

**BIOCHEMICAL AND *IN-SILICO* STUDIES OF LYCOPENE EXTRACT
AND *Solanum lycopersicum-Daucus carota* FOOD-MIX FOR CERVICAL
CANCER PREVENTION**

**ADEMOSUN, OLABISI THERESA
(14PCC00650)**

JULY, 2024

**BIOCHEMICAL AND *IN-SILICO* STUDIES OF LYCOPENE EXTRACT
AND *Solanum lycopersicum-Daucus carota* FOOD-MIX FOR CERVICAL
CANCER PREVENTION**

BY

ADEMOSUN, OLABISI THERESA

(14PCC00650)

B.Sc CHEMISTRY, Olabisi Onabanjo University, Ago-Iwoye.

M.Sc INDUSTRIAL CHEMISTRY, Covenant University, Ota.

**A Ph.D. THESIS SUBMITTED TO THE DEPARTMENT OF CHEMISTRY,
COLLEGE OF SCIENCE AND TECHNOLOGY, COVENANT UNIVERSITY,
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD
OF Ph.D. DEGREE IN INDUSTRIAL CHEMISTRY OF COVENANT
UNIVERSITY, OTA, OGUN STATE, NIGERIA**

JULY, 2024

ACCEPTANCE

This is to attest that this thesis is accepted in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy in Industrial Chemistry in the Department of Chemistry, College of Science and Technology, Covenant University, Ota, Nigeria.

Miss. Adefunke F. Oyinloye
(Secretary, School of Postgraduate Studies)

Signature and Date

Prof. Akan B. Williams
(Dean, School of Postgraduate Studies)

Signature and Date

DECLARATION

I, ADEMOSUN, OLABISI THERESA (14PCC00650), declare that this research was carried out by me under the supervision of Prof. Kolawole O. Ajanaku and Prof. Adebayo H. Adebayo of the Department of Chemistry, Landmark University and Department of Biochemistry, College of Science and Technology, Covenant University, Ota respectively. I attest that this thesis has not been presented either wholly or partially for the award of any degree elsewhere. All the sources of materials and scholarly publications used in this thesis have been duly acknowledged.

ADEMOSUN, OLABISI THERESA

Signature and Date

CERTIFICATION

We certify that the thesis titled '**BIOCHEMICAL and *In-silico* STUDIES OF LYCOPENE EXTRACT and *Solanum lycopersicum-Daucus carota* FOOD-MIX FOR CERVICAL CANCER PREVENTION**' is the original work carried out by **ADEMOSUN, OLABISI THERESA (14PCC00650)** in the Department of Chemistry, Covenant University, Ota, Ogun State, Nigeria under the supervision of Prof. Kolawole O. Ajanaku of Department of Chemistry and Prof. Abiodun H. Adebayo of Department of Biochemistry. We have examined and found this work acceptable as part of the requirements for the award of the degree of Doctor of Philosophy in Industrial Chemistry.

Prof. Kolawole O. Ajanaku
(Supervisor)

Signature and Date

Prof. Abiodun H. Adebayo
(Co-Supervisor)

Signature and Date

Dr. Cyril O. Ehi-Eromosele
(Ag. Head of Department)

Signature and Date

Prof. Olayide S. Lawal
(External Examiner)

Signature and Date

Prof. Akan B. Williams
(Dean, School of Postgraduate Studies)

Signature and Date

DEDICATION

I dedicate this work to the Almighty God, my source of wisdom and strength, for His ever-abiding presence throughout this project. To Him alone be all the glory. Amen.

