

# Recovery of Copper from Copper ores by roasting at different temperatures

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**ABSTRACT**— The study developed new, novel, and cheaper materials as micronutrients for plants. These studies showed that some copper ore can be utilized as a cheaper source of copper micronutrients. This method would be economically feasible for agriculture. The study has shown that roasting increased the recovery of copper from different ores differently. As the roasting time and temperature increase, the leaching of copper will also increase. The leaching of copper maximum in a sample was in the order of leaching of copper in three ores is as Sample C>sample D>Waziristan chalcopyrite. The experiments showed that the untreated raw oxidized copper ore show significant leaching which is 9.5% for saline and 35.5% for fertile soils respectively. This is an important finding which showed that oxidized copper ores can directly be used as slow-release micronutrients. A cheap process based on grinding to 200 mesh would be feasible. It is further seen that roasting at 750°C is suitable for treating sulfide ores. The acidification has shown much improvement in leaching and providing micronutrients to the soil.

**Index Terms**— Acidification, Fertilizers, Grinding, leaching, Micronutrients, Ores, Roasting

## 1. INTRODUCTION

Copper containing fertilizer is required for agriculture in Pakistan and the production of micronutrients are necessary for the country. Copper (Cu) insufficiency influences the metabolic procedures of plants, particularly photosynthesis and respiration. It can prompt depletion in soil practically and increase sterility. [1]

Copper ores, containing both a combination of sulfide minerals

(chalcopyrite) and those containing malachite azurite minerals, were studied for the preparation of micro-nutrients of copper by leaching and roasting. [2] The study of copper as a micronutrient produced from copper powder and copper ores needs investigations. The concentration of metals available to the soil has not been completely studied and needs research work. [3]

Among the notable coinage metals copper has been one of the noteworthy and most valuable metals. Physically the shade of copper metal is reddish and gives a splendid metallic brilliance at first glance. It is delicate, flexible, malleable, and effortlessly workable and can be effectively thrown or formed in any shape besides it is a fantastic conveyor of warmth and power. [4]

It was found that when copper is blended with different metals the subsequent composites are harder than the copper itself. [5]. Around 10-15% of this mineral is oxidized at the surface delivering malachite and azurite.  $Cu_2S$  is created when minerals are roasted to change overall sulfides into oxides. [6]

In spite of the fact that copper is a component that is required in littler amounts and is utilized as a micronutrient for plant and living life form however it can't be overlooked in light of the way that it is important for survival. [7]

Copper is the most important factor in plant progression. Chlorophyll is the basis of photosynthesis, giving the plant light to the intake of energy. In addition, copper is essential for plant respiration to help plants assimilate sugars and proteins. [8].

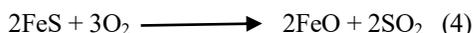
Due to copper deficiency in soils, there are side effects that have a tendency to happen in sporadic patches. Copper insufficiency is frequently connected with the illness of stem or head melanosis and an expanded occurrence of ergot. [9].

The most insignificant obsession is related to normal or peat soils. The availability of Cu is related to soil pH. With the extension of soil pH, the openness of this supplement is reduced. The deficiency of copper predominantly happens on natural soil and on sandy soils that are low in the natural issues. An increment in soil pH may likewise lessen copper poisonous quality, despite the fact that it can influence the deficiency of different supplements too. [10].

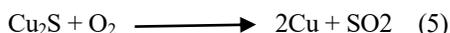
Copper sulfide mineral chiefly exists as Chalcopyrite (Copper Iron Sulfide), Chalcocite (Copper Sulfide), Tetrahedrite ((Cu, Fe, Sb, Sulfide), Tennantite,  $Cu_{12}As_4S_{13}$ , Bournonite,  $CuPbSbS_3$ . The minerals of copper other than sulfide metal incorporate after Cuprite,  $Cu_2O$ , Tenorite,  $CuO$ , Malachite,  $Cu[CO_3](OH)_n$ , Azurite,  $Cux[CO_3](OH)_n$ . [11].



At higher temperatures the reactions are



After the material is settled the copper metal is moved to another heater and air is blown in the heater to the subsequent item is copper metal.



