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**DEVELOPING A PROPER NANO MATERIAL TO USE
IN CUISINE CLAY POTTERY**

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Master of Science (Major Component of Research)

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Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree
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DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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Date: 05/08/2025

The above candidate has carried out research for the PhD/MPhil/Masters thesis/dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

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Signature of the Supervisor: ***UOM Verified Signature*** Date: 05.08.2025



DEDICATION

This thesis is dedicated to all those who provided unwavering support and encouragement throughout my academic journey. It stands not merely as a scholarly document, but as a testament to the perseverance and dedication applied during one of the most difficult periods of my life. This accomplishment is not solely my own, it is equally a reflection of the compassion, guidance, and solidarity extended by the remarkable individuals who stood by me during this transformative academic endeavor.

This is dedicated to my lovely family for the continuous encouragement towards these achievements. Especially to my loving husband for supporting me in maintaining my morale, for continuing this effort until success and for my parents for the immense support and the consideration given me within this period. Specially I should mention, this is dedicated as a tribute to my late father who was passed away during this academic period as fulfilling one of his dreams regarding my academic path.

My great teachers, I have met as my supervisors on this research study, Senior Professor R. U. Halwatura and Dr. Upanith S. Liyanarachchi, are offered this thesis as a result of their clever and super guidance with the subject knowledge and humanity.

To my friends and research colleagues, I dedicate this for their inspiration for fulfilling this research positively and successfully.

Finally, I dedicate this thesis for anyone who is interested in research, to courageous people to continue their academic studies effectively and efficiently and to all individuals who support me to be independent in my academic path and my personal life.

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ABSTRACT

Clay pottery, originating at dawn in civilization, is a fundamental village industry primarily used as eco-friendly and health safe cookware. Currently, nonstick metal cookware is popular for convenience but poses health risks from toxic compound releasing to food. Despite its traditional use, clay cookware tends to stick food to the inner surface of pottery during cooking, limiting its functionality. Thus, this study aims to develop a proper mineral nano material to improve the nonstick properties of clay cookware, addressing a key industrial gap. Sri Lankan industrial clays, minerals and their physiochemical properties were identified through the primary data and secondary data from an industrial survey and literature review. Using Gaussian Software under computational chemistry, suitable mineral type was identified through molecular modeling and binding energy calculation to combine with the most common clay. The nonstick performance of clay and mineral combination was assessed via binding energy analysis with fat/oil molecules. Red clay is the most used material for cooking pottery, predominantly utilized by small-scale domestic manufacturers. This sector surpasses medium-scale and government supporting units in usage. Male participation is highest compared to female and both gender involvement. BE calculations show Red clay and Apatite combination has the highest stability with the highest negative BE -3177 kcal/mol. Red clay with fats/oils mixtures have negative BEs of -1552 , -2142 , -2117 , and -1522 kcal/mol, indicating strong interactions, while the Red clay and Apatite mixture shows the positive BEs of 3212 , 2376 , 2450 , and 3903 kcal/mol with fat/oils indicating weaker interactions with less stable systems. The Red clay and Apatite blend reduces fat/oil adhesion and enhances nonstick properties by making Apatite is the ideal mineral to collaborate with Red clay to make pottery. When considering the applying of nanotechnology, using nanoscale particles increases binding energy making the Red clay and Apatite system more stable and nonstick.

Keywords: Nonstick Cooking Pottery, Clay and Mineral, Computational Chemistry, Binding Energy, Nanotechnology

TABLE OF CONTENTS

Declaration	i
Dedication	ii
Acknowledgement	iii
Abstract	iv
Table of Contents	v
List of Figures	viii
List of Tables	x
List of Abbreviations	xii
List of Appendices	xiii
Chapter 1	1
INTRODUCTION	1
1.1 Background of The Study.....	1
1.2 Research Gap Identification	2
1.3 Aims and Objectives	3
1.4 Methodology	3
1.5 Main Findings.....	4
1.6 Dissertation Structure	5
Chapter 2	6
LITERATURE REVIEW	6
2.1 Chapter Introduction.....	6
2.2 Hygienic Problems of Using Metal and Non-Stick Metal Cookware	6
2.2.1 Hygienic Problems of Using Metal Cookware	6
2.2.2 Hygienic Problems of Using Nonstick Metal Cookware	7
2.3 Food stickiness to the clay pottery	10
2.4 Clay and Clay Minerals	11
2.4.1 Types of Clay and Clay Mineral types in Sri Lanka.....	13
2.4.2 Clay Pottery Industry in Sri Lanka.....	13
2.4.3 Using Clay in Pottery Making	14
2.5 Nanotechnology.....	15

