

**POTENTIAL TOXICITY OF SELECTED NATIVE
VEGETABLES FROM SABAH AND THEIR HUMAN RISK
EXPOSURE**



YVONNE SIPAIN

UMMS
UNIVERSITI MALAYSIA SABAH

**FACULTY OF FOOD SCIENCE AND NUTRITION
UNIVERSITY MALAYSIA SABAH
2015**

**POTENTIAL TOXICITY OF SELECTED NATIVE
VEGETABLES FROM SABAH AND THEIR HUMAN RISK
EXPOSURE**

YVONNE SIPAIN



**THIS IS SUBMITTED IN PARTIAL FULFILLMENT FOR
THE DEGREE OF MASTER OF SCIENCE**

**FACULTY OF FOOD SCIENCE AND NUTRITION
UNIVERSITY MALAYSIA SABAH
2015**

PERPUSTAKAAN UNIVERSITI MALAYSIA SABAH



**BORANG PENGESAHAN STATUS
TESIS**

JUDUL: _____

IJAZAH: _____

SAYA: _____ **SESI PENGAJIAN:** _____
 (NAMA PENULIS DALAM HURUF BESAR)

Mengaku membenarkan tesis *(LPSM/Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Malaysia Sabah dengan syarat-syarat kegunaan seperti berikut:-

1. Tesis adalah hakmilik Universiti Malaysia Sabah.
2. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk tujuan pengajian, pembelajaran, penyelidikan dan pemeliharaan sahaja.
3. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat pendigitasian
5. Sila tandakan (/)

SULIT

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di AKTA RAHSIA RASMI 1972)

TERHAD

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana Penyelidikan dijalankan)

TIDAK TERHAD

Disahkan oleh:

 TANDATANGAN PENULIS

 (TANDATANGAN PUSTAKAWAN)

Alamat tetap:

 (NAMA PENYELIA)

Tarikh: _____

Tarikh: _____

Catatan :- *Potong yang tidak berkenaan.
 *Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT dan TERHAD.
 *Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana Secara penyelidikan atau disertai bagi pengajian secara kerja kursus dan Laporan Projek Sarjana Muda (LPSM)

DECLARATION

I hereby declare that the material in this thesis is my own except for quotations, excerpts, equations, summaries and references, which have been duly acknowledged.

01 June 2014

Yvonne Sipain
PN20118130



UMS
UNIVERSITI MALAYSIA SABAH

CERTIFICATION

NAME : **YVONNE SIPAIN**



MATRIC NO : **PN20118130**

TITLE : **SCREENINGS OF THE DUSUN ETHNIC NATIVE
VEGETABLES FOR THEIR POTENTIAL TOXICITY**

MASTERS : **MASTER OF SCIENCE (FOOD SCIENCE)**

VIVA DATE : **26 JANUARY 2015**

VERIFIED BY;

1. **SUPERVISOR**
Dr. Mohd Rosni Sulaiman
  Signature, _____
2. **CO-SUPERVISOR**
Associate Professor Dr Chye Fook Yee _____
3. **CO-SUPERVISOR**
Julius Kulip _____

ACKNOWLEDGEMENT

My deepest gratitude to Dr Mohd Rosni Sulaiman for his endless guidance, advices and support throughout the completion of this thesis. I would also like to thank Mr Julius Kulip for his great contribution in many ways in making the thesis a success. Special thanks also to Associate Professor Dr Chye Fook Yee for his guidance and advises. I would like to thank my mother Mdm Yanis Sompot and my husband Mr Hosana Christyon, all my family members, the primary and secondary informants, and all the villagers in the respective study areas for their time and cooperation during the research work. Last but not least to my fellow friends who have contributed in many ways in order to ensure the success of this research. Thank you.