After that oxygen is evacuated with the assistance of the presentation of methane. This procedure is known as flame refining. To get a more immaculate type of copper it is subjected to electrorefining. [12].

The objective of this paper is to study the direct use of copper powder and ground copper ores in soils, the effect of pH on leaching of copper as slow-release micronutrient (fertilizer), Copper powder utilization as micronutrient by different chemical treatment as a micronutrient, To prepare a fertilizer which will be readily dissolved in water and readily available to plant, To increase the growth rate of plants by providing micronutrients to the plants.

## 2. MATERIALS, METHODS AND EXPERIMENTAL WORK

### 2.1 Chemicals

Sulfuric Acid ( $H_2SO_4$ ), Nitric Acid ( $HNO_3$ ), Potassium Iodide (KI), Ammonium Hydroxide ( $NH_4OH$ ), Acetic Acid ( $CH_3COOH$ ), Perchloric Acid ( $HClO_4$ ), and Starch solution. All are E-MERK A.R. grade.

#### 2.1.1 Apparatus

The following apparatus used for both experimental techniques

which consist of roasting, leaching, and analysis.

- Sample bottles 100 ml (Pyrex)
- Graduated cylinder 25 ml, 50 ml (Soda glass)
- Beakers 250 ml (Pyrex)
- Conical flask 250 ml (Pyrex)
- Measuring pipette 2 ml, 5 ml, 1 ml (Boro Silicate)
- Whatman filter paper No. 41
- Measuring flask 10 ml (Pyrex)
- Burette 50 ml (Boro silicate)

#### 2.1.2 Equipments

- Electronic Balance
- Electric Furnace, (Muffle Gallenkamp UK 1200°C)
- Atomic Absorption Spectrophotometer (Z-8000) Hitachi Japan.
- DC supply with Voltage and Ampere for electro chemistry
- UV visible Spectrophotometer, Hitachi

## 2.2 Sample Collection

Soil samples were collected from the Pattoki region which lies at  $31^{\circ}1'0N$ ,  $73^{\circ}50'60E$ . Most of the surface is embedded by the water in the channel, which the underground water is salt water, which is not suitable for agriculture. The clay comes from salty soils near the graveyard in Pattoki. pH saline soil is alkaline during fertile soil pH is acidic. Samples taken are copper ores of Dalbandin, Baluchistan, and Waziristan in KPK.

### 2.2.1 Preparation of copper sulfate

Copper sulfate salt is taken from the Minhaj University Lahore research laboratory. It is an extra pure salt with 99.9 percent purity. Different concentrations of solutions were prepared after dilution from it.

### 2.2.2. Preparation of copper powder

The copper powder was produced electrometallurgical in the Laboratory. A DC supply with Voltage and Ampere setting for electro chemistry was used for this purpose. Copper electrode and acidified copper sulfate were taken as electrolytes. Rapid deposition of powder took place by using a high voltage of 0.5 and at 8 to 10 amperes. The copper powder was filtered and washed with distilled water and dried in an oven.

### 2.2.3. Use of copper metal

Copper metal is taken from the market. The scrap copper wire is in the form of small pieces. The copper wire is cleaned by burning and treatment with dil. HCl to remove surface contaminations. The copper wire is then cut into small pieces.

## 2.3. Experimental

### Ore Sample Preparation

The representative samples of copper ore were selected from different areas of Pakistan. These ores belong to the following types:

- a. Copper sulfide (chalcopyrite concentrates) of Waziristan areas (sample C)
- b. Oxidized ore of copper from Dalbandin area in Baluchistan (sample D).
- c. Mixed copper ore samples.

The samples were received from Prof. Dr. Izhar-ul-Haque Khan, who worked in these areas on geochemistry, petrology, and extractive metallurgy.

### Crushing and Grinding

Coarse Crushing and grinding were conducted to prepare samples of up to two inches size by a jaw crusher in PCSIR Laboratories. Then the material was subjected to a roll crusher for further size reduction up to half-inch size. After that disc grinding of the sample was done. One-half of each sample was subjected for pulverization by Teema mills, by which ore was grouped up to 300 mesh sizes. Samples were prepared by crushing and grinding in PCSIR Laboratories. By using a roll mill the crushed ore material was ground to ¼ inch size. The quartered material was passed through a disc grinder. Half of the material that was passed through the disc grinder was retained and another half of the material was passed through different sieves sizes of 60, 100, 150, 200, and 250 meshes.