ACKNOWLEDGMENTS

My most sincere appreciation goes to God, the source of all wisdom, knowledge, and understanding. I owe a great deal to Covenant University's Chancellor and Chairman of the Board of Regents, Dr. David O. Oyedepo, for giving me the chance to further my academic career and contribute to the wonderful vision that Covenant University is advancing. I really appreciate the Vice-Chancellor of Covenant University, Prof. Abiodun H. Adebayo; the Deputy Vice-Chancellor, Prof. O.A. Adekeye, and the Registrar Mrs. Regina A. Tobi-David, the entire management team in ensuring the success of this study. Also, I sincerely appreciate the Dean, School of Postgraduate Studies (SPS), Prof. Akan B. Williams, and the Sub-Dean, SPS, Dr. Hezekiah O. Falola. The Dean of College of Science and Technology, Prof. Timothy A. Anake, is also appreciated. I am grateful to my supervisor, Prof. Kolawole O. Ajanaku, and co-supervisor, Prof. Abiodun H. Adebayo for their patience, encouragement, advice and wisdom transferred throughout this programme. I am forever grateful for the sacrifice and the time you made out for me despite your busy schedules, thank you. I am highly indebted to you both, sirs.

My earnest appreciation goes to the Head of Department, Dr. Ehi-Eromosele C.O for his positive impact, support in the processing of my PG forms, and motivation throughout the Ph.D. programme. I must not fail to appreciate Dr. Akinsiku A.A, the Departmental PG coordinator, for her support and love during this programme. My deepest appreciation goes to all the faculty, staff and students of the Department of Chemistry for their contributions, input, and constructive criticisms at all the stages of this work. This study was conducted at Covenant University, Ota, and the Nigerian Institute of Medical Research (NIMR). I appreciate the staff of tissue culture laboratory, Nigerian Institute of Medical Research (NIMR).

My profound gratitude also goes to Prof Olayinka O. Ajani, Dr. Tolulope O. Siyanbola, Dr. Emmanuel A. Adedapo, Dr. Enerst Agwanba and Dr. Samuel O. Ajayi for their kind support and encouragement during this programme. I eternally grateful to my parents; Pst. and Dcns. Oluranti Emmanuel for their love, spiritual investment, and moral support during this programme, thank you so much for everything, you shall live long in sound health to eat the fruit of your labour. I deeply appreciate my siblings, Pastor Gbemisola Emmanuel, Barr (Mrs) Aramide Adelabu, Engr Oladipupo Emmanuel, and Mr. Olumide Emmanuel, for their love and unwavering support during my Ph.D study. My gratitude goes to my sons: Titobiloluwa and Oluwatomisin, for their endurance, love, and support throughout the

programme. I want to thank my loving spouse, brother, and friend, Oluwatobiloba Ademosun, thank you for bearing with me all through the course of this study. May the good Lord reward your sacrifice in multiple folds, thank you so much, Sir.

Finally, I want to thank all my colleagues, friends, and well-wishers for their support all through the course of this study.

TABLE OF CONTENT

CONTENTS	PAGES
TITLE PAGE	ii
ACCEPTANCE	iii
DECLARATION	iv
CERTIFICATION	v
DEDICATION	vii
ACKNOWLEDGMENTS	viii
TABLE OF CONTENT	ix
LIST OF FIGURES	xv
LIST OF TABLES	xvii
LIST OF MAJOR ABBREVIATIONS	xix
LIST OF APPENDICES	xxi
ABSTRACT	xxi
CHAPTER ONE	1
INTRODUCTION	1
1.1 Background to Study	1
1.2 Study fruits of interest	3
1.2.1 Tomatoes	3
1.2.1.1 Phytochemical Compounds in Tomatoes and their Impact on Human Health and Diseases	4
1.2.1.2 Phenolic Compounds	4
1.2.1.3 Carotenoid Content	5
1.2.1.4 Antioxidant Properties in Tomato	6
1.2.1.5 Health Benefits of Tomatoes	7
1.2.1.6 Types of Tomatoes	8
1.2.2 Carrots (<i>Daucus carota</i>)	9
1.3 Statement of the problem	10
1.4. Research Questions	11
1.5 Aim of the Research	11
1.6 Objectives	11
1.7 Justification for the Study	12

