as LcC (Lower charge Chenopodin, and 30% of entire chenopodin) and HcC (Higher charge Chenopodin, and 70% of entire chenopodin), following analyze the molecular characteristics of the pure protein. By assessing NF-B activity and IL-8 appearance investigations in undistinguishable Caco-2 cells, the biological functions of LcC and HcC were examined. IL-1 was used to induce inflammatory. According to the findings, LcC and HcC may have anti-inflammatory properties in an intestine typical system, and their actions may vary based on their physical structure. Additionally, in silico analysis and structurally estimations were used to look into the molecular action mechanisms and the structural or functional connections of the protein responsible for the identified bioactive components. This approach is ineffective because it does not usually preserve the relationship between transcript and protein levels. In fact, even a little change in transcriptional rates might have a significant impact on how much protein is produced [25].

To create extraction with a high concentration of polyphenols, two tomato pomace (TP) feedstocks were investigated. Biomass security is compromised by TPs rapid disintegration, therefore occurs naturally microflora was examined for preservation, and after 60 days of the treatment, own lactic bacterium predominated. Chemical characteristics of the extraction of TPs and TPs fermentation (TPF) and tests for anti-inflammatory and antioxidant activity were performed. A most bioactive polyphenol component, aglycone-polyphenols (A-PP), was used to categories phenolic and flavonoids acids. The quantity of A-PP was reduced by fermenting; however, the composition remained mostly same. Regardless of the decrease in A-PP, the existence of fermented metabolites with aromatic substitutes boosted antioxidant capacity. All TP and TPF possess anti-inflammatory qualities, which are solely reliant on the A-PP concentration. The Partial Least Square (PLS) method revealed greatest active compounds as kaempferol, naringenin chalcone, cinnamic acid as well as gallic acid along with description of the effective dosage, and fermenting kept the anti-inflammatory action. This attribute will recommend the use of the extraction for additional use as supplemental components or additional components in the nutraceutical, cosmetic, and bioactive compounds sectors, along with the good security aspect of the fermenting biomass. This method is ineffective since, in certain circumstances, high-dose antioxidant supplementation may be associated with health concern [26].

III. Problem Statement

The complexity of extracts, isolation of phytoconstituents with the highest levels of purity, and the poorest yield of active phytoconstituents from plants are all barriers to the detection and growth of drugs from natural sources. Despite the difficulties in developing drugs from phytoconstituents, plants make attractive targets for the search for fresh anti-inflammatory leads. The main difficulties in developing new drugs are finding novel compounds with appropriate activity and pharmacokinetic characteristics. More chiral centres, steric complexity, more oxygen atoms, molecular stiffness, and more hydrogen bond donors as well as acceptors are only a few of the distinctive characteristics of the phytoconstituents. The investigation focuses on musa sapientum's anti-inflammatory properties in copper nanoparticles with Artificial Neural Network. Numerous studies have found that using Musa sapientum, particularly the peels because of their potent anti-inflammatory and antibacterial properties, produces the best outcomes but here a soft computing approach like Artificial Neural Network is utilizing for predicting anti-inflammatory activity [27].

IV. Materials and Approaches

A. Extract Preparation

The powder of Musa sapientum was weighed and measured to be 1g. Following the measurement of the powdered sample, 100ml of distilled water was added to the sample and the mixture then was then boiled for about 5 to10 minutes at a temperature of 60–80 degrees Celsius. After cooling down, filtration was performed. Filter paper, a funnel, and a measuring cylinder were used to filter the mixture's contents. The resultant filtrate was viscous.

B. Synthesis of Musa Sapientum Mediated Cu Nanoparticles

CuSo4 in the amount of 0.01 mg was approximately weighed, and dissolved in 8 ml of distilled water, and then combined with the filtered extract. To produce green synthesis, the extract is retained in the shaker and allowed to sit in the stirrer for a period of one hour. An ultraviolet (UV) spectrometer was used to periodically check on the conversion of CuSo4 to Cu Nanoparticles.

