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Identification of Copper Content in Soil: A Review

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***Abstract*:**Human health, growth of animals and plants require various nutrients that are mandatory and essential and copper is also one of them. It is essential and also dangerous to life and plays a considerable role in each. It is needed by the body in considerably little amounts. Copper participates in various physiological processes and is an important chemical compound for several metalloproteins. However, it's probably unhealthful. Issues arise once excess copper gets in cells. Excess copper within the organic structure will cause abdomen and internal organ distress like nausea, vomiting, diarrhea, and abdomen cramps. Excess copper inhibits natural growth of plants and impairs vital cellular method (i.e., chemical change electron transport). Therefore analyzing copper in varied media is becoming extensively vital. Previous studies reveal that copper determination can be done using analytical techniques such as atomic absorption spectroscopic analysis, atomic emission spectroscopic analysis, electroanalytical techniques, spectrophotometry, inductive coupled plasma-emission spectroscopic analysis, inductive coupled plasma-mass spectroscopic analysis, flow injection diode array spectrophotometry and X-ray light spectroscopic analysis. In this paper, the strategies employed by different authors to estimate the soil copper contents are studied. The strategies that they used and their results and conclusions are studied.

***Keywords*:**Copper (Cu), Iron (Fe), VNIR spectroscopy, Spectrophotometry, PLSR

I. INTRODUCTION

Soil could be a crucial resource for the survival of plants, animals, and humans. Associate degree estimate of the amounts of components in average, or normal, is helpful during appraising the amounts of components in a soil sample as related to agricultural, mineral prospecting, environmental quality, and health and disease investigations. As there are socioeconomic developments, there are a series of issues that cause the deterioration of soils. Among these issues, soil contamination as a result of heavy metals dissolved in it causes potential harm to agricultural products, human health, and also the surroundings. Heavy metals dissolved in soil causes a great threat to human health. Heavy metals dissolved within soils could disrupt the soil balances physically, chemically and biologically. Plants also add to the process of accumulating metals in the soil. This might be magnified within ecosystems as plants incorporate into food chains and their environmental persistence, which could further impact the sustainable developments of ecosystems. Thus, it has become very important to determine metal concentrations in the soil so as to understand the soil contamination due to metals henceforth helping in the environment development.[1]

Copper occurs naturally in the environment. It is nutritionally essential element that occurs in soil at a mean concentration of concerning 50 parts per million (ppm). It is present in the living creatures and is essential for humans, animals and plants in some amounts. Since copper is necessary compound and also adangerous component, involving a complex network of metal trafficking pathways, there are different ways developed in plants to regulate its homeostasis appropriately as a function of the environmental copper level.[2].

Different types of metals might enter the industrial wastewaters as a result of phylogeny activity. As a result of corrosion and earth science factors some metal in complicated kind being environmental contaminants could even be gift in drinking waters and natural water bodies. By the biological cycle, lots of them pass into the bodies of plants, animals and man through the food chain, thus affecting them negatively. Hence, it has become very important to develop various methods for the determination of copper in environmental, biological and soil samples for continuous observation to establish the levels of Cu in environmental and biological matrices.[3]

II. LITERATURE SURVEY

Copper once was considered as a plant poison, as indeed it may be when excessive amount of it is used on soil. Other research workers determined that copper is distributed through all plant tissues in small amounts. Others said that the effects of little amounts of copper on plants and fungi were due to some indirect action of copper or to an irritation response. Others thought that copper can be a vital part in the metabolism of living creatures. The first credible evidence that copper was a vital part in the nutrition of lower plants was given by H. Bortels, a German scientist, in1927. Soon other scientists provided confirmation to his results. They discovered that copper is crucial for the normal growth of various fungi and yeasts. R. V. Allison and his associates in 1927 showed that the fertilization with copper can cure almost completely failed crop growth on the peat soils in Florida Everglades. They postulated that the disorder in plants was due to the lack of sufficient copper for plant growth.[4]