### Solution Preparation

#### Stock Copper Sulphate Solution

Take 1g of copper sulfate  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  is weighed and transferred it to a 500ml volumetric flask. Take 2ml of this stock solution in 100ml flask and make it up to the marked it with water and store it for further use. Sulfuric acid 10 % concentration was used for the dissolution of oxidized copper ore as this was a good leaching agent for the recovery of copper metal.

#### Leaching Reagent

Sulfuric acid was used for the dissolution of copper ore as this was a good leaching agent for the recovery of copper metal.

#### Atomic Absorption Spectrometry

Atomic Absorption Spectrometry was used for the analyses of samples which were not determined chemically by a conventional method.

### Iodometric Titration

Iodometric titrations are used for the determination of reducing agents like Thiosulphate or Sulphites. For the estimation of copper ion excess of KI is added which liberates the iodine corresponding to the amount of copper, which is back titrated with sodium thiosulphate.

### 2.4 Roasting and leaching Experiments on chalcopyrite ore of Waziristan (Sample C)

About one gram ore sample was weighed passed twice 300 mesh size was taken in a china crucible. The covered crucible was placed in a muffle furnace for roasting at different temperatures ranging from 550 to 750 degrees C. The roasting time was varied from 30 to 150 minutes. The copper ore sample marked as sample C (Waziristan Chalcopyrite sulfide ore) was heated at different temperatures and times. After heating the sample the crucible was placed in a desiccator for cooling. The roasted material was then ground for leaching studies. The same procedure was repeated for

350, 450, 550, 650, and 750 degrees centigrade. The weighed roasted material was leached with 2.5 percent sulfuric acid by using a 1:5 solid-liquid ratio. The sample solution was transferred to a 100-milliliter volumetric flask to make the volume up to the mark.

The 5ml of each of the solutions was taken and analyzed by iodometric titration. Ammonium hydroxide solution was added till the blue color appeared. Then acetic acid was added till light blue color appeared or the smell of ammonium vanished. KI was added and the flask kept under dark for 10 minutes till red-brown color appeared. The solution was titrated against 0.001 M sodium thiosulphate. Then 2 or 3 drops of the starch solution were added. A blue-black color appeared and titrated against 0.01M sodium thiosulphate. The endpoint was colorless.

The same procedure was repeated for standard copper solution for the calculation of the percentage of copper (sample C). The following formula was used to calculate the percentage of copper leached.

### 2.5 Roasting and leaching Experiments on mixed ore of Dalbaldin (Sample D)

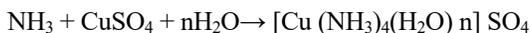
About one gram ore sample was weighed twice passing 300 mesh size was taken in a china crucible. The covered crucible was placed in a muffle furnace for roasting at different temperatures ranging from 550 to 750°C. The roasting time was varied from 30 to 150 minutes. The copper ore sample marked as sample D was heated at different temperatures and times. After heating the sample the crucible was placed in a desiccator for cooling. The roasted material was then ground for leaching studies. The same procedure was repeated for 350, 450, 550, 650, and 750°C. The weighed roasted material was leached with 2.5 percent sulfuric acid by using a 1:5 solid-liquid ratio. The sample solution was transferred to a 100-milliliter volumetric flask to make the volume up to the mark.

The 5ml of each of the solutions was taken and analyzed by iodometric titration. Ammonium hydroxide solution was added till the blue color appeared. Then acetic acid was added till light blue color appeared or the smell of ammonium vanished. KI was added and the flask kept under dark for 10 minutes till red-brown color appeared. The solution was titrated against 0.001 M sodium thiosulphate. Then 2 or 3 drops of the starch solution were added. A blue-black color appeared and titrated against 0.01 M sodium thiosulphate. The endpoint was colorless.