2.5.1	Applications of Clay Nano Particles	16
2.5.2	Synthesis of Nano clay and composite.....	18
2.6	Binding Energy (BE).....	19
2.6.1	Factors affecting Binding Energy	20
2.7	Computational Chemistry.....	20
2.7.1	Theories Apply in Computational Chemistry	21
2.7.2	Application of Computational Chemistry Tools in Modeling	23
2.7.3	Using Gaussian Software in Research Work	23
2.8	Relationship Between Edible Fat / Oil and Food Stickiness.....	25
2.9	Summary	26
Chapter 3		28
METHODOLOGY.....		28
3.1	General	28
3.2	Research Methods	28
3.2.1	Step-01: Collecting Primary and Secondary Data	31
3.2.1.1	Primary Data Collection.....	31
3.2.1.2	Secondary Data Collection.....	31
3.2.2	Step-02: Physical and Chemical Properties of Identified Clay Types and Minerals.....	31
3.2.3	Step 03: Identify a Suitable Mineral Material to Apply for Clay Potteries as Nano Material	32
3.2.3.1	Use GS to Model Identified Clay and Mineral Structures	32
3.2.3.2	Calculate Binding Energies of Monomers and Dimers by Simulation.....	33
3.2.4	Step 04: Analyze the Performances of the Identified Clay + Mineral Combination for Nano Composite	36
3.3	Summary	37
Chapter 4		38
RESULTS AND DISSCUSSION		38
4.1	General	38
4.2	Research Gap Identification	38
4.3	Experimental Results Overview	38
4.3.1	Step 01: Primary and Secondary Data	38

4.3.1.1	Industrial Survey Results	39
4.3.1.2	Abundant Clay Types and Industrial Mineral Types in Sri Lanka.....	46
4.3.2	Step 02: Physical and Chemical Properties of identified Clay Type and Minerals.. ..	47
4.3.3	Step 03: Suitable Mineral Material to Apply for Clay Potteries as Nano Material.....	55
4.3.3.1	Modeled Red Clay and Minerals Structures Using Gaussian Software.	55
4.3.3.2	Calculated Binding Energies of Monomers and Dimers Through Simulation and Binding Energy Analysis.....	63
4.3.4	Step 04: Nonstick Performances of the Identified Clay + Mineral Combination for Nano Composite	69
4.3.4.1	Designed Models of Fat/Oil (Saturated Fat, Unsaturated Fat, Coconut Oil and Vegetable Oil)	70
4.3.4.2	Calculated BEs of Red Clay and Fat/Oil (Saturated Fat, Unsaturated Fat, Coconut Oil and Vegetable Oil) Combinations	72
4.3.4.3	Calculated BEs of Red Clay + Apatite Mixture with Fat/Oil Combinations	74
4.3.4.4	Nonstick Property Performances through Binding Energy Analysis.....	76
4.4	Summary	78
Chapter 5	80
CONCLUSION, RECOMMENDATIONS AND FUTURE WORK	80
5.1	Conclusions	80
5.2	Recommendations	82
5.3	Future Work	83
References	84