Yvonne Sipain

June 2014



UMS
UNIVERSITI MALAYSIA SABAH

ABSTRACT

Native vegetables are still widely consumed by the people in North Borneo. However, some plants may contain plant toxicants which could lead to adverse health effects. This study was carried out to survey the native vegetables consumed by the Dusun ethnic group in Sabah and to their potentially toxicity. Determination of the potentially toxic native vegetables was done through interviews of plant informants. The potentially toxic native vegetables identified for this study were *Gigantochloa levis*, *Schizostachyum brachycladum*, *Schismatoglottis ahmadii*, *Colocasia esculenta*, *Colocasia gigantea*, *Schizostachyum blumei*, *Schismatoglottis motleyana*, and *Bambusa vulgaris*. Quantification of cyanogenic glycoside and oxalate were done by using picrate method of analysis and oxalate kit, respectively. Qualitative tests were conducted to detect the presence of glycoside and oxalate in the native vegetables samples. There were nine species of potentially toxic native vegetables from the Poaceae and Araceae family identified by the plant informants in Ranau, Tambunan and Kuala Penyu. The total hydrogen cyanide (HCN) content for raw samples of Poaceae and Araceae species ranged from 298 - 948 ppm and 14 - 175 ppm, respectively. A decrease in the total cyanide content was observed after the samples were boiled whereby the percentage of total cyanide content reduction in all samples ranged from 71.4 - 95.2%. For oxalate, the total oxalate content ranged from 19.65 - 64.06 mg/100g for raw samples which decreased to 2.33 - 5.40 mg/100g after boiling. Exposure assessment calculation showed that the exposure to cyanogenic glycoside and oxalate from native vegetables consumption among the Dusun ethnic in Ranau, Tambunan and Kuala Penyu are considered below the safe level. The highest exposure dose for cyanogenic glycoside calculated accounted only 15.23% from the ARfD among the male respondents and 18.60% from the ARfD among the female respondents. For oxalate exposure, the highest dose of exposure calculated for male respondents was 0.0270% from the reported fatal dose and 0.058% from the reported fatal dose among female respondents. In conclusion, all nine species of native vegetables in this study contain cyanogenic glycoside and oxalate. However, boiling the native vegetables before consumption may reduce the potential toxicity of the native vegetables and reduce the exposure to a safer level.

ABSTRAK

POTENSI KETOKSIKAN SAYUR-SAYURAN TEMPATAN TERPILIH DARI SABAH AND RISIKO PENDEDAHAN KEPADA MANUSIA

*Sayur-sayuran tempatan masih lagi menjadi sumber makanan bagi penduduk di Borneo Utara. Namun, sesetengah tumbuhan mungkin mengandungi bahan toksik yang boleh memberikan kesan kepada kesihatan. Kajian ini telah dijalankan untuk membuat survei tentang sayuran-sayuran tempatan yang diambil oleh kumpulan etnik Dusun di Sabah dan menentukan sayur-sayuran tempatan yang berpotensi menjadi toksik. Penentuan sayur-sayuran toksik telah dijalankan melalui temubual dengan pakar tumbuhan di setiap daerah kajian. Sayuran-sayuran tempatan yang berpotensi toksik yang diidentifikasi bagi kajian ini adalah *Gigantochloa levis*, *Schizostachyum brachycladum*, *Schismatoglottis ahmadii*, *Colocasia esculenta*, *Colocasia gigantea*, *Schizostachyum blumei*, *Schismatoglottis motleyana*, dan *Bambusa bulgaris*. Kuantifikasi sianogenik glikosida dan oksalat telah dijalankan menggunakan kaedah analisis pikrat dan kit oksalat. Pengukuran kualitatif telah dijalankan untuk menguji kehadiran glikosida dan oksalat dalam kesemua sampel sayur-sayuran tempatan. Terdapat sembilan spesies sayur-sayuran tempatan berpotensi toksik dari family Poaceae dan Araceae telah diidentifikasi oleh pemberi maklumat dari Ranau, Tambunan dan Kuala Penyu. Jumlah kandungan HCN untuk sampel mentah spesies Poaceae dan Araceae adalah masing-masing dalam julat 298 – 948 ppm dan 14 – 175 ppm. Penurunan dalam kandungan sianida dilihat setelah sampel dididihkan di mana julat penurunan adalah daripada 71.4 – 95.2%. Bagi oksalat, jumlah kandungan oksalat berada dalam julat 19.65 – 64.06 mg/100g bagi sample mentah dan menurun kepada 2.33 – 5.40 mg/100g selepas dididihkan. Pengukuran nilai dedahan menunjukkan bahawa tahap dedahan hydrogen sianida dan oksalat melalui pengambilan sayur-sayuran tempatan di kalangan etnik Dusun di Ranau, Tambunan dan Kuala Penyu adalah dibawah tahap selamat. Dos dedahan tertinggi bagi HCN yang dicatatkan hanya 15.23% daripada nilai ARfD bagi responden lelaki dan hanya 18.60% daripada ARfD di kalangan responden perempuan. Bagi dedahan oksalat, nilai dedahan tertinggi bagi responden lelaki adalah 0.0270% daripada dos kematian dan 0.058% daripada dos yang membawa kematian di kalangan responden wanita. Kesimpulannya, semua Sembilan sepsis sayur-sayuran tempatan dalam kajian ini mengandungi hydrogen sianida dan oksalat. Namun demikian, kaedah pemprosesan yang betul sebelum pengambilan mampu mengurangkan potensi ketoksikan oleh sayur-sayuran tempatan dan menurunkan pendedahan ke tahap yang selamat.*

