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Effect of temperature on the extraction of aluminum by *Thiobacillus ferrooxidans* from the bauxite ore

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ABSTRACT

The temperature is a critical environmental factor which determines the metabolic activities of the living organisms. A particular living organism has its own optimum temperature to survive. In the present investigation the effect of temperature on the extraction of aluminum from the bauxite ore by *Thiobacillus ferrooxidans* has been studied. The temperature 36°C was found to be optimum for the *Thiobacillus ferrooxidans* for extracting aluminum from bauxite ore.

Key words: *Thiobacillus ferrooxidans*, Bauxite ore, metals, temperature.

INTRODUCTION

Most of the microbes interact with metals. This property can be explored for metal extraction (Karavaiko, 1980). The metal extraction can be worked out from large quantities of low grade ores. Metal leaching begins with the circulation of water through large quantities of ores (Brierley and Brierley, 2001). The bacteria which are naturally associated with the rocks, cause the metal to be leached by either acting directly on the ore to extract the metal or the bacteria produces substances such as ferric iron and sulphuric acid which later on leached the metals (Chang *et al.,* 2008).

These mechanisms are dependent on the enzymatic set up of the bacterium (Bansal *et al.,* 2007). The enzymes carry out the metabolic reactions response to the environmental conditions (Almass *et al.,* 2005). Temperature is an environmental factor which keeps the body temperature at a particular level and determines the rate of metabolic reactions in the living organisms (Michael *et al.,* 1999). In the present investigation attempt has been made to find out the optimum temperature for the maximum metal extraction by *Thiobacillus ferrooxidans*.

MATERIAL AND METHODS

The metal bioleaching experiment was carried out in 250ml Erlenmeyer flasks containing 40ml 9K medium [composition g/l $(NH_4)_2SO_4$ – 3.0, $MgSO_47H_2O$ -0.5, K_2HPO_4 - 0.5, KCl- 0.1, Ca $(NO_3)_2$ -0.01, $FeSO_4.7H_2O$- 21.00] proposed by Silverman and Lundgren, (1959). The medium was autoclaved at 121 °C for 15 minutes to prevent interference of other micro organisms. The pH of the medium was adjusted to 2.0 with 10 N H_2SO_4. 60 ml of the inoculum (2×10^4 cells) was added. The pulp density of bauxite ore was 2%. The flasks were incubated at different temperature such as 4 °C, 10°C, 20°C, 24°C, 28°C, 32°C, 36°C, 40°C, 44°C, and 48°C, with constant shaking speed at 140rpm. The experiment was run for one month. At the end of the experiment final pH was measured. The content of the flasks were filtered. From the filtrate, the aluminum was estimated using spectrophotometric method proposed by Raquel *et al.* (2008) as follows. 20 µl leached samples from the filtrate was added with 20 µl H_2SO_4. The volume was made up to 3ml with double distilled water. 500 µl of 15 % sodium acetate was added to it for adjusting reaction pH. 200 µl of 0.1 % ascorbic acid was added to overcome the interference of iron.

Lastly 200 µl of chrome azurol-s (0.04 % working solution diluted from stock solution of 0.1 %) was added to it. The mixture was incubated for 10 minutes for violet colour development. The absorbance was measured at 545 nm wavelength. For standard curve aluminum potassium sulphate was used.

RESULTS AND DISCUSSION

Table 1 indicates that, out of the 10 different temperatures ranging from 4°C to 48°C. The aluminum extraction by *Thiobacillus ferrooxidans* from bauxite ore was found to be increased with the increase in temperature up to 36°C and then there was decline in the aluminum extraction onwards. The work of Bharathi et al. (2008) supports this results who has extracted 82 % nickel from copper flotation concentrate at 30°C, 32 °C and 40 °C. Hossain *et al*. (2004) also studied the effect of temperature on bioleaching of Zn (II) where they stated that optimum temperature is 35 ^{0}C for Zn extraction. Ollumbambi *et al.* (2008) found that the intensity of bacterial leaching for both Zn and sulphide minerals was dependent on the rate of supply and dissolution of O_2 and CO_2. The dissolution of O_2 and CO_2 decreased with increase in temperature. Hossain and Anantharaman (2005) during experiment noticed that the mesophiles grew better within the temperature range at 20 °C to 50 °C. Duarte et al. (2006) summarized that the temperature directly affect the micro organisms behaviour and it was observed the small variation (± 5°C) in the operating temperature could lead to significantly affected copper extraction rate. Chan and Ting (2005) also support the present findings.

Table 1: Effect of temperature on extraction of metals from bauxite ore by *Thiobacillus ferrooxidans*

Temperature	Bauxite ore (g) Initial wt	Final wt	Aluminum extracted(mg)	Percent extraction
4 °C	2	2.87	23.00±1.72	3.15
10°C	2	2.96	39.66±1.49	5.44
20°C	2	2.123	94.33±1.76	12.95
24°C	2	2.167	124.66±1.36	17.12
28°C	2	2.423	244.43±2.47	33.57
32°C	2	2.621	384.00±2.23	52.74
36°C	2	2.878	596.34±3.23	81.91
40°C	2	2.864	587.36±2.36	80.68
44°C	2	2.846	574.67±2.76	78.93
48°C	2	2.71	524.33±2.47	72.02
C.D. (p=0.05)			195.38	

CONCLUSION

From the results it is concluded that the optimum temperature for the aluminum extraction by *Thiobacillus ferrooxidans* was 36 °C which was 81.91 %.

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