The same procedure was repeated for standard copper solution for the calculation of the percentage of copper (sample D). The following formula was used to calculate the percentage of copper leached.

### 2.6 Experiments of leaching of copper sulphate in Saline Soil

50 gram of fertile soil was taken in a 250 ml beaker and 2 gram of copper sulfate was added and mixed with stirrer and mixture was again mixed with the addition of 50 ml distilled water. The mixture was kept for different periods of time in a closed vessel. The mixture was filtered after 4 weeks and the filtrate was made up to a mark off 100 ml flask and leaching of copper was estimated. It was estimated first by adding an excess of ammonium hydroxide and measuring the ammonium.



Copper leached was evaluated by spectrophotometer. This gives the amount of copper that was leached during this period.

### 2.7 Experiments of leaching of copper sulphate in Saline Soil at elevated temperature

50 grams of fertile soil were taken in a 250 ml beaker and 2 gram of copper sulfate was added and mixed with stirrer and the mixture was mixed with the addition of 50 ml distilled water. The mixture was heated at 100 degrees C for half an hour. Then Mixture was kept for different periods of time in a closed vessel. The mixture was filtered after 4 weeks and the filtrate was up to mark 100ml in a flask and leaching of copper evaluated by atomic absorption and UV-visible spectrophotometer. This gives the amount of copper that was leached during this period.

### 2.8 Experiments of leaching of copper sulphate in Fertile Soil

50 grams of fertile soil were taken in a 250 ml beaker and 2 gram of copper sulfate was added and mix with stirrer and the mixture was mixed with the addition of 50 ml distilled water and 1ml of concentrated sulfuric acid. The Mixture was heated for half an hour. Then Mixture was kept for different periods of time in a closed vessel. The Mixture was filtered after 4 weeks and the filtrate was made up to mark of 100 ml in a flask and leaching of copper evaluated by atomic absorption and UV-visible spectrophotometer. This gives the amount of copper that was leached during this period.

#### Typical Experimental Details

50 gram of saline soil or fertile soils were taken in a 250 ml beaker and 1gram of one of the reagents (CuSO<sub>4</sub> salt, Dalbandin Ore Ox, Dalbandin Ore D, Roasted Sample D, Roasted Sample C, Waziristan Sample C, Copper powder, Copper metal) was added and mixed with stirrer and mixture was further mixed with the addition of 50ml distilled water. Then the mixture was kept for different periods of time in a closed vessel. The mixture was filtered after 4 weeks and the filtrate was up to mark 100ml in a flask and leaching of copper evaluated by atomic absorption spectrophotometer or UV visible spectrophotometer. This gives the amount of copper that was leached during this period.

The same sets of experiments were conducted at elevated temperatures under the same conditions. The mixture was heated for half an hour. Then Mixture was kept for different periods of time in a closed vessel. The mixture was filtered after 4 weeks and the filtrate was up to mark 100ml in a flask and leaching of copper evaluated by atomic absorption spectrophotometer. This gives the amount of copper that was leached during this period.

The same sets of experiments were conducted by acidifying the soil with sulphuric acid.at elevated temperature under the same conditions. 50 gram of saline soil was taken in a 250ml beaker and 1gram of copper sulfate was added and mix with a stirrer and mixture was mix with the addition of 50ml distilled water and 1ml of concentrated sulfuric acid. The mixture was heated for half an

hour. Then Mixture was kept for different periods of time in a closed vessel. The mixture was filtered after 4 weeks and the filtrate was up to mark 100ml in a flask and leaching of copper evaluated by atomic absorption spectrophotometer.

### Testing of slow release CuSO<sub>4</sub> products

Copper solutions of different concentrations were added to US bentonite and US bentonite is separated after different time periods (e.g. 2 hours, 4 hours, and 8 hours) and dried. 5 gram of this US bentonite is mixed with 150 gram of soil. The same amount of Copper solution was added to the soil without US bentonite, The mixture is washed and Copper tested after repeated washing.

It is seen that Copper is retained and slowly released due to US bentonite as compared to soil samples with no US bentonite. Further studies are required.

