Spectrophotometric Method For The Determination Of Manganese (II) In Soil Samples And Plant Materials Using Morpholine Dithiocarbamate

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Abstract:

A simple method is developed to determine trace quantities of Manganese using sodium morpholine dithiocarbamate (Na-MDTC) as a chelating agent by extraction spectrophotometry. Manganese (II) reacts with MDTC in sodium acetate-sodium hydroxide buffer of pH 8.0 and gives a brown colored complex. The absorbance of the extracted complex in chloroform is measured at 510 nm. The method is sensitive up to 0.40 ppm and it is free from interference of many metal ions like Cd^{+2}, Cu^{+2}, Zn^{+2}, Ni^{+2}, $Fe^{+2.}$ The quantitative conditions developed are applied for the estimation of manganese in soil samples and plant materials.

Key words:

Spectrophotometry, Manganese (II), Soil samples and Plant materials.

"1. Introduction"

Manganese is found in plants as well as animal tissues[1] and occurs in all foods[2] and drinking water[3]. Sehroeder et. al[4] confirmed the highest Manganese levels in nuts and whole cereals, variable amounts in vegetables, and low concentrations in meat, fish and dairy products. Tea was found to be exceptionally rich in Manganese[4.5].

The average daily intake of adult is 2.2-2.7 mg of manganese. Bowen[6] found normal human blood to have an average of 24±8 μg Mn/litre. Lassiter and Morton[7] reported a mean of 6.1 ppm Mn in the wool of lambs fed with a low Mn diet for 22 weeks, compared with 18.7 ppm in the wool of control lambs. In a study by Dewar et al[8] hens fed with good diet containing 81 ppm manganese produced eggs containing 28.6 ± 0.78 μg manganese. Generally, exposure to ambient Mn air concentrations in excess of 5 mg Mn/m3 can lead to Mn-induced symptoms.[9]

Manganese is necessary for the proper function of several enzymes & is an essential micronutrient for the function of the brain, nervous system & normal bone growth. It optimizes enzyme and membrane transport functions.[10-12]. It plays an important role in the plants respiratory process such as oxidation of carbohydrates to CO_2 and H_2O. This process is catalyzed by an enzyme which is activated by manganese. According to physiologists manganese together with iron, controls the redox potentials in plant cells during the light and dark phases.

Manganese is the least toxic of the trace elements to mammals and birds. The adverse effects of excess manganese on growth were shown to be mainly a reflection of depressed appetite.

Manganese deficiency has been observed in man with vitamin K deficiency[13]. Similar to other essential metals, both excess & deficiency of manganese in the body can cause serious impairment of vital physiological & biochemical processes, psychotic behavior, drowsiness and other related symptoms and / or diseases [14-16]. Chronic manganese poisoning occurs among miners following prolonged working with manganese ores. Excess manganese enters the body mainly as oxide dust via the lungs and also via the gastrointestinal tract from the contaminated environment[13]. Manganese poisoning is characterized by a severe psychiatric disorder resembling schizophrenia, followed by a permanently crippling neurological disorder clinically similar to Parkinson's disease[17.]

The analysis of manganese in biological and environmental samples is usually performed using radio-analytical and atomic absorption spectrophotometric methods. These instruments require sophisticated laboratory conditions. An alternative method is therefore developed for trace analysis of manganese (II) using simple U.V - Visible spectrophotometer available in most of the laboratories.

The method is extended for the detection and determination of Mn (II) in soil samples and in plant materials.

"2. Experimental"

Bio Spectrophotometer with TE controller- Analytical Jana was used for absorbance measurements. A digital pH meter (model No. 335), of systronic make is employed for pH measurements. All other chemicals were of A.R grade. A stock solution of manganese (II) was prepared by dissolving 0.169 gms of manganese sulphate in distilled water. Sodium morpholine dithiocarbamate solution was prepared in double distilled water.