LIST OF FIGURES

Figure	Description	Page
Figure 2.1	Damaging of nonstick layer of nonstick metal cookware	8
Figure 2.2	Teflon fume and polymer/Teflon fume flu	8
Figure 2.3	Sticking foods in inner surface of clay pottery	10
Figure 2.4	Classification of soil grain	11
Figure 2.5	Hexagonal crystal structures	12
Figure 2.6	Industrial mineral material in Sri Lanka	13
Figure 2.7	Types of clayware in Sri Lanka	14
Figure 2.8	Applications of nano clay	16
Figure 2.9	Nano particle synthesis methods	18
Figure 2.10	Application of computational chemistry	21
Figure 2.11	Three main interfaces of GS	25
Figure 2.12	Fortification food product pyramid-Standard food vehicle for staple food	25
Figure 2.13	Saturated and unsaturated fat/oil	26
Figure 3.1	Complete research methodology	29
Figure 3.2	Research Design	30
Figure 3.3	Modeling molecules using GS	32
Figure 3.4	Geometry optimization and Frequency calculation (Opt+Freq) relevant molecules	33
Figure 3.5	Semiempirical theory option as the calculation method	34
Figure 3.6	Identify monomers to be combined (Atom Group Editor)	34
Figure 3.7	Clay and mineral combination	35
Figure 3.8	Analyzing nonstick property of identified clay + mineral combination	36
Figure 4.1	Most usable clay type for pottery making	39
Figure 4.2	Industry type clay consumption	39
Figure 4.3	Gender participation in pottery industry	40
Figure 4.4	Industry type gender participation	40
Figure 4.5	Cuisine and non-cuisine clayware	41
Figure 4.6	Clayware making by using mould and “Sakaporuwa”	41
Figure 4.7	Cooking Pottery Making Process	42
Figure 4.8	Raw clay and clay storing areas	42
Figure 4.9	Initial cleaned clay	43
Figure 4.10	Clay mixing	43
Figure 4.11	Clay cubes partitioning	43
Figure 4.12	Clay seasoning after mixing	43
Figure 4.13	Clay pottery making by using “Sakaporuwa”	44
Figure 4.14	Clay pottery making by mould	44
Figure 4.15	Prepared pottery drying under shade before burning	44

Figure 4.16	New oven system	44
Figure 4.17	Old oven system	45
Figure 4.18	Store clay pots in new oven system	45
Figure 4.19	Store clay pots in old oven system	45
Figure 4.20	Keeping burnt pots for cooling	45
Figure 4.21	Prepared clayware after oven process	46
Figure 4.22	Clay Types and Industrial Mineral Types in Sri Lanka	46
Figure 4.23	Modeled Red Clay using GS	55
Figure 4.24	Modeled Montmorillonite using GS	56
Figure 4.25	Modeled Kaolinite using GS	56
Figure 4.26	Modeled Graphite using GS	57
Figure 4.27	Modeled Silica Sand using GS	57
Figure 4.28	Modeled Quartz using GS	58
Figure 4.29	Modeled Feldspar using GS	58
Figure 4.30	Modeled Apatite using GS	59
Figure 4.31	Modeled Mica using GS	59
Figure 4.32	Modeled Ilmenite using GS	60
Figure 4.33	Modeled Rutile using GS	60
Figure 4.34	Modeled Zircon using GS	61
Figure 4.35	Modeled Garnet Sand using GS	61
Figure 4.36	Modeled Calcite using GS	62
Figure 4.37	Modeled Dolomite using GS	62
Figure 4.38	Gaussian Calculation Summary for Red Clay	63
Figure 4.39	Gaussian Calculation Summary for Montmorillonite and for Red Clay and Montmorillonite System	64
Figure 4.40	Red Clay + Material combination with Highest (-) BE	69
Figure 4.41	Modeled Saturated Fat Using GS	70
Figure 4.42	Modeled Unsaturated Fat Using GS	71
Figure 4.43	Modeled Coconut Oil Using GS	71
Figure 4.44	Modeled Vegetable Oil (Canola) Using GS	72
Figure 4.45	Gaussian Calculation Summary for Saturated Fat and for Red Clay and Saturated Fat System	73
Figure 4.46	Gaussian Calculation Summary for Red Clay+ Apatite and Saturated Fat System	75
Figure 4.47	Negative and Positive BE value levels of Red clay+ fat/oil and Red Clay+ Apatite and fat/oil	77
Figure 4.48	Negative and Positive BE value levels of Red clay+ coconut oil/vegetable oil and Red Clay+ Apatite and coconut oil/vegetable oil	77
Figure 4.49	Stickiness of Red Clay +Fat/Oil and Red Clay + Apatite and Fat/Oil	78