C. UV-Visible Spectra Examination

UV-Visible spectroscopy was utilised to track the Cu Nanoparticles' signature. For the characterization of colloidal particles, this is a useful force. Metal particles display substantial surface plasmon resonance (SPR) absorption in the visible range and are extremely sensitive to surface change, making them excellent candidates for research with UV-Visible spectroscopy. Surface Plasmon Resonance property confirmed the existence of Cu Nanoparticles.

D. Anti-Inflammatory Activity

The following procedure, which was modified somewhat from Muzushima and Kabayashi's original suggestion, was utilized to test the anti-inflammatory possessions of musa sapientum. In order to adjust the pH level of the mixture to 6.3, a small amount of 1N hydrochloric acid was used in combination with 0.45 mL of bovine serum albumin (1% aqueous solution) and also 0.05 mL of musa sapientum extract of differed fixation (10μL, 20μL, 30μL, 40μL, and 50μL). These samples underwent a 20-minute period of room temperature incubation followed by a 30-minute period of heating at 55 °C of temperature in a water bath. After cooling the prepared samples and the absorbance at 660 nm was calculated spectrophotometrically. The benchmark was Diclofenac sodium. As a control, Dimethyl Sulfoxide (DMSO) is used. The following Eq. (1) was used to calculate the percentage of protein denaturation.

$$\text{Inhibition } \% = \frac{\text{Absorbance of control} - \text{Absorbance of sample}}{\text{Absorbance of control}} \times 100 \tag{1}$$

E. Soft Computing Approach

Soft computing approaches, such as Artificial Neural Networks (ANNs), offer distinct advantages and relevance compared to existing methods in various fields, including drug discovery and prediction of bioactive properties. Unlike traditional computational techniques that rely on explicit mathematical models and assumptions. One key advantage of soft computing approaches is their ability to learn from data and adapt to changing conditions. ANNs, for example, can be trained using large datasets to capture intricate patterns and correlations, enabling them to make accurate predictions and classifications. This adaptability makes soft computing approaches well-suited for handling diverse and dynamic datasets, especially when dealing with complex molecular structures and interactions in drug discovery. Soft computing approaches can effectively handle incomplete or noisy data, which is common in biological and chemical systems. By employing robust algorithms and learning mechanisms, ANNs can tolerate missing or uncertain data points, providing reliable predictions even in the presence of such imperfections. This flexibility allows researchers to work with real-world datasets that may be incomplete or contain measurement errors, enhancing the applicability and reliability of the predictions. The relevance of soft computing approaches lies in their ability to handle complexity, adaptability to dynamic datasets, robustness to noise and incomplete data, and capability to model nonlinear relationships. These characteristics make them powerful tools in the prediction and analysis of bioactive properties, facilitating the discovery of potential drug candidates and enhancing our understanding of complex biological systems.

F. Artificial Neural Network

A variety of applications have successfully used ANN is established in Fig. 2. A computing system called an artificial neural network (ANN) is stimulated by the biological neural networks in the human brain that carry out specific tasks. Huge datasets gathered from simulations or experiments can be "learned" by neural networks, which can also correlate these datasets. Using the created neural network as an evaluation tool, precise outcome predictions are made. Thanks to their efficient validation and training methods, they may generate great prediction accuracy ratings.

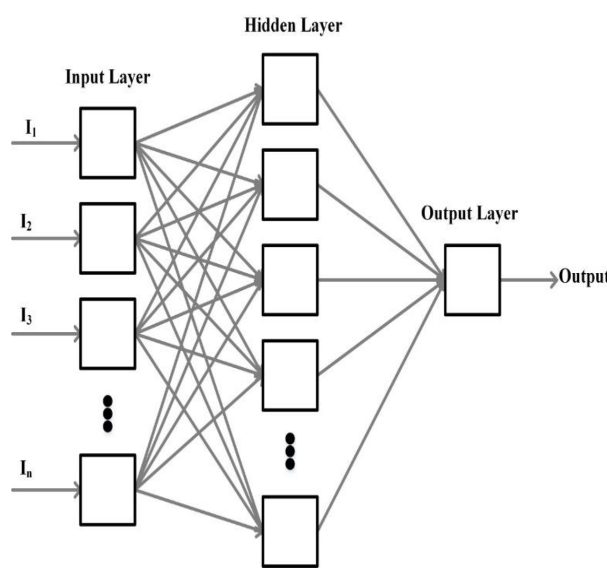

Fig. 2. Proposed artificial neural network.