Copper was determined by an adapted extraction - spectrophotometric technique in the form of a complex with sodium(I) diethyldithiocarbamate. The influence of the extraction solvent, a masking agent and interfering elements (Fe(III) and Cr(IH)) on estimation of copper by this

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technique was examined. Potentialities of elimination of the extraction stage by employing a protective colloid for spectrophotometric determination of copper in soil were investigated. (B. Jankiewicz, B. Ptaszyński, A. Turek, 1999) [5]

A simple spectrophotometric technique is delineated for the fast estimation of copper at a trace level using 2,5-dimercapto-1,3,4-thiadiazole(DMTD) as a spectrophotometric reagent. The strategy relies on the reaction of non-absorbent DMTD in an exceedingly slightly acidic aqueous solution with copper(II) to produce anextremely absorbent greenish-yellow chelate product. The strategy was with success applied for copper estimation in several Standard Reference Materials as well as in some environmental water, biological, soil samples and solutions that contained both copper(I) and copper(II) and complex synthetic mixtures. (M. Jamaluddin Ahmed, Israt Jahan and SaeraBanoo, 2002) [6]

Estimating copper in tap water, polluted water, human hair and alloys is done using a simple, spectrophotometric method. The planned technique relies on the reaction of copper with potassium iodide in acidic medium to liberate iodine, that bleaches violet color of azure B and the absorbance is measured at 644nm. The strategy needs neither heating for the entire color development nor extraction into any organic phase. (Mendalin Mathew and B Narayana, 2006). [7]

Crystal E. Sabel, Joseph M. Neureuther, Stefan Siemann(2008), used Zincon as a colorimetric reagent for the detection of zinc and copper ions in aqueous solution. The spectral properties of Zincon were investigated in the presence of guanidine hydrochloride andurea, two common denaturants used to labilize metal ions in proteins, to increase the chelator's versatility to the quantification of metal ions in metalloproteins. (E. Sabel, Joseph M. Neureuther, Stefan Siemann, 2009) [8]

REN Hong-Yan, ZHUANG Da-Fang(2009), Concentrations of Iron (Fe), As, and Cu in soil samples were analyzed and ASD FieldSpecspectroradiometer (Analytical Spectral Devices, Inc., USA) was used to measure soil spectral reflectance under laboratory condition. For predicting soil metal concentrations, Partial Least Square Regression (PLSR) models were developed. They concluded that concentrations of heavy metals in contaminated soils could be determined indirectly by soil spectra according to the correlation between the spectrally featureless components and Iron; therefore, for monitoring soil heavy metals contamination, spectral reflectance would be an alternative tool. (REN Hong-Yan, ZHUANG Da-Fang, A. N. SINGH, PAN Jian-Jun, QIU Dong-ShengandSHI Run-He, 2009). [9]

III. METHODOLOGY

M. J. Ahmed, M. Saifuddin, T. Jannat and S. C. Bhattacharjee (2010) used spectrophotometric methodology to determine copper using 1-(2-pyridylazo)-2-naphthol (PAN) as a new spectrophotometric reagent. Copper determination can be directly conducted in an aqueous solution without the need for any separations or clean up step. The spectrophotometric analysis in a very dilute solution was derived from Beer's law. [10]

Yaolin Liu &Yiyun Chen (2012) found that mechanism of estimating copper content lay in its correlation with iron (Fe) content. They selected PLSR model with logarithmic scale to transformed copper content. For estimating copper contamination from untreated soil samples, the standard normal variate spectrum was chosen. They concluded that, in the PLSR model, the correlation analyses and regression results, both suggest that the main mechanism for estimating Cu content, lies in its correlation with Fe content.[11]

M. Jamaluddin Ahmed and TasnimaZannat(2012), used a really easy, ultra-sensitive,highly selective and non-extractive spectrophotometric methodology for the determination of copper. Salicylaldehydebenzoylhydrazone (SAL-BH) is employed as a new analytical reagent for the direct non-extractivespectrophotometric determination of copper. The calibration graph was plotted and a equation for a spectrophotometric analysis in a very dilute solution was derived from Beer's law.[12]

