

根酸とマイクロ波加熱を用いる 農地土壌からのセシウムの抽出

Extraction of Cesium from Agricultural Soil by the
Combination of Root Acid (Organic Acid)
and Microwave Heat Treatment

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INTRODUCTION

A magnitude 9.0 earthquake occurred on March 11, 2011 off the Pacific coast of the northeastern part of the Japanese main island (Tohoku Region). The earthquake was followed by a huge tsunami that hit the Pacific coast of the Tohoku district causing serious damage to the coastal area.

The earthquake and tsunami caused a meltdown at the Fukushima Daiichi nuclear power plant, resulting in the release of radioactive material that spread over a large area including Tohoku and Kanto districts and also part of Hokkaido.

PURPOSE

The purpose of this study was to establish a simple and inexpensive method for removing radioactive material from agriculture soil using a combination of root acid and microwave heat treatment.

What is root acid

Plants secrete organic acids and absorb elements that are needed for growth. These organic acids are called root acids and included Acetic acid, tartaric acid, malic acid, succinic acid, citric acid, succinic acid, fumaric acid, malonic acid, oxalic acid and glycolic acid. It is known that root acids are effective for dissolution of carbonate minerals in soil.

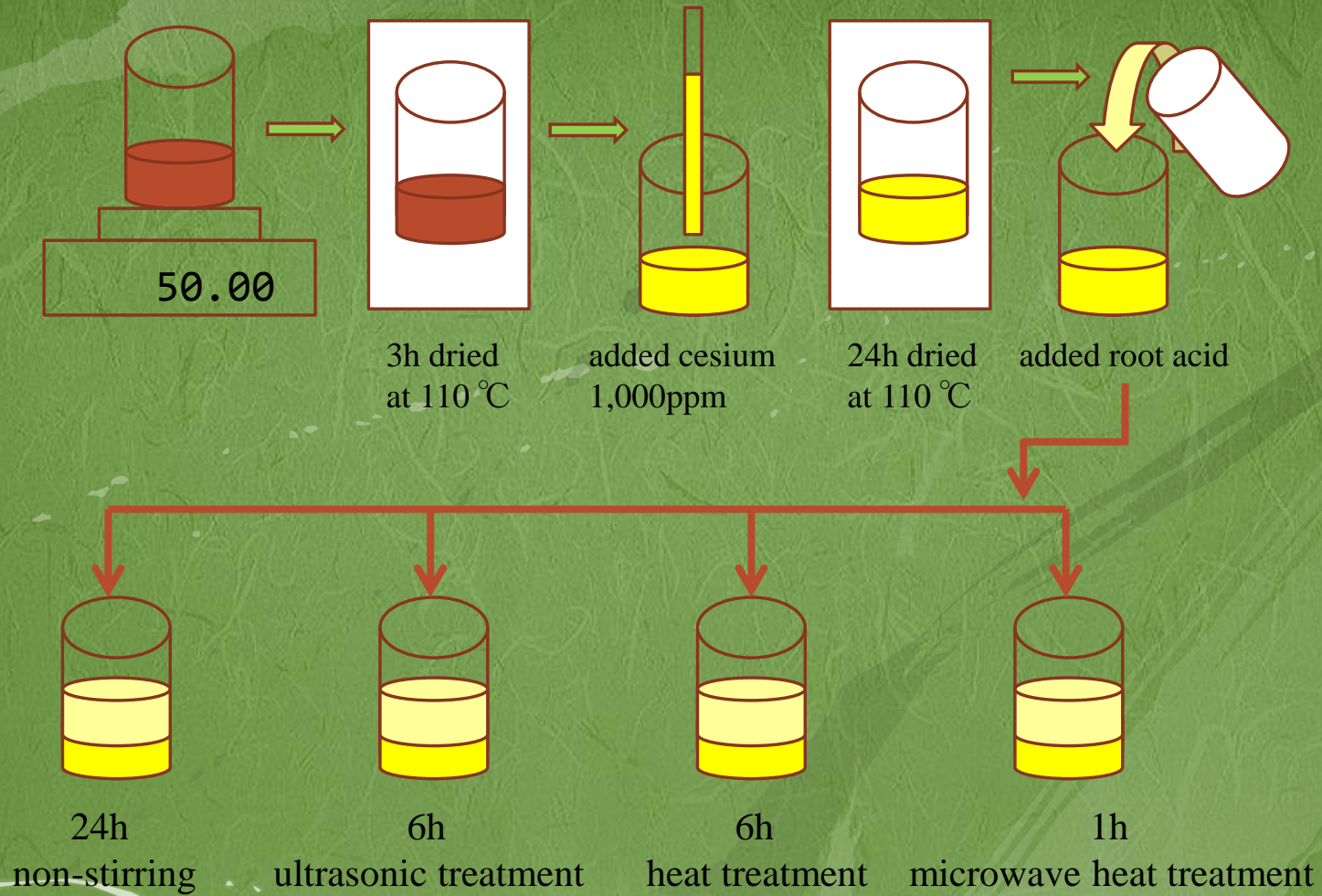
(酢酸、酒石酸、リンゴ酸、クエン酸、コハク酸、フマル酸、マロン酸、乳酸)