1) Data pre-processing: The experimental results were modelled using a feed-forward back propagation training approach in an effort to forecast the effectiveness of Cu Nanoparticles on anti-inflammatory utilizing Artificial Neural Network. One S variable at a time formed the foundation of the experimentation in this study. This was accomplished by varying just one input factor while holding the other two variables constant. Experimental cases were created in the work using the outcomes of experiments. The testing and training sets of the dataset were split randomly. The remaining data were used for testing, and the rest for training. Eq. (2) was used to normalize the training and testing datasets in order to reduce error.

$$A_i = \frac{y_i - y_{\min}}{y_{\max} - y_{\min}} \times \left(s_{\max} - s_{\min}\right) + s_{\min} \quad (2)$$

The variable y_i stands in for the input or output in (2). y_{min} and y_{max} are the extreme values of y_i, while A_i is the normalised value of y_i. The range limits to which our y_i is scaled are s_{min} and s_{max}. The input and also output data in this study were normalised among 0 and 1. After modelling, results were restored to their original value. A three-layer Artificial Neural Network was used to simulate the experimental dataset.

2) Creation of an artificial neural network model: The usage of ANN [28] as a modelling tool is very common to approximate complicated systems that cannot be modelled using traditional modelling techniques. They are typically employed in classification, pattern recognition, as well as function approximation. To choose the artificial neural network (ANN) and training procedure for a specific task, no precise formula has been discovered. Trial and error is used to determine the framework and method to apply while tackling a certain problem. However, this choice could begin with a modest network construction before moving on to a complicated one up until a satisfactory solution is found with a permissible smallest fault. There are numerous network designs used in ANN modelling. The fundamental design that uses a back propagation training technique to train input data is the feed-forward neural network. The framework may vary depending on the counting of layers in the architecture, the number of neurons in every layer, and then the allocation functions at the layer of input as well as output.

A three-layer ANN was used in the study, with the input layer (autonomous variable) including 3 neurons that is contact time, operating temperature, as well as initial concentration, a hidden layer containing 17 neurons, as well as an output layer (dependent variable) comprising 1 neuron. The output and hidden layers of the neural network were activated using both linear as well as non-linear activation functions according to the network structure. There were created experimental data instances. The training sub-dataset of 70% and then testing sub-dataset (30%) of the dataset were randomly separated. The efficiency of the constructed ANN models was evaluated. The powdered Musa Sapientum is used to create the extract. Cu nanoparticles are produced using the extract that we previously made. In step three, Cu materials were studied utilizing UV-visible spectroscopy. Calculating inhibition leads to the identification of anti-inflammatory. By confirming the function of the proposed methodology is demonstrated in Fig. 3.