CHAPTER TWO	14
LITERATURE REVIEW	14
2.1 History of Functional Food	14
2.1.1 Fruits and Fruits Products as Functional Food	15
2.2 Functional Ingredients in Fruits and their Properties	16
2.2.1 Polyphenols	17
2.2.2 Flavonoids	17
2.2.3 Isoflavones	18
2.2.4 Flavanones	18
2.3 Bioactive Compounds	18
2.4 Nutraceuticals	19
2.4.1 Nutraceuticals and Diseases	20
2.5 Antioxidants	21
2.5.1 Classification of Antioxidants	21
2.5.1.1 Based on their Location	21
2.5.1.2 Based on Defense	21
2.5.1.3 On the Basis of their Action	22
2.5.1.4 Based on their Nature	22
2.6 Antioxidant Defence	22
2.7 Terpenoids	23
2.7.1 Lycopene	24
2.7.2 Lycopene and Cancer	26
2.8 Cancer: History and Aetiology	28
2.8.1 History and Origins of Cancer	28
2.8.2 The Etymology of Cancer	29
2.8.3 The Aetiology of Cancer	31
2.9 How Cancer is triggered	32
2.10 Cancer Classification and Types	33
2.10.1 Classification by Location or Site	34
2.10.2 Classification by Tissue Type	34
2.10.2.1 Carcinomas	34
2.10.2.2 Sarcomas	35
2.10.2.3 Lymphomas	35
2.10.2.4 Leukemis	35

2.10.2.6 Mixed Types	35
2.10.3 Classification by Grade	36
2.10.4 Classification by stage	36
2.11 Cancer Risk Factors	36
2.12 Trends in the prevention and treatment of cancerous cells using Tomatoes and Carrots	37
2.13 Cervical Cancer	39
2.13.1 The Woman's Cervix	40
2.13.2 Causes of Cervical Cancer and Common Risk Factors	41
2.14 Cervical cancer types	42
2.14.1 Squamous Cell Cancer	42
2.14.2 Adenocarcinoma	42
2.15 Common Signs and Symptoms of Cervical Cancer	42
2.15.1 Screening and Early Detection	42
2.15.2 Treatment options	45
2.15.2.1 Cryotherapy	45
2.15.2.2 Simple hysterectomy	45
2.15.2.3 Chemotherapy	45
2.15.2.4 Radiation Therapy	46
2.16 Incidence of Cervical Cancer in Nigeria	48
2.17 Human Papillomavirus	50
2.19 <i>In-vitro</i> studies	54
2.19.1 Flow cytometry	54
2.19.2 MTT (3-(4-5-dimethylthiazol-2-yl)-2, 5- diphenyl-2H- tetrazolium bromide) Assay	55
2.20 Gaps in Literature	55
CHAPTER THREE	56
MATERIALS AND METHODS	56
3.1 Materials	56
3.1.1 List of Reagents	56
3.2 Experimental Methods	57
3.2.1 Preparation of Tomato Concentrate	57
3.2.2 Preparation of Carrots Concentrate	57
3.2.3 Batch Preparation of Tomatoes-Carrots Concentrate Mix	57
3.3 Preparation of Extracts	58

3.3.1 Tomato-carrot Ethanol Extraction (70% and 100%) (TCE)	58
3.3.2 Tomato-carrot Aqueous Extraction (TCA)	58
3.4 Nutritional Analysis of the Concentrate Blends	59
3.4.1 Determination of Moisture Content	59
3.4.2 Determination of Ash Analysis	59
3.4.3 Determination of Crude Fat Content	60
3.4.4 Determination of Crude Fibre Content	60
3.4.5 Determination of Protein Content	61
3.4.6 Determination of Carbohydrate Content	61
3.4.7 Energy computation in (kcal)	61
3.4.8 Atomic Absorption Spectroscopy (AAS)	62
3.4.9 Sensory Evaluation of Tomato-carrots Food Mix	62
3.5 Functional Analysis of the Concentrate mix	62
3.5.1 Determination of pH	62
3.5.2 Titratable Acidity (TA) assessment	62
3.6 Phytochemical Analyses	63
3.6.1 Qualitative assessment	63
3.6.2 Quantitative estimation	64
3.6.2.1 Total phenolic content (TPC) assessment	64
3.6.2.2 Total flavonoid content (TFC) assessment	64
3.6.2.3 Beta-carotene (β -carotene) and lycopene assessment	64
3.6.2.4 Total Alkaloids assessment	65
3.7 Preparation of Tomatoes Pomace	65
3.7.1 Solvent Extraction of Lycopene from Tomato Pomace	66
3.8 Spectroscopic Characterisation of Lycopene Extract	66
3.8.1 Nuclear Magnetic Resonance (^1H and ^{13}C NMR)	67
3.8.2 GC-MS Analysis	67
3.9. <i>In vitro</i> antioxidant assessment	68
3.9.1 2, 2-Diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assay	68
3.9.2 Ferric reducing antioxidant power (FRAP)	68
3.9.3 Total Antioxidant Activity (TAC)	68
3.10 <i>In-vitro</i> anticancer cytotoxicity evaluation	69
3.10.1 Preparation of 1 X Phosphate Buffer Solution (PBS)	69
3.10.2 Preparation of 1X DMEM	69