TABLE OF CONTENTS

	Page
TITLE	i
DECLARATION	ii
CERTIFICATION	iii
ACKNOWLEDGEMENT	iv
ABSTRACT	v
<i>ABSTRAK</i>	vi
LIST OF CONTENTS	vii
LIST OF TABLES	xi
LIST OF FIGURES	xiv
LIST OF ABBREVIATIONS	xvi
LIST OF SYMBOLS	xvii
LIST OF APPENDICES	xviii
CHAPTER 1: INTRODUCTION	1
1.1 Native Vegetables and Their Importance	1
1.2 Safety of Native Vegetables	1
1.3 Problem Statement	2
1.4 Hypotheses	3
1.5 Importance of the Study	3
1.6 Objectives	3
CHAPTER 2: LITERATURE REVIEW	4
2.1 Dusun Ethnic Group of Sabah	4
2.2 Native Vegetables	5
2.2.1 Definition	5
2.2.2 World Consumption Scenario	5
2.2.3 Consumption Pattern in Malaysia	8

2.3 Plant Toxic Constituents	9
2.3.1 Cyanogenic Glycoside	10
2.3.2 Oxalate	12
2.3.3 Picrate Method Analysis	13
2.3.4 Oxalate Kit Method	13
2.4 Safety Issues of Native Vegetables	14
2.4.1 Human Exposure to Plant Toxic Constituents	16
2.4.2 Poisoning Cases Reported Related to Native Vegetables	17
2.5 Assessment of Intake from the Diet	20
2.5.1 Risk Assessment	20
2.5.2 Exposure Assessment	21
2.5.3 Food Intake Assessment	22
2.6 Current Trend of Research and Future Studies	23
CHAPTER 3: MATERIALS AND METHODS	26
3.1 Ethnic Groups, Location and Area of Study	26
3.2 Plant Informant Selection	27
3.3 Interview and Observations	27
3.4 Native Vegetables Samples Collection	28
3.5 Dietary Intake Measurement	31
3.5.1 Sampling	31
3.5.2 Food Frequency Questionnaire	31
3.6 Data Processing and Analysis	32
CHAPTER 4: SCREENING OF POTENTIALLY TOXIC NATIVE VEGETABLES FROM SABAH	33
4.1 Introduction	33
4.2 Materials and Methods	33
4.3 Results and Discussion	34
4.3.1 Plant Informants	34
4.3.2 Native Vegetables Sold at the Tamu (weekly market)	35
4.3.3 Potentially Toxic Native Vegetables	37

4.4 Conclusion	44
CHAPTER 5: LEVELS OF POTENTIALLY TOXIC CYANOGENIC GLYCOSIDE AND CALCIUM OXALATE IN SELECTED NATIVE VEGETABLES FROM SABAH	45
5.1 Introduction	45
5.2 Materials and Methods	46
5.2.1 Materials	46
a. Qualitative Test	46
b. Quantitative Test	46
i. Picrate Methods Analysis for total Cyanogen Content	46
ii. Oxalate Kit Method for Total Oxalate Content	46
5.2.2 Methods	47
a. Qualitative Test	47
i. Test for Glycoside Content	47
ii. Test for Oxalate Content	47
b. Quantitative Test	47
i. Picrate Reduction Method for Total Cyanogen Content	47
ii. Oxalate Kit Method for Total oxalate Content	50
5.3 Results and Discussion	52
5.3.1 The Presence of Glycoside and Oxalate	52
5.3.2 Total Cyanogen Content	54
5.3.3 Total Oxalate Content	59
5.4 Conclusion	62
CHAPTER 6: HUMAN EXPOSURE ASSESSMENT OF POTENTIALLY TOXIC CYANOGENIC GLYCOSIDE AND OXALATE FROM THE NATIVE VEGETABLES FROM SABAH	63
6.1 Introduction	63
6.2 Materials and Methods	63
6.2.1 Dietary Intake Measurement	63
6.2.2 Exposure Assessment Calculation	64