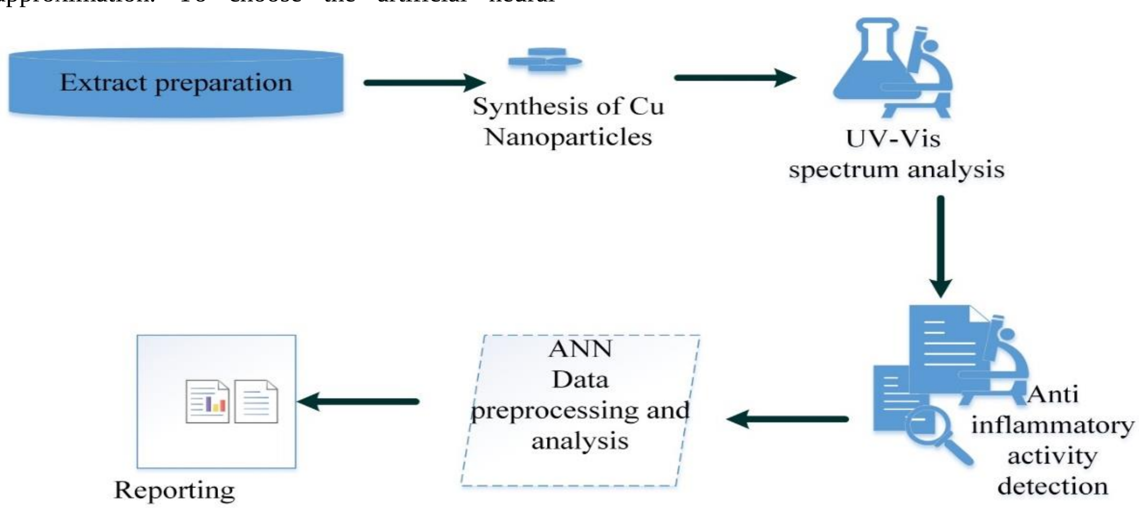

Fig. 3. Proposed ANN model for predicting anti-inflammatory activity.

V. Results

The purpose of the research was to determine whether Musa Sapientum and the copper nanoparticles that it was mediated by had anti-inflammatory properties. It made use of descriptive statistics. It has been determined that the inhibition percentage was reported to be 43.4% in 10 µL concentration, 47.6% in 20 µL concentration, 83.5% in 30 µL, 85.5% in 40 µL, and 85.9% in 50 µL concentration. These results in a good anti-inflammatory activity were found from 10 µL concentration to 50 µL concentration in Table I and Fig. 4.

The standard value of the concentration at 10 µL is 50.8%, 20 µL is 57.8%, 30 µL is 67.6%, 40 µL is 77.9%, and 50 µL is 89.6%; these values likewise gradually rise with concentration. The standard value of the concentrations is compared with the Cu Nano particles inhibition % is tabularized in Table II and explained in Fig. 5.

TABLE I. INHIBITION PERCENTAGE FOR ANTI-INFLAMMATORY ACTIVITY

Concentration (µL)	Inhibition (%)
10	43.4
20	47.6
30	83.5
40	85.5
50	85.9

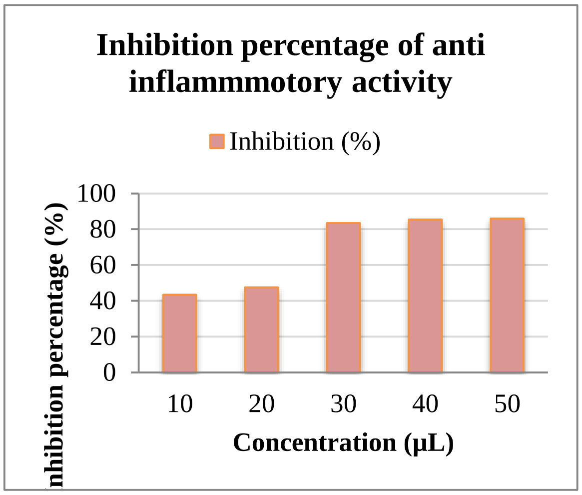

Fig. 4. Inhibition percentage for anti-inflammatory activity.