Merit

This method has a merit that plant cultivation is possible in the soil where cesium was extracted.

除染後作物の栽培が可能である。

EXPERIMENTAL



RESULTS AND DISCUSSION

Table 1 Cesium extraction efficiencies (%) from each soil and minerals

	Pure water	Acetic acid	Tartaric acid	Malic acid	Citric acid	Succinic acid ¹	Fumaric acid ²	Malonic acid	Lactic acid
	Extraction efficiency (%)								
Paddy soil	19.8	19.4	19.1	22.2	22.8	29.8	28.9	25.2	29.2
Black loam	18.5	27.8	58.0	50.5	46.7	52.7	41.6	48.0	53.9
Akadama soil	13.4	24.3	61.2	45.8	54.4	42.8	22.9	30.6	24.9
Kanuma soil	30.7	66.3	95.3	95.7	98.2	85.0	98.1	98.0	98.4
Vermiculite	27.3	40.0	36.8	40.4	52.0	41.6	39.8	45.0	51.7
Diatomaceous earth	71.3	64.0	67.6	83.8	85.2	55.9	57.6	93.7	98.7

¹Succinic acid 3%, ²Fumaric acid 0.3%

The extraction efficiency of citric acid solution was found to be the highest among the root acids.

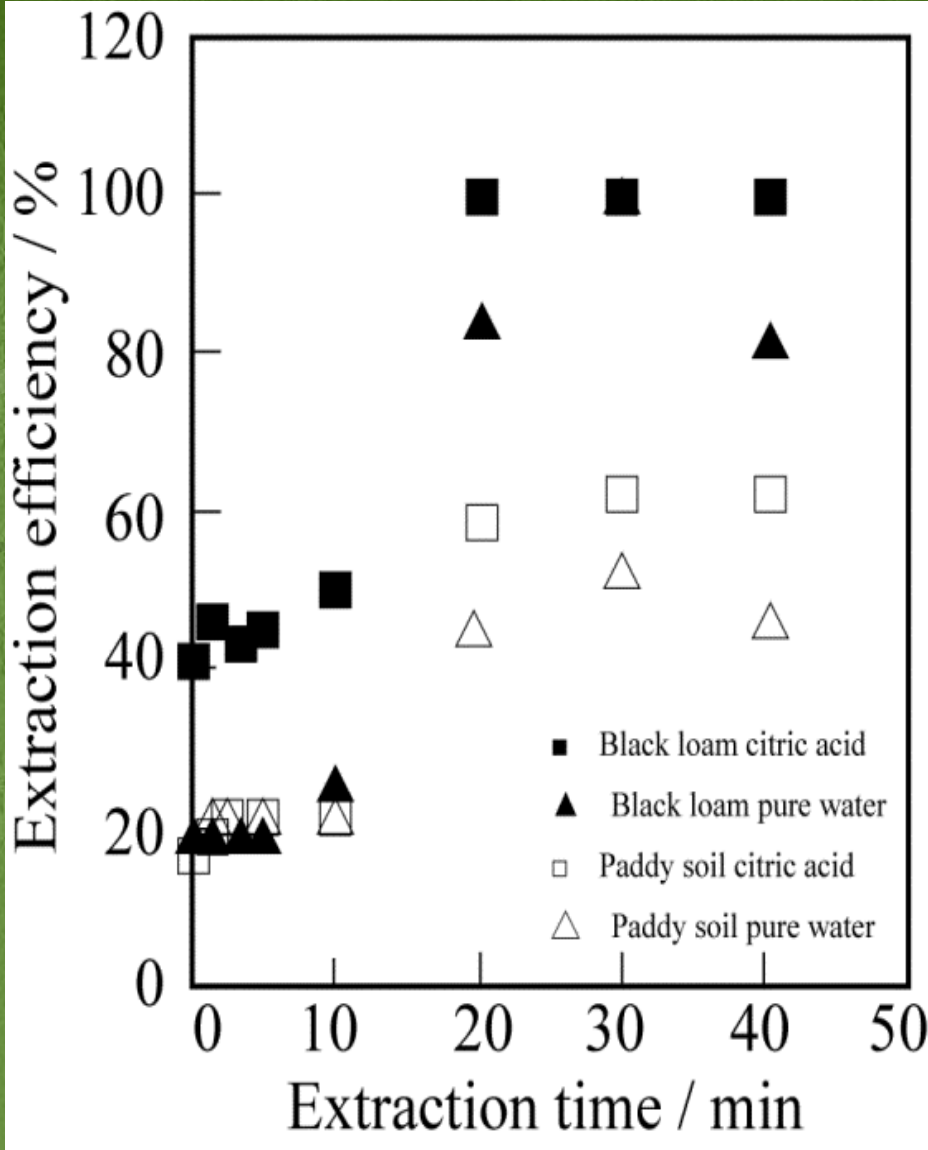
抽出効率の高さ、作業の簡便さ、低価格
であることからクエン酸を使用する。

Table 2 Extraction efficiencies (%) by using heat-treatment, ultrasonic treatment and the non-stirring

Time/h	water bath				ultrasonic treatment				Non-stirring			
	paddy soil		black loam		paddy soil		black loam		paddy soil		black loam	
