

DECLARATION

The work in this thesis was carried out by me as a project at the Coconut Development Authority under the supervision of Prof. Arthur Bamunuarachchi, Dr. K.K.D.S. Ranaweera, Mrs. S.S. Purasinghe and Mrs Indira Wickramasinghe and a report on this has not been submitted in whole or in part to any University or any other institution for another Degree.



.....
W.M.M.P.D.K. Warsakoon

We Dr. K.K.D.S. Ranaweera, Mrs. I. Wickramasinghe and Mrs. S.S. Purasinghe jointly here by certify that the above statement in the preceding page made by the candidate is true and that this thesis is suitable for submission for the university for the purposes of evaluation.



.....

Signature

Supervisor

Dr. K.K.D.S. Ranaweera
HEAD DEPARTMENT OF FOOD SCIENCE & TECHNOLOGY
CO-ORDINATOR FOOD SCIENCE & TECHNOLOGY
POSTGRADUATE PROGRAMMES
UNIVERSITY OF SRI JAYAWARDENEPURA
SRI LANKA.

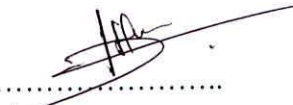


.....

Signature

Supervisor

Mrs. I. Wickramasinghe
LECTURE - DEPARTMENT OF FOOD SCIENCE & TECHNOLOGY
FACULTY OF APPLIED SCIENCE
UNIVERSITY OF SRI JAYAWARDENEPURA
SRI LANKA.



.....

Signature

Supervisor

Mrs. S.S. Purasinghe
DIRECTOR -QUALITY CONTROL & QUALITY ASSUARANCE DIVISION
COCONUT DEVELOPMENT AUTHORITY
NARAHENPITA
SRI LANKA.

**HEAVY METALS IN COCONUT AND
COCONUT PRODUCTS**

By

Warsakoon Mudiyansele Maduri Prabha Darshani Kumari
Warsakoon

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science

In

Food Science and Technology

of the Faculty of Applied Sciences

University of Sri Jayewardenepura

Gangodawila, Nugegoda,

Sri Lanka

2008

TABLE OF CONTENTS

	Page
Table of content	i - vi
List of tables	vii
List of figures	viii
Acknowledgment	ix
Abbreviations	x
Abstract	xi- xii

CHAPTER 1

1. INTRODUCTION	1-2
-----------------	-----

CHAPTER 2

2. LITERATURE REVIEW	3
2.1 The Coconut Palm and its Environment.	3
Historical Background	3
Botany	3
Morphology	3-4
Climate and Soil	4
2.1 Uses of Coconut	5
Coconut kernel products	5
Coconut oil	5
Virgin coconut oil	5-6
Copra	6
Desiccated coconut	6
Toasted coconut	6

Sweetened coconut	7
Coloured coconut	7
Creamed coconut	7
Coconut Milk and Coconut Cream	8
Extraction of Spray Dried Coconut Milk Powder	8
Poonac	9
Coconut water	9
Coconut jams	10
White cheese from coconut and cow milk	10
Yoghurt from coconut and cow milk	11
Coconut Sap Products	11
Toddy	11
Arrack	11
Coconut Trackle and Jaggery	11
Coconut vinegar	12
Coconut Non Kernel Products	13
Coir fibre	13
White coir fibre	13
Brown coir fibre	13
Coir fibre dust or coco peat	13
Coconut shell charcoal	14
Activated carbon	14
Coconut shell and wood handicraft	14

2.3	Coconut Products in Health and Nutrition	15
	Health beneficial for coconut oil	15
	Health beneficial for coconut water	15
3.0	Heavy metals	16
3.1	Lead	16
	Chemical and Physical Properties	16-17
	Production and Uses	17
3.2	Mercury	17
	Chemical and Physical Properties	17-18
	Chemical changes on exposure to the environment	18
3.3	Arsenic	18
	Chemical and Physical Properties	19
	Production and Uses	19
3.4	Cadmium	20
	Chemical and Physical Properties	20
	Production and Uses	20
3.5	Copper	20
	Chemical and Physical Properties	21
	Production and Uses	21
3.6	Aluminium	21
	Chemical and Physical Properties	21
	Production and Uses	21
3.7	Iron	22
	Chemical and Physical Properties	22
	Production and Uses	22