TABLE II. COMPARISON BETWEEN STANDARD AND CU NANOPARTICLE

Concentration (µL)	Inhibition (%)	
	standard	Cu Nanoparticles
10	50.9	43.4
20	57.9	47.6
30	67.7	83.5
40	78.0	85.5
50	89.7	85.9

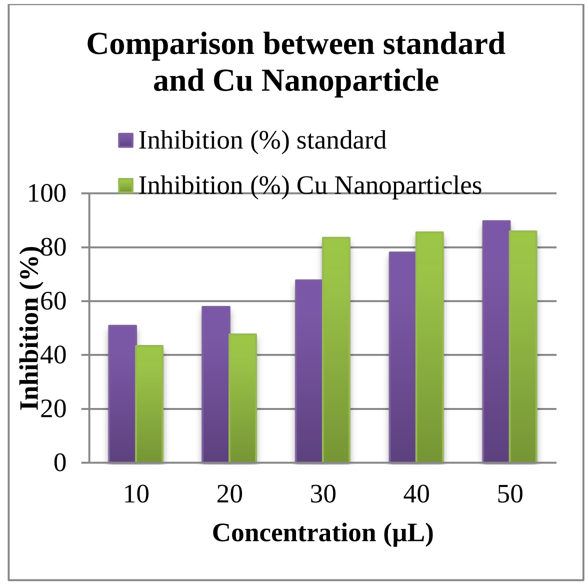

Fig. 5. Comparison between standard and Cu Nanoparticle.

TABLE III. EXPERIMENTAL AND NUMERICAL DATA ANALYSIS WITH EXISTING EXPERIMENTS

Concentration (µL)	Incineration	
	Experimental Data (CuNPs)	Numerical Data
10	43.5	44.6
20	47.5	47.1
30	83.6	85.5
40	85.4	87.9
50	85.8	88.4

Table III presents the experimental and numerical data analysis for different concentrations of Cu nanoparticles (CuNPs). The table shows the inhibition percentage of CuNPs obtained through experimental incineration and numerical calculations. The comparison between the experimental and numerical data indicates a close agreement, with the numerical values closely matching the experimental values. This suggests that the soft computing methodology, specifically the Artificial Neural Networks (ANNs) used in this study, effectively predicts the anti-inflammatory activity of CuNPs. The alignment between the experimental and numerical results validates the reliability and accuracy of the soft computing approach in predicting bioactive properties, contributing to its relevance in drug discovery [29].

A. Detection of the Ideal Number of Hidden Neurons

The neural network technology's key parameter is the number of hidden neurons. Essentially, this is helpful in figuring out the ideal brain architecture. Using a trial-and-error methodology, 1 to 20 neurons were utilised in hidden layer to optimize the network structure. The effectiveness of every chosen number of neurons is detailed.

B. Performance Evaluation

The structure model's accuracy is a measure of how accurately it operates. Typically, it is determined by the ratio of successfully predicted measurements to all observable data. Accuracy is stated in Eq. (3).

$$Accuracy(\%) = \frac{T_{positive} + T_{negative}}{(T_{positive} + F_{possitive} + F_{negative} + T_{negative})} \times 100 \quad (3)$$

Nevertheless, the inhibition process approaches equilibrium for inhibition% of 50 µL with 85.9%. 50 µL was deemed to be the ideal concentration has 96.34% accuracy for process in the Table with a high priority for inhibition %. The correlation between the experiment's results and the projected ANN accuracy results is shown in Fig. 6 and Table IV.

TABLE IV. ACCURACY OF PROPOSED ANN

Concentration (µL)	Inhibition (%)	Accuracy (%)
10	43.4	64.76
20	47.6	65.88
30	83.5	77.61
40	85.5	77.58
50	85.9	96.34

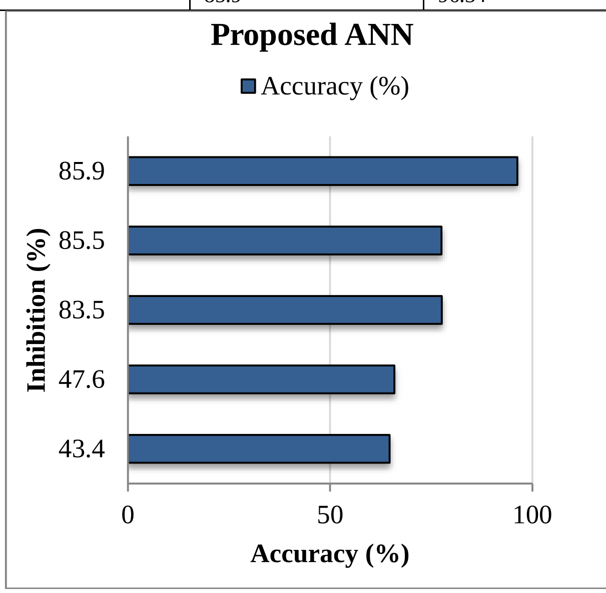

Fig. 6. Accuracy of proposed ANN.