Junjie Wang, LijuanCui,Wenxiu Gao(2013), estimated heavy metal accumulation in agricultural soils. GA-PLSR and PLSR models, along with VNIR-reflectance spectroscopy, were calibrated for the heavy metals using a leave-one-out cross-validation procedure.[13]

Ayman A. Gouda,Alaa S. Amin(2014), used simple and sensitive cloud point extraction procedurefor the preconcentration and determination of copper(II) ion in food, water and biological samples. The method is based on the cloud point extraction of the complex of copper with ATAP. They used synthesized reagent, 2-amino-4-(m-tolylazo) pyridine-3-ol (ATAP) as a new complexing agent and Triton X-114 as the surfactant.[14]

MalihehBarazandehTehrani(2014), used MNDTT (6-(2-methoxynaphthyl)-2,3-dihydro-1,2,4-triazine-3-thione) as the reagents for spectrophotometric analysis of copper. MNDTT was synthesized depending on the acylation of methoxy naphthalene and reaction of the product with amyl nitrite. For determining the spectrophotometric equation, Beer's Law was used.[15]

IV. RESULT AND DISCUSSION

José M. Soriano-Disla, Les J. Janik (2014), applied visible (Vis), near-infrared (NIR), and mid-infrared (MIR) reflectance spectroscopy for predictingthe soil properties. MIR made higher predictions than Vis-NIR, however Vis-NIR outperformed MIR for variety of properties (e.g., biological).[16]

Soil pH value, organic matter and macronutrients contents in the soil were analyzed using two spectrometers: Veris VIS/NIR soil sensor (Veris Technology Inc.) and MPA FT-NIR spectrometer (Bruker Optics Inc). They used optical diffuse reflectance spectroscopy (Yubing Wang, Tianyu Huang, Jing Liu, 2014).[17]

Visible/near-infrared diffuse reflectance spectroscopy was accustomed to estimate soil attributes to classify soils as per their properties. Principal component (PC) analysis and multinomial logistic regression were accustomed to classify the soils.[18]

Wenjun J, Zhou S, Jingyi H, Shuo L (2014), used the vis-NIR reflectance spectroscopy to get the soil characteristics. The linear partial least squares regression (PLSR) was and then the nonlinear least square support vector machine (LSSVM) algorithm was carried out in order to retrieve additional helpful data from the soil.[19]

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A.Gholizadeh,M. S. M. Amin (2014), used VIS-NIR-reflectance spectroscopy to estimate copper in paddy soil using the fieldspecspectroradiometer(350–2500 nm). Firstly, the Savitzky–Golay algorithm was applied and then the stepwise multiple linear regression (SMLR) was applied to preprocess, model, and predict the properties based on the spectral reflectance within the Vis-NIR range. [20]

Daniel Admasu, DesamNagarjunaReddy(2016), used spectrophotometric technique for the determination of copper in soil and vegetables samples. The spectrophotometric reagents used were 2-acetylpyridine thiosemicarbazone (2-APT) and 3-acetylpyridine thiosemicarbazone(3-APT). The Beer's law was obeyed. Comparisons of the results with those obtained using a flame atomic absorption spectrophotometer for Cu(II) determination also tested the validity of the method using paired samples.[21]

V. CONCLUSION

In this study, we explored the feasibility of estimating copper in soils using different techniques. Copper is both essential and harmful for living beings if it exceeds some limit. The key objective of this paper is to study the determination of copper in soil through various methods followed by different authors. Using the spectrophotometric approach, different spectrophotometric reagents are used along with Beer's Law. Using VNIR reflectance spectroscopy, Partial Least Square Regression is the mostly used method. We can conclude that by estimating the amount of copper in soil, the fertility of the soil can be determined.

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