

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
ABSTRACT (ENGLISH)	iv
ABSTRACT (THAI)	vi
TABLE OF CONTENTS	viii
LIST OF TABLES	xii
LIST OF FIGURES	xiii
ABBREVIATIONS AND SYMBOLS	xv
 CHAPTER 1 INTRODUCTION	
1.1 Fluoride in the environment	2
1.1.1 Fluoride in soil	2
1.1.2 Fluoride in water	2
1.1.3 Fluoride in air	2
1.2 Fluoride ingestion by man	3
1.2.1 Fluoride in solid food	3
1.2.2 Fluoride in drinks	4
1.2.3 Fluoride in pharmaceutical products for caries prevention	4
1.2.4 Fluoride intake from the air	5

1.3	Toxic effects of fluoride	5
1.3.1	Dental fluorosis	5
1.3.2	Skeleton fluorosis	6
1.3.3	Other effects	6
1.4	Methods for removing fluoride in drinking water	6
1.4.1	Precipitation	7
1.4.2	Ion exchange	8
1.4.3	Adsorption	8
1.4.4	Membrane techniques	9
1.5	Potentiometry	10
1.5.1	Principles of potentiometric measurements	10
1.5.2	The Nernst Equation	10
1.5.3	Electrodes of potentiometry	14
1.5.4	Reference Electrodes	14
1.5.5	Indicator Electrodes	15
1.5.5.1	Electrodes of the First Kind	15
1.5.5.2	Electrodes of the Second Kind	16
1.5.5.3	Ion-Selective Electrodes	16
1.6	Soil	19
1.6.1	Soil Forming Materials	20
1.6.1.1	Minerals	20
1.6.2	Factors influencing soil formation	22

1.6.3	Soil texture	22
1.6.4	Textural classification	23
1.7	Literature reviews	24
CHAPTER 2 EXPERIMENTAL		
2.1	Apparatus and chemicals	28
2.2	Preparation of the standard solutions and reagents	29
2.2.1	Stock standard fluoride solution, 1000 mg/l	29
2.2.2	Standard fluoride solutions, 0.5, 1.0, 2.0, 4, 6, 8, 10, 50 and 100 mg/l	29
2.2.3	Total ionic strength adjustment buffer; TISAB	30
2.2.4	Sodium hydroxide, 6 M	30
2.2.5	Hydrochloric acid, 1 M	30
2.2.6	Ammonium acetate, 1 M	30
2.2.7	Calcium chloride, 0.01 M	30
2.3	Experimental method	31
2.3.1	Soil Sample Preparation	31
2.3.2	Selection of the extractants	31
2.3.3	Optimization of extraction conditions	31
2.3.4	Sampling of the soil	32
2.3.5	Sampling Soil analyses	32

CHAPTER 3 RESULTS AND DISCUSSION

3.1	Preparation of a calibration graph	37
3.2	Selection of the extractants	39
3.3	Optimization of extraction conditions	40
3.4	Fluoride Distribution in Soil	43
3.4.1	Soil collected from Ban Luk	43
3.4.2	Soil collected from Ban Mae San Pa Daed	45
3.4.3	Soil collected from Ban San Makrut	47
3.4.4	Soil collected from Ban Phrachao Daeng	49
3.4.5	Soil collected from Ban Thi	51

CHAPTER 4 CONCLUSIONS

54

REFERENCES

55

CURRICULUM VITAE

58

LIST OF TABLES

Table		Page
2.1	The desired volume for diluting the stock standard fluoride solution to working standard fluoride solution	29
2.2	The description of the soil sampling sites	33
3.1	Logarithm of the concentrations and the voltage of standard and fluoride solutions	37
3.2	The fluoride content in soil sample for each layer of Ban Luk	44
3.3	The fluoride content in soil sample for each layer of Ban Mae San Pa daed	46
3.4	The fluoride content in soil sample for each layer of Ban San Makrut	48
3.5	The fluoride content in soil sample for each layer of Ban San Phrachao Daeng	50
3.6	The fluoride content in soil sample for each layer of Ban Thi	52

LIST OF FIGURES

Figure	Page
1.1 Various types of ion-selective electrodes: (a) internal reference electrode; (b) silver wire for direct contact to the membrane; (c) internal solution; (d) glass membrane; (e) solid-state membrane; (f) ion exchanger filled at the tip of capillary; (g) ion exchanger incorporated in PVC membrane.	18
1.2 The components of the soil	20
1.3 Soil types by clay, silt and sand composition	24
2.1 Soil sampling location of Ban Luk	34
2.2 Soil sampling location of Ban Mae San Pa Daed	34
2.3 Soil sampling location of Ban San Makrut	35
2.4 Soil sampling location of Ban San Phrachao Daeng	35
2.5 Soil sampling location of Ban Thi	36
3.1 Calibration graph of standard fluoride solutions	38
3.2 Percent recovery of fluoride using 4 different extractants ; deionized water, ammonium acetate ($\text{CH}_3\text{COONH}_4$), calcium chloride (CaCl_2) and hydrochloric acid (HCl).The extraction done by using 15 ml of the extractant volume for 60 minutes at room temperature	40

3.3	Percent recovery of fluoride from the extraction at the temperatures of 50, 60, 70, 80 and 90 °C. The extraction done by using 15 ml of the extractant volume for 60 minutes.	41
3.4	Percent recovery of fluoride from the extraction using the extractant volumes of 10,15, 20, 25 and 30 ml. The extraction done for 60 minutes at 80 °C .	42
3.5	Percent recovery of fluoride from the extraction by shaking for 30, 60, 90 and 120 min. The extraction done by using 15 ml of DI water at 80°C	42
3.6	Distribution of fluoride (mg/kg) at each soil depth according to soil sampling positions (orange band) of Ban Luk	45
3.7	Distribution of fluoride (mg/kg) at each soil depth according to soil sampling positions (orange band) of Ban Mae San Pa Daed	47
3.8	Distribution of fluoride (mg/kg) at each soil depth according to soil sampling positions (orange band) of Ban San Makrut	49
3.9	Distribution of fluoride (mg/kg) at each soil depth according to soil sampling positions (orange band) of Ban San Phrachao Daeng	51
3.10	Distribution of fluoride (mg/kg) at each soil depth according to soil sampling positions (orange band) of Ban Thi	53

ABBREVIATIONS AND SYMBOLS

°C	Degree Celsius
F ⁻	fluoride ion
h	hour
kg	kilogram
l	liter
M	molar
mg	milligram
min	minute
ml	milliliter
mV	millivolt
ppm	part per million
WHO	World Health Organization