3.10.3 Extract solubility test	69
3.10.4 Seeding of cells for cytotoxicity study	69
3.11 Preparation of extracts for cell culture	70
3.11.1 Preparation of lycopene extract for cell culture	70
3.11.2 Preparation of aqueous and ethanol extracts for cell culture	70
3.11.3 Preparation of Camptothecin (standard drug) for cell culture	70
3.12 Cell Treatment/ MTT Assay	70
3.13 <i>In silico</i> study	71
3.13.1 Molecular docking	71
3.13.2 Molecular dynamic (MD) simulation study	72
3.14 Statistical Analysis	72

CHAPTER FOUR 73

RESULTS 73

4.1 Proximate analysis of tomato-carrot food mix	73
4.1.1 Moisture content analysis	73
4.1.2 Ash content analysis	74
4.1.3 Crude protein content analysis	74
4.1.4 Crude fiber content analysis	75
4.1.5 Crude fat content analysis	76
4.1.6 Carbohydrate content analysis	76
4.1.7 Sensory evaluation of the formulations	77
4.2 pH and titratable acidity analyses	78
4.2.1 Bulk density analysis	78
4.3 Trace metals analysis	80
4.4 Yield quantification	81
4.5 Phytochemical Analyses	82
4.5.1 Qualitative phytochemical analyses	82
4.5.2 Quantitative phytochemistry of formulations	84
4.6.1 DPPH radical scavenging ability	87
4.6.2 Ferric reducing antioxidant power (FRAP)	90
4.6.3 Total antioxidant capacity (TAC)	93
4.7 Lycopene content in different ratio of solvent	96
4.8 Spectroscopic Data and Structure Elucidation of Lycopene Extract from Tomatoes	98

4.9 <i>In-vitro</i> Anticancer Cytotoxicity	106
4.9 <i>In-silico</i> study	115
4.10: Molecular Dynamic Study	117
CHAPTER FIVE	122
DISCUSSION	122
5.1 Proximate Analysis of tomato-carrots food mix	122
5.1.1 Sensory Evaluation of Tomato-carrot Food Mix	125
5.1.2 Trace Metals Analysis of Tomato-Carrot Food Mix	126
5.2 Phytochemical Investigation of Ethanol and Aqueous Extract of Tomato-Carrot Mix	128
5.3 Solvent extraction of Lycopene from Tomato Pomace	130
5.5 <i>In vitro</i> Anticancer Cytotoxicity of TCE and TCA	132
5.6 Molecular Docking	136
5.6.1 Molecular dynamic (MD) simulation analysis	142
CHAPTER SIX	144
CONCLUSION AND RECOMMENDATIONS	144
6.1 Summary of findings	144
6.2 Conclusion	145
6.3 Contributions of the study to knowledge	146
6.4 Limitations	146
6.5 Recommendations	147
REFERENCES	149
APPENDICES	167