6.3 Results and Discussion	65
6.3.1 Sociodemographic Data	65
6.3.2 Dietary Consumption Pattern of Native Vegetables	67
6.3.3 Dietary Intake Measurement of Native Vegetables	75
6.3.4 Exposure Assessment of Cyanogenic Glycoside from Native Vegetables in Male Respondents	80
6.3.5 Exposure Assessment of Cyanogenic Glycoside from Native Vegetables in Female Respondents	86
6.3.6 Exposure Assessment of Oxalate from Native Vegetables in Male Respondents	91
6.3.7 Exposure Assessment of Oxalate from Native Vegetables in Female Respondents	96
6.4 Conclusion	102
CHAPTER 7: CONCLUSION AND RECOMMENDATION FOR FUTURE RESEARCH	103
7.1 Conclusion	103
7.2 Limitation of Study	104
7.3 Suggestion for Further Studies	104
REFERENCES	106
APPENDIX	123

LIST OF TABLES

	Page
Table 2.1: Some reported toxic compounds in edible plants	10
Table 2.2: Number of bamboo species found in respective countries	17
Table 2.3: Disorders related to cyanogenic plants consumption	19
Table 3.1: Descriptions of native vegetables samples collected	30
Table 4.1: List of plant informants in the respective location of study	35
Table 4.2: Native vegetables sold at weekly Tamu in Ranau, Tambunan, and Kuala Penyu districts, Sabah, Malaysia	36
Table 4.3: Potentially toxic wild native vegetables consumed by the Dusun ethnic in Ranau, Tambunan, and Kuala Penyu districts	38
Table 5.1: Native vegetables studied and their plant parts analyzed	48
Table 5.2: The presence of glycoside and oxalate	53
Table 5.3: Moisture content of the dried native vegetables samples	54
Table 5.4: Total cyanide content (mean \pm SD, ppm) in different plant parts of the bamboo shoots (Poaceae) family	55
Table 5.5: Total cyanide content (mean \pm SD, ppm) in different plant parts of the Araceae family	57
Table 5.6: Mean total cyanide content (mean \pm SD, ppm) of all samples before and after cooking	58
Table 5.7: Total oxalate content (mean \pm SD, g/100g) in different parts of <i>G. levis</i> in raw and cooked samples	59
Table 5.8: Mean total oxalate content (mean \pm SD, g/100g) in raw and cooked samples of wild native vegetables	60
Table 6.1: Age groups for exposure doses comparison	65
Table 6.2: Socio-demographic characteristics of respondents in all location	66
Table 6.3: Sources of native vegetables	70

Table 6.4:	Processing and preparation method of Poaceae species to reduce the toxicity	72
Table 6.5:	Processing and preparation method of Araceae species to reduce the toxicity reported by the respondents	72
Table 6.6:	Percentages of respondents who have experienced any sign and symptoms of toxicity prior to eating the selected native vegetables	74
Table 6.7:	Mean consumption data (g/day \pm SD) of native vegetables according to gender	78
Table 6.8:	Mean consumption data (g/day \pm SD) of native vegetables according to age groups in Ranau	77
Table 6.9:	Mean consumption data (g/day \pm SD) of native vegetables according to age groups in Tambunan	78
Table 6.10:	Mean consumption data (g/day \pm SD) of native vegetables according to age groups in Kuala Penyu	80
Table 6.11:	Dose of exposure (mg/kg/day) of cyanogenic glycoside in raw and cooked native vegetable samples among male respondents	81
Table 6.12:	Dose of exposure (mg/kg/day) of hydrogen cyanide among male respondents according to age groups in Ranau	83
Table 6.13:	Dose of exposure (mg/kg/day) of hydrogen cyanide among male respondents according to age groups in Tambunan	84
Table 6.14:	Dose of exposure (mg/kg/day) of hydrogen cyanide among male respondents according to age groups in Kuala Penyu	85
Table 6.15:	Dose of exposure (mg/kg/day) of cyanogenic glycoside in raw and cooked native vegetable samples among female respondents	86
Table 6.16:	Dose of exposure (mg/kg/day) of hydrogen cyanide among female respondents according to age groups in Ranau	88