The results of the analysis are shown in the following tables and graphs:

TABLE 1: SHOWING THE AMOUNT OF COPPER TAKEN IN DIFFERENT BEAKERS WITH US BENTONITE AND CLAYS MIXTURES, AND ADSORPTION OF COPPER AFTER DIFFERENT TIMES OF TREATMENT

Beaker No.	mg. Copper	mg. left	2 hour	4 hour	8 hour
1	20	0	10	16	20
2	40	5	16	26	35
3	60	19	18	32	41
4	80	37	19	33	43
5	100	55	20	34	45
6	120	74	24	36	46

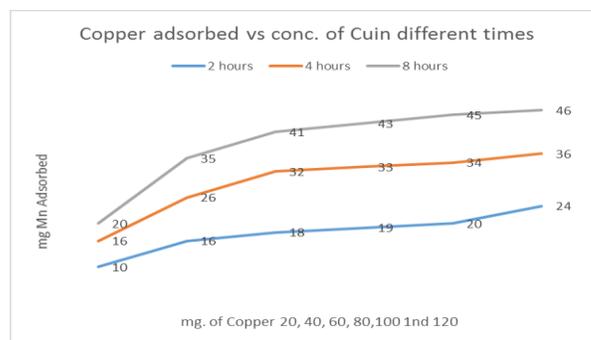


Figure 1: Graph showing amount of Copper taken in different beakers with US bentonite and clays mixtures, and adsorption of Copper after different times of treatment.

TABLE 2: SHOWING EFFECT OF ADSORPTION OF COPPER AFTER DIFFERENT TIMES OF TREATMENT

3	60	18	32	41
4	80	19	33	43
5	100	20	34	45
6	120	24	36	46

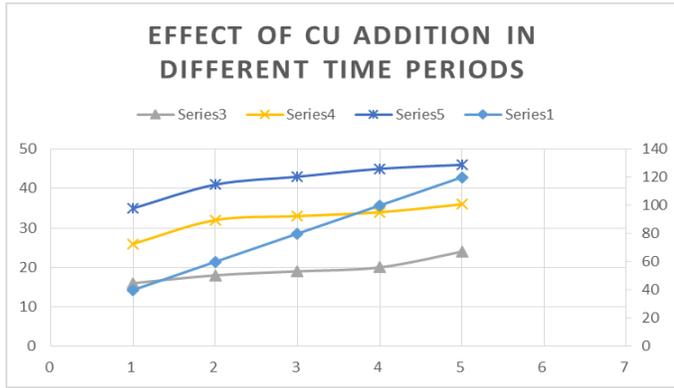


Figure.2: Graph showing effect of adsorption of Copper after different times of treatment in which series 1 is for conc. Of Copper Solution while Series 3, 4 and 5 is for adsorption of Copper

TABLE 3: SHOWING THE TREND OF AMOUNT OF COPPER TAKEN IN DIFFERENT BEAKERS VERSUS THE ADSORPTION OF COPPER AFTER 8 HOURS AS TIME OF TREATMENT

2	40	35
3	60	41
4	80	43
5	100	45
6	120	46

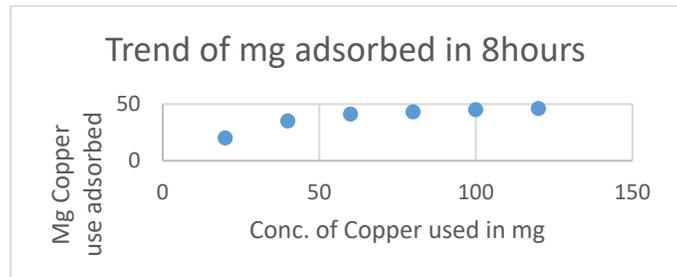


Figure 3: Graph showing the trend of amount of Copper taken in different beakers versus the adsorption of Copper after 8 hours as time of treatment.