4.0	How heavy Metals Damages to Human Body	23
	Lead	23
	Mercury	23-24
	Arsenic	16-17
	Cadmium	25
	Copper	25
	Iron	25
	Chromium	25
	Manganese	26
	Aluminium	26
5.0	Importance of metals to human body.	27-29
6.0	Metals in Food Legislation	30
	The UK regulation and Recommendation	30
	The general regulation concerning trace metals in coconut	31-32
7.0	Accumulation of Heavy Metals in Plant	33
8.0	Preparation of samples for analysis	33
	Dry ashing	34
	Wet ashing	34-35

CHAPTER 3

3.	MATERIALS AND METHODS	36
3.1	Atomic Absorption Spectorphotometry after dry ashing – AOAC official method 999.11	36
	Principle	36

	Apparatus	37
	Reagents	37
	Procedure	37-38
	Calculation and Evaluation of results	38
3.2	Atomic Absorption Spectrophotometry after Microwave Digestion - – AOAC official method 999.10	39
	Principle	39
	Apparatus	39
	Reagents	39
	Procedure	40
	Calculation and Evaluation of results	40-41
3.3	Microwave oven	42
3.4	Atomic Absorption Spectrophotometer	42
	Recommended parameters for AAS	43-47

CHAPTER 4

	4. RESULTS & DISCUSSION	48
4.1	Summery and statistical analysis of the results for heavy metals in coconut based by the Varian Atomic Absorption Spectrophotometric method.	48-52
4.2	Kruskal –Wallis one-way analysis of variance was used to get the statistical part	53-54
4.2.1	Data types that can be analyzed with Kruskal –Wallis	54
4.2.2	Limitations of the test	55

4.3	Comparison of difference of Cu, Zn, Mn, Fe in coconut and coconut based products.	56-61
4.4	Comparison of the difference of Cu, Zn, Mn and Fe in inorganic and organic fresh coconuts.	62-65

CHAPTER 5

5. CONCLUSION		66-67
6. REFERENCES		68-70
7. APPENDICES		
Appendix A		
Sample weight and lead concentration found in the samples		71
Sample weight and arsenic concentration found in the samples		72
Sample weight and cadmium concentration found in the samples		73
Sample weight and copper concentration found in the samples		74
Sample weight and chromium concentration found in the samples		75
Sample weight and zinc concentration found in the samples		76
Sample weight and manganese concentration found in the samples		77
Sample weight and aluminium concentration found in the samples		78
Sample weight and iron concentration found in the samples		79
Appendix B		
Calculate the concentration (C) of metal (Copper) in the Fresh coconut meat (organic) samples		79-83
Appendix C		
Pair wise Comparison		84

LIST OF TABLES

		Page
Table 1	Proximate composition of the important types of desiccated coconut	07
Table 2	Composition of oil cake	09
Table 3	Composition of coconut water in mg/100ml	10
Table 4	Limits for heavy metals	31
Table 5	Iron content of coconut	31
Table 6	Mineral composition of coconut and coconut based products	32
Table 7	Parameters of Microwave Digestion	42
Table 8	Metal Composition of Fresh Coconut Meat (Organic) in mg/100g	48
Table 9	Metal Composition of Fresh Coconut Meat (inorganic in mg/100g	49
Table 10	Metal Composition of Desiccated Coconut in mg/100g	49-50
Table 11	Metal Composition of Coconut milk powder in mg/100g	50-51
Table 12	Metal Composition of Coconut Cream in mg/100g	51
Table 13	Metal Composition of Coconut Milk in mg/100g	52

LIST OF FIGURES

		Page
Figure1	Copper concentration of coconut and coconut based products.	56-57
Figure2	Zinc concentration of coconut and coconut based products.	58-59
Figure3	Manganese concentration of coconut and coconut based products	59-60
Figure4	Iron (Fe) concentration of coconut and coconut based products.	61
Figure5	Mean deference of Cu between organic and inorganic fresh coconut	62
Figure6	Mean deference of Zn between organic and inorganic fresh coconut	63
Figure7	Mean deference of Mn between organic and inorganic fresh coconut	64
Figure8	Mean deference of Fe between organic and inorganic fresh coconut	65

ACKNOWLEDGEMENTS

First and foremost I wish to express my deepest gratitude to Dr K.K.D.S. Ranaweera , Head ,Department of food Sciences , University of Sri Jayawardenapura for his valuable advise, encouragement and guidance throughout this study and for reading the manuscript and sparing his valuable time in bringing this study to a successful completion.