LIST OF FIGURES

FIGURES	TITLE OF FIGURES	PAGES
1.1	Fresh tomatoes in harvested state	3
1.2	Fresh carrots in harvested state	9
2.1	Schematic diagram showing all the nutrients embedded in fruits	17
2.2	Chemical structures of selected terpenoids	23
2.3	Chemical structure of Lycopene	25
2.4	Occurrence of Cancer	29
2.5	Chemical structure of Ubiquinone	38
2.6	The woman's reproductive tract	40
2.7a	The female reproductive tract	49
2.7b	The incidence of cervical cancer in a female	49
2.8	Chemical structure of Thymoquinone	52
2.9	A flow cytometer	54
3.1	Preparation of TCE and TCA	57
3.2	Modified Solvent Extraction of Lycopene	65
4.1	Bar chart showing the effect of fortification on the protein content (%) of tomato- carrot food mix	75
4.2	Bar chart showing the effect of fortification on the fat content (%) of tomato food mix	76
4.3a	^1H NMR spectrum (60 Hz, CDCl_2) of lycopene extract	99
4.3b	^{13}C NMR spectrum (15 Hz, CDCl_2) of lycopene extract	100
4.4	FT-IR spectrum of lycopene	102

4.5	GC-MS Chromatogram of lycopene	105
4.6	MD simulation analysis of Lycopene-1G5M complex (blue) and Lycopene complex (red)	118
4.7	Time dependent protein C α atoms RMSD	119
4.8	Protein individual amino acid RMSF of Lycopene-1G5M complex	120
4.9	Radius of gyration analysis data for Lycopene (1G5M, 4S0O) complex from MD Trajectory	121
5.1	Percentage (%) inhibition against Concentration (Camptotecin)	135
5.2	Percentage (%) inhibition against Concentration (LC)	135
5.3a	2D representation of Lycopene with pro-apoptotic BAX I protein (4S0O) indicating the amino acid residues	138
5.3b	2D representation of Lycopene with anti-apoptotic HUMAN BCL-2 protein (1G5M) indicating the amino acid residues	139
5.4a	2D representation of Camptothecin with pro-apoptotic BAX I protein (4S0O) indicating the amino acid residues	140
5.4b	2D representation of Camptothecin with anti-apoptotic HUMAN BCL-2 protein	141

LIST OF TABLES

TABLES	TITLE OF TABLES	PAGES
1.1	Carotenoid contents in tomatoes	6
2.1	Classification of fruits based on climate adaptability	15
2.2	The lycopene content of some tomato processed foods	25
2.3	Cervical Cancer Incidence in Nigeria (estimates for 2020)	48
2.4	Gaps in Literature	55
3.1	Batch composition of tomato- carrot concentrate mix	57
4.1	Effect of fortification on the moisture content (%) of tomato-carrot food mix	73
4.2	Effect of fortification on the ash content (%) of tomato-carrot food mix	74
4.3	Effect of fortification on the crude fiber content (%) of tomato-carrot food mix	75
4.4	Effect of fortification on the carbohydrate (%) and total energy (Kcal) of tomato- carrot food mix	77
4.5	Sensory Evaluation of Tomato-Carrots Powder	77
4.6	Effect of pH and titratable acidity values of the tomatoes-carrots food blends	77
4.7	Values of (g/cm ³) bulk density content	78
4.8:	Trace metals analysis of the tomato-carrots food mix	79
4.9a	Percentage Yield of the Extracts in 70% Ethanol solvent (TCE)	80
4.9b	Percentage Yield of the Extracts in 70% Ethanol solvent (TCA)	80
4.10	Qualitative phytochemical constituents yield of tomato: carrots functional food mix	82
4.11a	Total phenolic, total alkaloid, total flavonoid, lycopene and β -carotene concentration of formulations for TCE	84