Table 6.17:	Dose of exposure (mg/kg/day) of hydrogen cyanide among female respondents according to age groups in Tambunan	89
Table 6.18:	Dose of exposure (mg/kg/day) of hydrogen cyanide among female respondents according to age groups in Kuala Penyu	90
Table 6.19:	Dose of exposure (mg/kg/day) of oxalate in raw and cooked native vegetable samples among male respondents	92
Table 6.20:	Dose of exposure of oxalate (mg/kg/day) among male respondents according to age groups in Ranau	93
Table 6.21:	Dose of exposure (mg/kg/day) of oxalate among male respondents according to age groups in Tambunan	94
Table 6.22:	Dose of exposure (mg/kg/day) of oxalate among male respondents according to age groups in Kuala Penyu	95
Table 6.23:	Dose of exposure (mg/kg/day) of oxalate in raw and cooked native vegetable samples among female respondents	97
Table 6.24:	Dose of exposure (mg/kg/day) of oxalate among female respondents according to age groups in Ranau	98
Table 6.25:	Dose of exposure (mg/kg/day) of oxalate among female respondents according to age groups in Tambunan	99
Table 6.26:	Dose of exposure (mg/kg/day) of oxalate among female respondents according to age groups in Kuala Penyu	100

LIST OF FIGURES

	Page
Figure 3.1: Fresh samples were sampled with the aid of the plant informant	28
Figure 3.2: Samples were washed and kept inside plastic bags	29
Figure 3.3: Samples were kept with ice to preserve samples before being transported to the laboratory	29
Figure 4.1: Some vegetables sold at the <i>Tamu</i> (weekly market) in Ranau	37
Figure 4.2: Some vegetables sold at the <i>Tamu</i> (weekly market) in Tambunan	37
Figure 4.3: Some vegetables sold at the <i>Tamu</i> (weekly market) in Kuala Penyu	37
Figure 4.4: Young shoot of <i>poring</i> (<i>Gigantochloa levis</i>) from Ranau	39
Figure 4.5: Young shoots of <i>tulu</i> (<i>Schizostachyum brachycladum</i>) from Ranau	39
Figure 4.6: Stem and leaf of <i>dukaruk</i> (<i>Schismatoglottis ahmadii</i>) from Ranau	40
Figure 4.7: Tuber of <i>lolundu</i> (<i>Colocasia gigantea</i>) from Ranau	40
Figure 4.8: Young shoots of <i>poring</i> (<i>Gigantochloa levis</i>) from Tambunan	41
Figure 4.9: Young shoots of <i>wuluh</i> (<i>Schizostachyum brachycladum</i>) from Tambunan	41
Figure 4.10: Young shoots of <i>tombotuon</i> (<i>Schizostachyum blumei</i>) from Tambunan	42
Figure 4.11: Stem and leaf of <i>dungkalang</i> (<i>Schismatoglottis ahmadii</i>) from Tambunan	42
Figure 4.12: Stem and leaf of <i>dar</i> (<i>Colocasia esculenta</i>) from Tambunan	42
Figure 4.13: Young shoot of <i>poring</i> (C) (<i>Gigantochloa levis</i>) from Kuala Penyu	44

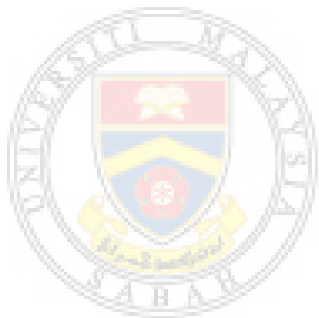
Figure 4.14:	Young shoot of <i>tamalang</i> (<i>Bambusa vulgaris</i>) from Kuala Penyu	45
Figure 5.1:	Young shoots of bamboo shoots were analysed on their different parts	48
Figure 5.2:	Tuber of <i>lolundu</i> (<i>Colocasia gigantean</i>) from Ranau	49
Figure 5.3:	Color changes of picrate papers in samples bottles	52
Figure 5.4:	Immersion of picrate papers in distilled water	50
Figure 5.5:	Samples with oxalate reagents to be measured	52
Figure 6.1:	Percentages of wild native vegetables consumer in Ranau	68
Figure 6.2:	Percentages of wild native vegetables consumer in Tambunan	68
Figure 6.3:	Percentages of wild native vegetables consumer in Kuala Penyu	69