LIST OF TABLES

Table	Description	Page
Table 2.1	The product range of clayware in Sri Lanka	14
Table 3.1	Calculated energy value storing table	35
Table 4.1	Different types of clayware	41
Table 4.2	The chemical and physical properties of Red Clay	47
Table 4.3	The chemical and physical properties of Montmorillonite	47
Table 4.4	The chemical and physical properties of Kaolinite	48
Table 4.5	The chemical and physical properties of Graphite	48
Table 4.6	The chemical and physical properties of Silica Sand	49
Table 4.7	The chemical and physical properties of Quartz	49
Table 4.8	The chemical and physical properties of Feldspar	50
Table 4.9	The chemical and physical properties of Apatite	50
Table 4.10	The chemical and physical properties of Mica	51
Table 4.11	The chemical and physical properties of Ilmenite	51
Table 4.12	The chemical and physical properties of Rutile	52
Table 4.13	The chemical and physical properties of Zircon	52
Table 4.14	The chemical and physical properties of Garnet Sand	53
Table 4.15	The chemical and physical properties of Calcite	54
Table 4.16	The chemical and physical properties of Dolomite	54
Table 4.17	BE Calculation for Red Clay and Montmorillonite Combination	64
Table 4.18	BE Calculation for Red Clay and Kaolinite Combination	64
Table 4.19	BE Calculation for Red Clay and Graphite Combination	65
Table 4.20	BE Calculation for Red Clay and Silica Sand Combination	65
Table 4.21	BE Calculation for Red Clay and Quartz Combination	65
Table 4.22	BE Calculation for Red Clay and Feldspar Combination	65
Table 4.23	BE Calculation for Red Clay and Apatite Combination	66
Table 4.24	BE Calculation for Red Clay and Mica Combination	66
Table 4.25	BE Calculation for Red Clay and Ilmenite Combination	66
Table 4.26	BE Calculation for Red Clay and Rutile Combination	66
Table 4.27	BE Calculation for Red Clay and Zircon Combination	67
Table 4.28	BE Calculation for Red Clay and Garnet Sand Combination	67
Table 4.29	BE Calculation for Red Clay and Calcite Combination	67
Table 4.30	BE Calculation for Red Clay and Dolomite Combination	67
Table 4.31	BEs Comparison of Red Clay and Mineral Combination	68
Table 4.32	BE Calculation for Red Clay and Saturated Fat Combination	73

Table 4.33	BE Calculation for Red Clay and Unsaturated Fat Combination	73
Table 4.34	BE Calculation for Red Clay and Coconut Oil Combination	74
Table 4.35	BE Calculation for Red Clay and Vegetable Oil (Canola Oil) Combination	74
Table 4.36	BE Calculation for Red Clay + Apatite and Saturated Fat Combination	75
Table 4.37	BE Calculation for Red Clay + Apatite and Unsaturated Fat Combination	75
Table 4.38	BE Calculation for Red Clay + Apatite and Coconut Oil Combination	76
Table 4.39	BE Calculation for Red Clay + Apatite and Vegetable Oil (Canola Oil) Combination	76
Table 4.40	BE value comparison between Red clay + fat/oil and Red Clay+ Apatite and fat/oil	76
Table 4.41	BE value comparison between Red clay + coconut oil/vegetable oil and Red Clay + Apatite and coconut oil/vegetable oil	77

LIST OF ABBREVIATIONS

Abbreviation	Description
BE	Binding Energy
GS	Gaussian Software
AU	Atomic Unit
PTFE	Teflon, Poly Tetra Fluoro Ethylene
PFC	Poly Fluoro Carbon
IARC	The International Agency for Research on Cancer
PFOA	Perfluorooctanoic acid
kcal/mol	kilocalorie per mole
ICP device	Inductively Coupled Plasma device
PFOA	Perfluorooctanoic acid
PFOS	Perfluoro Octane Sulfonate
PFAS	Per- and polyfluoroalkyl substances
HFPO	Hexafluoropropylene oxide
PFBS	Perfluorobutane Sulfonic acid
EPA	United States Environmental Protection Agency
GDP	Gross Domestic Product
NMR spectra	Nuclear magnetic resonance spectra
CD spectra	Circular Dichroism spectra
IR spectra	Infrared spectra
DFT	Density Functional Theory
MD	Molecular Dynamics
MM	Molecular Mechanics
GNM	Gaussian Network Model
PBC	Periodic Boundary Conditions
E	Energy
Opt + Freq	Geometry optimization and Frequency calculation

LIST OF APPENDICES

Appendix	Description	Page
Appendix - A	Industrial Survey Questionnaire on clay type utilization and potters' contribution on Clay pottery Industry in Gampaha District	97