VI. DISCUSSION

Banana peel is a significant by-product of numerous small-scale and large-scale hospitality industries and functions as a sophisticated biological matter. Chemically, it is composed of simple cellulose, sugars, lignin, and hemicelluloses. It can serve as a suitable substrate for microbial operations to achieve products with value added because of its availability and worth. Numerous initiatives have been attempted to create protein-enriched animal feed, citric acid, industrial enzymes, and other commercially viable goods. It has been demonstrated that plantain bananas have anti-inflammatory and ulcer-healing properties. The medication made from plantain sources that helps ulcers heal may also have an impact on how wounds mend. For instance, plantain blossoms have been used to heal ulcers and diarrhoea, and extracts from the plant have antihyperglycemic properties. The peel has antibacterial, antifungal, and anti-denaturation effects. Banana leaf methanolic extract was claimed to have anti-inflammatory and antibacterial properties in earlier research. The hem agglutinations as well as hydrogen peroxide-induced hemolysis of human red blood cells were inhibited by the banana extract. The anti-inflammatory properties of Musa sapientum and their connection to copper-mediated nanoparticles are shown in a bar graph. It is clear that copper-mediated nanoparticles have good anti-inflammatory effect because the virtually maximum percentage of inhibition (86%) was seen and 83.5% of that inhibition was detected in copper nanoparticles. Yet, with an inhibition percentage of 50 µL with 85.9%, the inhibition process gets closer to equilibrium. 50 µL was determined to have a 96.34% accuracy rate for the process and a vital element for inhibition percentage.

VII. CONCLUSION

Cu Nanoparticles synthesised by Musa sapientum has significant biological processes, and the recognized biological technique is chosen over alternative ways because it is less harmful to the environment and calls for fewer downstream processing steps. Plant-based bio-resources are used in this cutting-edge, environmentally friendly approach as stabilizing and reducing agents. UV-Visual study indicates that Cu-NPs had formed. According to this study's findings, Musa sapientum has stronger anti-inflammatory effects when copper nanoparticles are included. This information can be used for further research into using them as reduced bio toxic substitutes for currently available chemically synthesized biomaterials. Numerous designed nanoparticles have been prepared and evaluated and finished the clinical studies in light of this. The healthy cells throughout the body are left behind as this infiltrate the unhealthy cells. As kind of a result of the aforementioned findings, it is clear that environmentally friendly copper nanoparticles could operate as a great biological activity agent and could also be efficiently and economically applied for numerous medicinal purposes. Future research issues have arisen as a result of how nanoparticle aggregation impacts biological activity by inhibiting their entrance inside bacterial cells in addition to how variations in manufacture, processing, and storage can cause oxidation and result in undesired forms. Based on specified inputs, the artificial neural network archetypal was provided to forecast the inhibition% of anti-inflammatory action. The model was evaluated, and the overall result for 50 µL was 96.34%. As a result, the ability of the artificial neural network to forecast inhibition percentage was examined with accuracy level of 96.34% for 50 µL. The proposed model also evaluated the Experimental and numerical data analysis for different concentrations of Cu. While the study's usage of Artificial Neural Networks (ANNs), a type of soft computing, has some intriguing benefits, the drawbacks that must be noted is the calibre and representativeness of the training dataset have a significant impact on ANN performance. Insufficient or skewed data might provide poor models and wrong forecasts. Therefore, efforts should be taken to guarantee that there are plenty and varied datasets available for the ANN model's training.

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