UMS
UNIVERSITI MALAYSIA SABAH

LIST OF ABBREVIATIONS

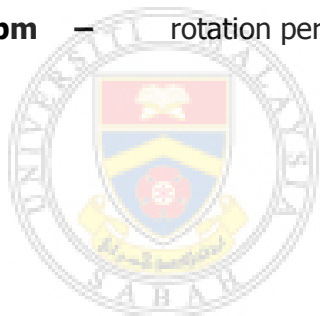
WHO	–	World Health Organization
FSANZ	–	Food Safety Australia and New Zealand
FAO	–	Food and Agriculture Organization
ATSDR	–	Agency for Toxic Substances and Disease Registry
ARfD	–	Acute Reference Dose



UMS
UNIVERSITI MALAYSIA SABAH

LIST OF SYMBOLS

mg	–	milligram
kg	–	kilogram
%	–	percent
HCN	–	hydrogen cyanide
HCL	–	hydrochloric acid
ppm	–	parts per million
Σ	–	sum of
μl	–	microlitre
°C	–	degree celcius
mL	–	milliliter
nm	–	nanometer
N	–	normality
rpm	–	rotation per minutes

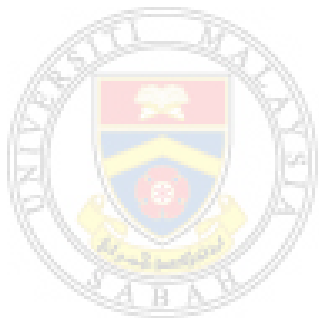


UMS
UNIVERSITI MALAYSIA SABAH

LIST OF APPENDICES

	Page
Appendix A: Exposure assessment of cyanogenic glycoside for male respondents	123
Appendix B: Exposure assessment of cyanogenic glycoside for male respondents according to age groups in Ranau	124
Appendix C: Exposure assessment of cyanogenic glycoside for male respondents according to age groups in Tambunan	125
Appendix D: Exposure assessment of cyanogenic glycoside for male respondents according to age groups in Kuala Penyu	126
Appendix E: Exposure assessment of cyanogenic glycoside for female respondents	127
Appendix F: Exposure assessment of cyanogenic glycoside for female respondents according to age groups in Ranau	128
Appendix G: Exposure assessment of cyanogenic glycoside for male respondents according to age groups in Tambunan	129
Appendix H: Exposure assessment of cyanogenic glycoside for male respondents according to age groups in Kuala Penyu	130
Appendix I: Exposure assessment of oxalate for male respondents	131
Appendix J: Exposure assessment of oxalate for male respondents according to age groups in Ranau	132
Appendix K: Exposure assessment of oxalate for male respondents according to age groups in Tambunan	133
Appendix L: Exposure assessment of oxalate for male respondents according to age groups in Kuala Penyu	134
Appendix M: Exposure assessment of oxalate for female respondents	135
Appendix N: Exposure assessment of oxalate for female respondents according to age groups in Ranau	136
Appendix O: Exposure assessment of oxalate for female respondents according to age groups in Tambunan	137

Appendix P:	Exposure assessment of oxalate for female respondents according to age groups in Kuala Penyu	138
Appendix Q:	Qualitative Results for Glycoside and Oxalate	140
Appendix R:	Food Frequency Questionnaire for respondents in Ranau	142
Appendix S:	Food Frequency Questionnaire for respondents in Tambunan	146
Appendix T:	Food Frequency Questionnaire for respondents in Kuala Penyu	150



UMS
UNIVERSITI MALAYSIA SABAH

CHAPTER 1

INTRODUCTION

1.1 Native vegetables and their importance

Vegetables are necessary and highly recommended for daily life as it provides the human body with the essential nutrients (Mohamed *et al.*, 2003). According to Knudsen *et al.* (2008), 30 types of plants deliver 95% of human daily intake of plant food calories and the other 5% are delivered by another 300 other plants species. There are foods traditional and well known in one country or region but maybe unknown by others, hence known as the country's or region's novel food. Many wild edible plants are nutritionally rich especially vitamins and nutrients which are perceived to have health benefits (Ali-Shtayeh *et al.*, 2008; Herforth, 2010).