TABLE 4: SHOWING ORIGINAL COPPER CONC., COPPER ADSORBED AND ADSORPTION IN DIFFERENT TIME PERIODS

mg. Copper	mg. left	2 hours	4 hours	8 hours
20	0	10	16	20
40	5	16	26	35
60	19	18	32	41
80	37	19	33	43
100	55	20	34	45
120	74	24	36	46

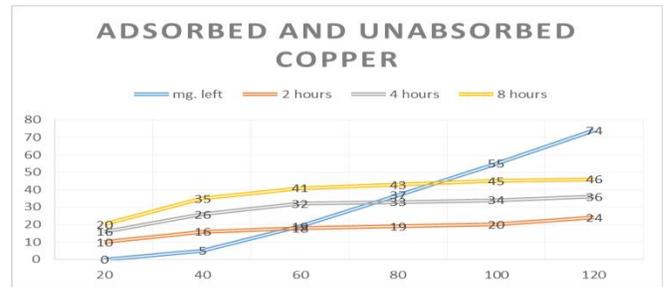


Figure 4: Graph showing relation between unabsorbed Copper and adsorption in different time periods.

TABLE 5: SHOWING XY PLOT RELATION OF DIFFERENT ADSORPTION TIMES

mg. copper	2 hours	4 hours	8 hours
20	10	16	20
40	16	26	35
60	18	32	41
80	19	33	43
100	20	34	45
120	24	36	46

TABLE 6: SHOWING ORIGINAL COPPER CONC., COPPER ADSORPTION IN DIFFERENT TIME PERIODS.

Beaker No.	mg. copper	mg ads 2h	mg ads 4h	mg ads 8h
1	20	10	16	20
2	40	16	26	35
3	60	18	32	41
4	80	19	33	43
5	100	20	34	45
6	120	24	36	46

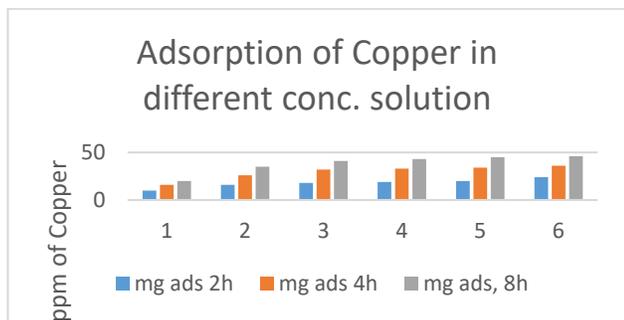


Figure 5: Bar diagram Models showing original Copper conc., Copper adsorption in different time periods.

### 3. RESULTS

#### 3.1 Results of Sample C (Leaching of copper after roasting)

TABLE 7: DETERMINATION OF THE PERCENTAGE OF COPPER IN COPPER ORE OF SAMPLE C BY ROASTING AT DIFFERENT TEMPERATURES

% Cu Leaching			
Minutes	350 oC	450 oC	750 oC
30	8	11	58
60	11	22	69
90	21	32	88
120	34	44	92
150	45	60	96

#### 3.2 Results of Sample D

TABLE 8: DETERMINATION OF THE PERCENTAGE OF COPPER IN COPPER ORE OF SAMPLE D BY ROASTING AT DIFFERENT TEMPERATURES

% Cu Leaching			
Minutes °C	350°C	450°C	750°C
30	5	8	55
60	7	16	67
90	15	27	85
120	25	35	90
150	30	55	95

TABLE 9: SUMMARY OF THE EXPERIMENTS UNDER ROOM TEMPERATURE

Sr. No.	Soil sample	Cu reagent added	Cu Leaching % age
1	saline soil sample 50 g	CuSO <sub>4</sub> salt 1g	98.1
2	saline soil sample 50 g	Dalbandin Ore Ox. 1 g	9.5
3	saline soil sample 50 g	Dalbandin Ore D. 1 g	4.5
4	saline soil sample 50 g	Roasted SampleD,1g	37.1
5	saline soil sample 50 g	Roasted SampleC,1g	21.6
6	saline soil sample 50 g	Waziristan SampleC,1g	0.5
7	saline soil sample 50 g	Copper powder, 1 g	0.1
8	saline soil sample 50 g	Copper metal, 1 g	0.1