	Pure water	Citric acid	Pure water	Citric acid	Pure water	Citric acid	Pure water	Citric acid	Pure water	Citric acid	Pure water	Citric acid
	Extraction efficiency (%)				Extraction efficiency (%)				Extraction efficiency (%)			
0	15.5	14.9	30.9	29.8	10.8	10.7	18.1	24.7	14.2	12.5	14.8	19.3
0.5	33.1	35.7	36.9	34.4	12.6	13.7	27.7	28.4	17.5	16.2	16.4	18.6
1	35.6	38.3	39.5	37.7	15.0	15.2	29.2	29.1	17.3	21.6	19.9	18.5
2	35.9	40.4	41.8	47.3	16.9	18.5	30.9	32.4	16.4	23.8	21.0	19.4
4	43.7	49.8	49.9	64.0	21.1	24.5	38.0	42.6	16.7	22.8	23.6	18.5
6	49.3	59.7	57.9	90.5	27.6	30.6	43.2	53.1	15.6	23.3	26.0	20.8
24	53.5	65.1	69.1	100	31.9	36.9	55.0	65.9	20.0	29.8	43.5	55.2

Extraction must be performed at a high temperature to achieve high extraction efficiency.

低コストで高温にする必要がある。



**Citric acid
Black loam, 100 % at 30
minutes.**

**Paddy soil, 62.8% at 30
minutes.**

Figure 1 Extraction efficiencies (%) from black loam and paddy soil using microwave heat treatment.

CONCLUSION

Extraction efficiencies of cesium from paddy soil and black loam are 63 % and 100 %, respectively. This method is effective for removing radioactive cesium from soil polluted with radioactive material.

Acknowledgement

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