The largest ethnic group in Sabah; the Dusun ethnic group is selected for the study. Approximately 70.6% of the Kadazandusun and Murut communities residing along the eastern boundary of the Crocker Range National Park are actively involved in gathering and consuming wild plants (Noweg *et al.*, 2003). However, most of the ethnobotanical researches in Malaysia are concentrated in Peninsular Malaysia and more similar studies should be done in Sabah and Sarawak (Mat Salleh *et al.*, 2000). Furthermore, most studies emphasize on the consumption or uses of plants for medicinal purposes.

1.2 Safety of native vegetables consumed among the Dusun ethnic groups

The Dusun ethnic group is selected for the study as it is the largest ethnic group in Sabah (Department of Statistics Malaysia, 2010). Moreover, according to Thompson and Subar (2008), interviewers of the same ethnic background are preferable so that dietary information can be more effectively communicated.

Poisonous plants are plants which may result in illness or death when consumed. It can also be understood as poisonous plants which are able to disrupt a normal health condition (Ingebrigtsen, 2010). Plant constituents which have potential adverse effects in humans when planted or their products are ingested are regarded as inherent food plant toxicants (Essers *et al.*, 1998). Plants from the Poaceae family have been reported to contain cyanogenic glycosides while plants from the Araceae family have been reported to contain calcium oxalate (Vetter, 2000; Oscarsson & Savage, 2006; Catherwood *et al.*, 2007; Satya *et al.*, 2010; Du *et al.*, 2012). For instance, acute cyanide poisoning due to hydrogen cyanide gas from pickled bamboo shoots were reported in Thailand (Sang-A-Gad *et al.*, 2011). Calcium oxalate has been reported to produce irritating effects and swelling of some parts of the gastrointestinal tract (Spillum and Muan, 2010; Du *et al.*, 2012). Bernhoft (2010) stated that secondary plant metabolites which cause pharmacological or toxicological effects in human and animals can be termed as bioactive compounds. Plants which contain potent bioactive compounds are characterized as poisonous as well as having medicinal values. Therefore, it is vital to understand the health benefits and/or potential toxicity of these edible plants. In order to ensure safe usage of the individual plant food item, the country or region's knowledge and tradition on the handling of the plant food are vital. It is so as some of the knowledge, way of consumption and known intake level of the individual plant food items may be useful in the prevention of acute or chronic diseases development (Knudsen *et al.*, 2008).

1.3 Problem statement

Scientific data and history of safe consumption for most plant foods are very difficult to be obtained even though they may have been eaten for several hundreds of years (Knudsen *et al.*, 2008). There are also few initiatives and scientific data to establish the safety of botanical products when used in food (Schilter *et al.*, 2003). Some food was assumed safe because no evidence of adverse effects has been reported over time. Moreover, the community has acquired experiences in proper processing or preparation method to safely consume the food (Knudsen *et al.*, 2008). In Sabah, there are still lack of data which represent the range of dose consumption and toxicity effect of native vegetables, despite several studies and surveys done on native plants used for food and medicine by the local people of Sabah.

1.4 Hypotheses

The exposure level of hydrogen cyanide and calcium oxalate from native vegetables consumption among the Dusun ethnic group in Sabah are lower than the acute reference dose and the fatal dose, respectively.

1.5 Importance of the study

It is proposed that the input from this research can be used as a starting point to further investigate the potential toxicity of native vegetables to its consumers in Sabah. An exposure level of various toxic compounds due to consumption of native vegetables mostly used by the people in Sabah and the range of safe dose consumption can be determined for safer short and long term usage.

1.6 Objectives

This study was carried out with the objectives as follows:

- 1.6.1 To survey the native vegetables consumed by the Dusun ethnic group in Ranau, Tambunan and Kuala Penyu.
- 1.6.2 To determine the potentially toxic native vegetables species consumed by the Dusun ethnic group
- 1.6.3 To quantify the presence of toxic compound(s) in the selected native vegetables including the different plant parts.
- 1.6.4 To estimate the human exposure level of the toxic compound(s) found in the native vegetables.