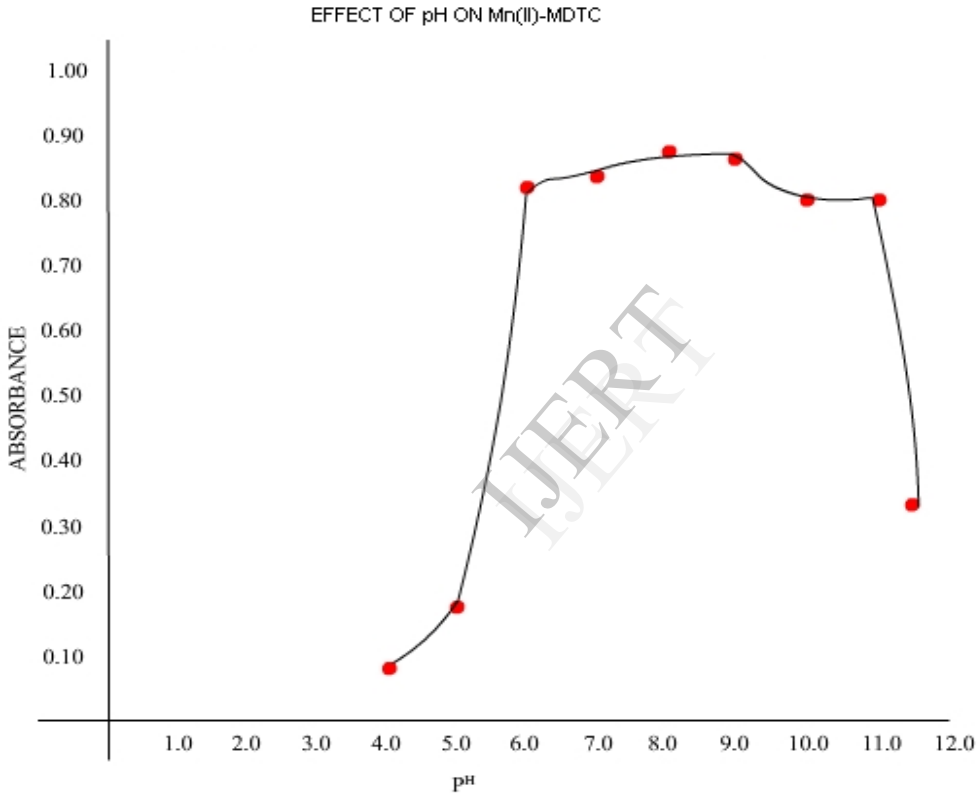
"3. Results and discussion"

For developing the quantitative experimental conditions various factors effecting the extraction are studied.

1. Effect of pH
2. Effect of sodium acetate
3. Effect of magnesium sulphate
4. Effect of reagent
5. Solvent effect
6. Applicability of Beer's law

Effect of p^H:-

Keeping metal ion concentration constant at 4.8 ppm, sodium acetate of 0.2M, 5ml of 0.2M salting out agent (magnesium sulphate) and 1ml of 10^{-4}M reagent (MDTC), pH of the solution is varied from 6.0 to 11.5 taking extracted complex in chloroform. The absorbance values at 510nm indicated that pH of 8.0 gives maximum absorbance which is chosen for all other studies.



"Figure 1.EFFECT of pH on Mn (II)-MDTC"

Effect of Sodium acetate concentration:

Varying the concentrations of sodium acetate from 0.1 to 0.5M keeping the metal ion, reagent and magnesium sulphate as above and the complex is extracted into chloroform at pH 8.0 in three installments (5+3+2) and the absorbance values are recorded at 510nm. The concentration of sodium acetate has no much effect as shown below and 0.2M is chosen for the quantitative studies.

"Table 1. Effect of sodium acetate"

Concentration of Mn (II)	-	1ml of 10^{-4}M
Concentration of Na (MDTC)	-	1ml of 10^{-4}M
Magnesium sulphate	-	0.2 M
p^H	-	8.0

Concentration of Sodium acetate, M	**Absorbance**
0.1	0.881
0.2	0.886
0.3	0.878
0.4	0.883
0.5	0.881

Effect of Magnesium Sulphate:

Salting out agent effect has been studied keeping pH, sodium acetate and metal ion constant as indicated in above effects and varying its concentration from 0.2 to 1.0 M and absorbance measurements are recorded at 510nm after extracting into chloroform. There is no much effect of all concentrations studied and therefore 0.2M is maintained in all studies.

Effect of reagent, Na (MDTC) concentration:

Different concentrations of reagent, Na (MDTC) solution are taken into a separating funnel, Mn (II), sodium acetate buffer and salting out agent are added and after extraction with chloroform, absorbance values are recorded and found that 1.0ml of 10^{-4} M is sufficient for complete precipitation.

"Table 2. Effect of Na (MDTC)"

Concentration of Mn (II)	-	1ml of 10^{-4}M
Concentration of Na (MDTC)	-	1ml of 10^{-4}M
Sodium acetate	-	0.2M
Magnesium sulphate	-	0.2 M
p^H	-	8.0

Reagent(ml)	**Absorbance**
1.0	0.789
1.5	0.739
2.0	0.738
2.5	0.710
3.0	0.709
3.5	0.695
4.0	0.667