TABLE 10: SUMMARY OF THE EXPERIMENTS AT HIGH TEMPERATURE 100 DEGREE C FOR 5 HOURS

Sr. No.	Soil sample	Cu reagent added	Cu Leaching % age
1	saline soil sample 50 g	CuSO <sub>4</sub> salt 1g	98.1
2	saline soil sample 50 g	Dalbandin Ore Ox. 1 g	9.5
3	saline soil sample 50 g	Dalbandin Ore D. 1 g	4.5
4	saline soil sample 50 g	Roasted SampleD,1g	37.1
5	saline soil sample 50 g	Roasted SampleC,1g	21.6
6	saline soil sample 50 g	Waziristan SampleC,1g	0.5
7	saline soil sample 50 g	Copper powder, 1 g	0.1
8	saline soil sample 50 g	Copper metal, 1 g	0.1

	sample 50 g	metal, 1 g	
1	fertile soil sample 50 g	Cu SO <sub>4</sub> Salt 1 gm	98.5
2	fertile soil sample 50 g	Dalbandin Ore Ox. 1 g	35.5
3	fertile soil sample 50 g	Dalbandin Ore D. 1 g	25.5
4	fertile soil sample 50 g	Roasted SampleD,1g	38.4
5	fertile soil sample 50 g	Roasted SampleC,1g	27.5
6	fertile soil sample 50 g	Waziristan SampleC,1g	1
7	fertile soil sample 50 g	Copper Powder, 1 g	0.1
8	fertile soil sample 50 g	Copper metal, 1 g	0.1

TABLE 11: SUMMARY OF THE EXPERIMENTS UNDER ROOM TEMPERATURE WITH 20 ML 10% H<sub>2</sub>SO<sub>4</sub>

Sr. No.	Soil sample	Cu reagent added	Cu Leaching % age
1	saline soil sample 50 g	CuSO <sub>4</sub> salt 1g	98.1
2	saline soil sample 50 g	Dalbandin Ore Ox. 1 g	17.2
3	saline soil sample 50 g	Dalbandin Ore D. 1 g	10.2
4	saline soil sample 50 g	Roasted SampleD,1g	55.5
5	saline soil sample 50 g	Roasted SampleC,1g	51.2
6	saline soil sample 50 g	Waziristan SampleC,1g	2.1
7	saline soil sample 50 g	Copper powder, 1 g	2.1
8	saline soil sample 50 g	Copper metal, 1 g	1.5
1	fertile soil sample 50 g	Cu SO <sub>4</sub> Salt 1 gm	98.5
2	fertile soil sample 50 g	Dalbandin Ore Ox. 1 g	45.5
3	fertile soil sample 50 g	Dalbandin Ore D. 1 g	35.5
4	fertile soil sample 50 g	Roasted SampleD,1g	55.1
5	fertile soil sample 50 g	Roasted SampleC,1g	33.2
6	fertile soil sample 50 g	Waziristan SampleC,1g	3.1
7	fertile soil	Copper	2.5

	sample 50 g	Powder, 1 g	
8	fertile soil sample 50 g	Copper metal, 1 g	1.2

#### 4. DISCUSSIONS

The study was undertaken to find new, novel, and cheaper materials as micronutrients for plants. The different ores of copper were studied to find their utilization as a cheaper source of copper micronutrients. It was envisaged that direct use of ore and metal powder should be investigated to see its leaching in different soils. This method would be economically feasible for agriculture.

Copper is extracted from its ore by various modifications of Pyrometallurgical and Hydrometallurgical processes. The roasting study was undertaken on the chemical treatment of copper-sulfide-ore and copper oxide-ore for its ultimate utilization. Roasting was done at different temperatures ranging from 350-750 C in the Muffle furnace. The roasting in the furnace was done without using any salt, oxidizing agent .the roasting time was varied between 30-150 minutes. Leaching of the roasted material was done at a very low concentration of Sulfuric acid.

The study has shown that roasting increased the recovery of copper from different ores differently. As the roasting time and temperature increase, the leaching of copper will also increase, However when the temperature reaches 750 C the percentage of leaching copper start decreasing. The leaching of copper maximum in the sample was in the order of leaching of copper in three ores is as Sample C>sample D>Waziristan chalcopyrite.