I wish to express my sincere thanks to Prof. A. Bamunuarachchi , Professor of Applied Chemistry and Coordinator, Food Technology Programme, University of Sri Jayawardenapura, and for all the academic and non academic staff of the department.

I would like to thank Mrs S.S. Purasingha , Director Quality Control and Quality Assurance Division , Coconut Development Authority and Mrs Indira Wickramasinghe, Lecturer department of food Science University of Sri Jayawardenapura , for providing me the opportunity to carry out this study at the department.

I extend my thanks to the technical staff of the Coconut Development Authority Laboratory for their assistance and support.

Finally with my deepest gratitude I should thank Taraka Wijebandara who gave me assistance in processing the report and moral support throughout this study.

ABBREVIATIONS

AAS	-	Atomic Absorption Spectrophotometer
APCC	-	Asia and Pacific Coconut Community
VCO	-	Virgin Coconut oil
ppm	-	parts per million
mL	-	milliliter
g	-	Gram
Pb	-	Lead
Cd	-	Cadmium
As	-	Arsenic
Cr	-	Chromium
Cu	-	Copper
Al	-	Aluminium
Mn	-	Manganese
Fe	-	Iron
Zn	-	Zinc
DL	-	Detection Limit
df	-	dilution factor
w/w	-	weight basis

HEAVY METALS IN COCONUT AND COCONUT PRODUCTS

By – W.M.M.P.D.K. Warsakoon

ABSTRACT

The level of heavy metal content in environment and soil has dramatically increased over the last decade. Consequently the concentration of heavy metals in the food we consume has increased to a large extent, which in turn raised consumers concern over the level of heavy metals in food. As far as the export market is considered, quality becomes the highest priority and products have to undergo various quality tests before to obtain the approval for export. Among the three largest agro products exported by Sri Lanka, coconut products are very important as a component of the foreign income generation. As heavy metal contaminants of soils are quite high, and these can be assimilated in tissues of the coconut endosperm. It can also be accumulated in the end products.

A study was carried out to assess the level of heavy metals and their importance of the coconut, based products; coconut milk, coconut cream, desiccated coconut. Testing was carried out on samples of products obtained from coconut grown under two different fertilizing systems; organic fertilizer and chemical fertilizers. Muffle furnace (Carbolite S30 2AU) and Microwave digester (XP 1500 PlusTM) were used for digesting the samples. AOAC official method of 999.10, 986.15 and 999.11 were used for analysis of heavy metals in coconut and coconut products. Results were obtained by using Atomic Absorption Spectrophotometer.

The minimum detection levels of the Atomic Absorption Spectrophotometer instrument (Varian - AA240) for the tested heavy metals are considered as Lead 0.1ppm, Arsenic 3 ppm, Cadmium 0.02ppm, Chromium 0.06ppm, Aluminium 0.3ppm, Copper 0.03ppm, Zinc 0.01ppm , Manganese 0.02ppm , Iron 0.06ppm .

Nine metals were analysed for coconut and coconut based products. The lead, cadmium, arsenic, chromium and aluminium were not detected. Other metals are found in 100g as follows;

	Iron (mg/100g)	Zinc (mg/100g)	Copper (mg/100g)	Manganese (mg/100g)
Fresh coconut (organic)	1.58	0.41	0.45	1.06
Fresh coconut (inorganic)	1.25	0.46	0.36	0.69
Desiccated coconut	2.19	1.11	0.75	2.01
Coconut milk powder	0.17	0.37	0.20	0.39
Coconut cream	0.35	0.18	0.16	0.19
Coconut milk	1.35	0.92	0.33	0.78