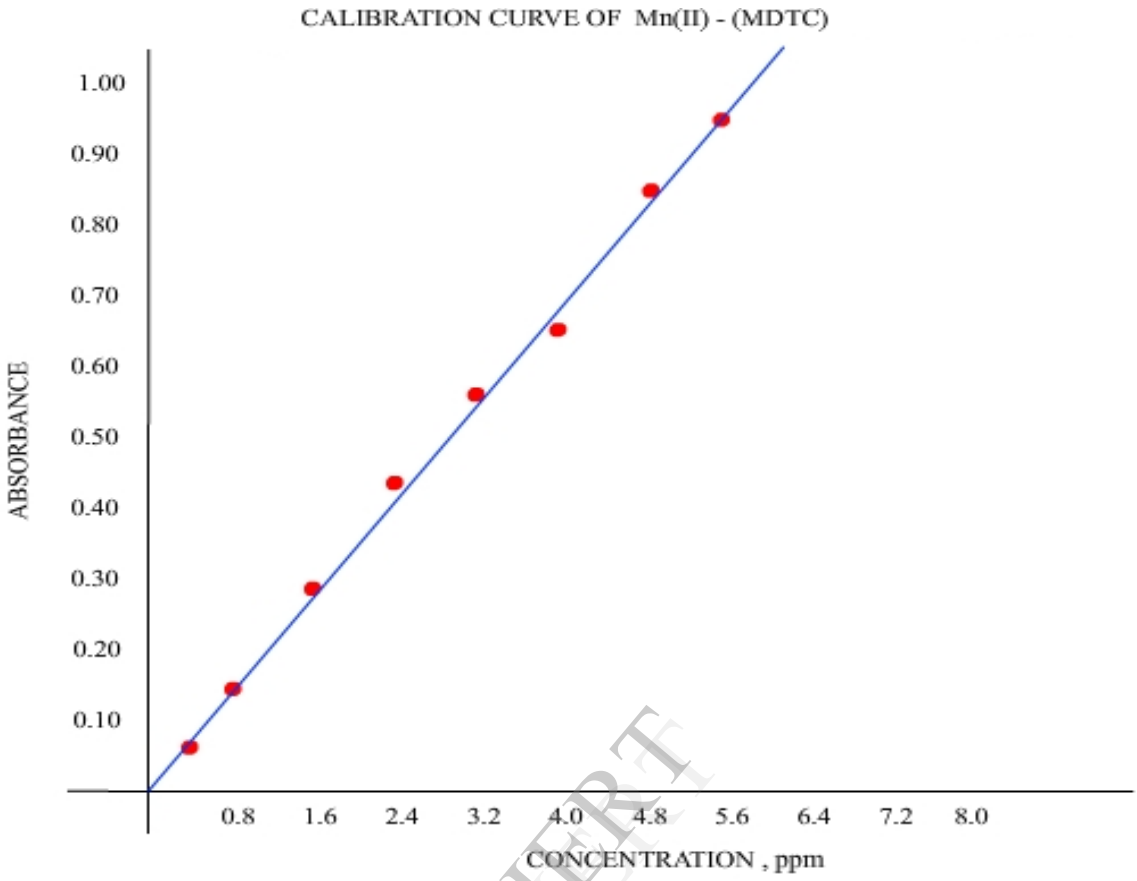
Solvent Effect:

Various solvents like n-butanol, isoamyl alcohol, MIBK, chloroform, 1; 4-dioxan, carbon tetra chloride, nitrobenzene, benzene, hexane and methyl ethyl ketone are tried at p^H 8.0. Among the solvents used chloroform is found to be effective in extracting the complex quantitatively.

The complex is appreciably stable in this solvent at pH 8.0 as there is no change in the absorbance even after keeping it for 24 hours.

Applicability of Beer's law:

Quantitative experimental conditions obtained in affects studied above are kept constant and using chloroform as extractant, metal ion concentration is varied from 0.4 to 6.4 ppm and the Beer's applicability graph is drawn. The absorbance values are taken at 510 nm. Manganese (II) in ppm is plotted against the absorbance, and the graph is given below.



"Figure 2.CALIBRATION curve of Mn (II) – MDTC"

"4. Estimation of Manganese in Soil samples and Plant materials"

The quantitative conditions developed are applied for the estimation of manganese in soil samples and plant materials.

a) Soil samples:-

About 2 gms of soil, collected from Agricultural college farms, Bapatla, Andhra Pradesh, India, is dried, digested

by wet digestion method[18] and brought into solution.

b) Plant Material:-

1 gm of oscimum sanctum leaves is dried and digested by dry ash method[19] and brought into solution.

Aliquots of the above solutions and a known amount of Mn (II) are taken and analyzed using conditions developed. The amounts of Mn (II) in the total quantity of samples taken are calculated and are given in the table below.

"Table 3."

Estimation of Mn (II) in soil sample and in osmium sanctum leaves:

Sodium acetate	-	0.2 M
MDTC	-	1ml of 10^{-4}M
Magnesium sulphate	-	0.2 M
p^H	-	8.0

	Mn (II) in the sample, ppm	
Sample	**Soil**	**Leaves**
	MDTC Method	MDTC Method
1	15.820	9.64
2	15.830	9.64
3	15.820	9.62
4	15.830	9.62
5	15.820	9.63

"5. Conclusions"

The amount of Mn (II) found is within the tolerance limits.

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