When we treated the mixture of soil samples and copper source it gives the low % age of copper leaching as compared to the mixture of soil samples and copper source by heating and treating with concentrated sulfuric acid. The leaching of copper maximum in Fertile soil as compared to the saline soil sample the order of leaching of copper is as copper salt >> copper roasted ore > copper oxidized >> copper powder > copper metal.

TABLE 12: THE PERCENTAGE OF COPPER LEACHED IN SALINE SOILS FROM DIFFERENT ORES

Saline Soils
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	sample 1	sample 2	sample 3
CuSO <sub>4</sub>	98.1	98.1	98.1
Dal Ore Ox.	9.5	9.5	17.2
Dal Ore	5.5	4.5	10.2
Roasted D	36	37.1	55.5
Roasted C	21.6	21.6	51.2
Waz C	0.5	0.5	2.1
Cu Powder	0.1	0.1	2.1
Cu Metal	0.1	0.1	1.5

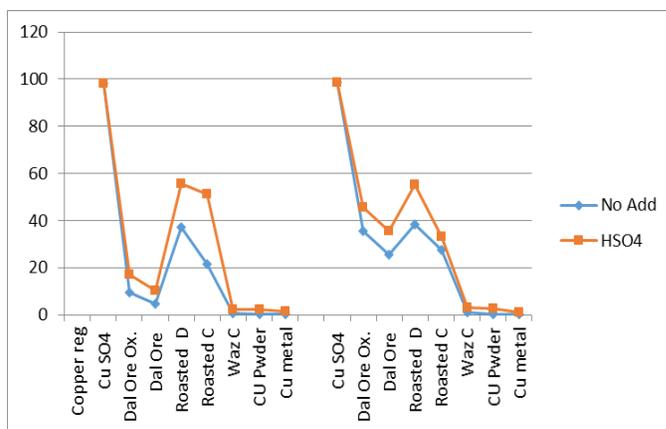


Figure 7: The graphs showing the percentage of copper leached in fertile soils from different ores

TABLE 13: THE PERCENTAGE OF COPPER LEACHED IN FERTILE SOILS FROM DIFFERENT ORES

Fertile Soil			
	sample 1	sample 2	sample 3
CuSO <sub>4</sub>	98.5	98.5	98.5
Dal Ore Ox.	35.5	35.5	45.5
Dal Ore	25.5	25.5	35.5
Roasted D	38.4	38.4	55.1
Roasted C	27.5	27.5	33.2
Waz C	1	1	3.1
Cu Powder	0.1	0.1	2.5
Cu Metal	0.1	0.1	1.2

### 5. CONCLUSION

Ores of copper from different places are studied. These ores can be utilized as micronutrients for plants. Different factors that depend upon the leaching of copper are also studied like roasting temperature and roasting time etc. If roasting temperature and time increase then the leaching of copper also increases. Copper leach must faster. Leaching of copper from copper ore of different samples is in order of Sample C>sample D>Waziristan chalcopyrite.

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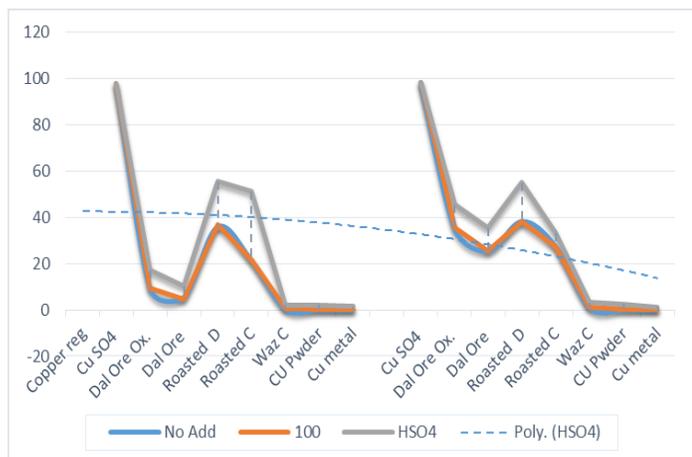


Figure 6: The graphs showing the percentage of copper leached in Saline soils from different ores

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