4.11b	Total phenolic, total alkaloid, total flavonoid, lycopene and β -carotene concentration of formulations for TCA	85
4:12a	Effect of DPPH on TCE	87
4:12b	Effect of DPPH on TCA	88
4:13a	Effect of Ferric reducing antioxidant on tomatoes-carrots mix ethanol extracts	90
4.13b	Effect of Ferric reducing antioxidant on tomatoes-carrots mix aqueous extract	91
4.14a	Total antioxidant capacity power of tomatoes-carrots mix ethanol extracts (TCE)	94
4.14b	Total antioxidant capacity power of tomatoes-carrots mix aqueous extracts (TCA)	95
4:15	Lycopene content using different volumes of Acetone:Ethylacetate solvent	97
4.16	Compounds identified in the lycopene extract by GC-MS	104
4.17	Cytotoxicity assessment of TCE using the MTT Assay	107
4.18	Cytotoxicity assessment of TCA using the MTT Assay	110
4.19	Cytotoxicity assessment of LC using the MTT Assay	113
4.20	Cytotoxicity assessment of Camptothecin (Standard) extract using the MTT Assay	114
4.21	Binding energy and bond distance of Lycopene and Camptothecin with pro-apoptotic BAX I protein (4S0O)	115
4.22	Binding energy and bond distance of Lycopene and Camptotechin with isoform 1 of anti-apoptotic Human BCL-2 protein (IG5M)	116

LIST OF MAJOR ABBREVIATIONS

ARDS	Acute Respiratory Distress Syndromes
BHT	Butylated Hydroxytoluene
CC	Cervical Cancer
CVD	Cardiovascular Disease
CIN	Cervical Intraepithelial Neoplasia
DPPH	2,2-Diphenyl-1-picrylhydrazy
DMSO	Dimethyl Sulphoxide
DNA	Deoxyribonucleic Acid
GC-MS	Gas Chromatography – Mass Spectrometry
FTIR	Fourier Transform infrared Spectroscopy
FRIN	Forestry Research Institute of Nigeria
FRAP	Ferric Reducing Ability of Plasma
HIV	Human Immunodeficiency Virus
HPV	Human Papillomavirus
HSIL	High Grade Squamous Intraepithelial Lesion
IARC	International Agency for Research on Cancer
IC ₅₀	Half Maximal Inhibitory Concentration
IBD	Inflammatory Bowel Disease
LIC	Low- Income Countries
LSIL	Low Grade Squamous Intraepithelial
MS	Mass Spectrometry

MAE	Microwave Assisted Extraction
MT	Magness Taylor
MTT	(3-(4-5-dimethylthiazol-2-yl)-2,5- diphenyl-2H- tetrazolium bromide
NMR	Nuclear Magnetic Resonance
PAP	Papanicolaou Smear
ROS	Reactive Oxygen Specie
SCJ	Squamocolumnnar Junction
SFE	Supercritical Fluid Extraction
SSC	Soluble Solid Content
TAC	Total Antioxidant Capacity
TCA	Tomato – Carrots Aqueous Extract
TCE	Tomato – Carrots Ethanol Extract
UAE	Ultrasound- Assisted Extraction
WHO	World Health Organization

LIST OF APPENDICES

APPENDIXES	TITLE OF APPENDIXES	PAGES
1:	Effect of fortification on the protein content (%) of tomato-carrot food mix	167
2:	Effect of Fortification on the Fat Content (%) of Tomato-Carrot Food Mix	167
3:	Ethical Approval form Clifford University, Owerinta	168
4:	Ethical Approval form Covenant University, Ota, Ogun State, Nigeria	169
5:	Identification and Authentication of Fruits Samples	170

ABSTRACT

Cervical cancer poses a significant global health burden, necessitating the development of effective chemopreventive strategies. This study investigates the nutritional, antioxidant, *in-vitro* cytotoxic assessment of a functionalised tomato (*Solanum lycopersicum*) -carrot (*Daucus carota*) food mix and the effect of extracted lycopene from tomato for apoptotic assessment on cervical cancer cell lines. Proximate analysis was conducted to determine the nutritional composition, while pH, titratable acidity, and bulk density measurements evaluated the physicochemical properties of the food samples. Trace metals analysis was used to assess the presence of potentially harmful metals, and yield quantification was used to determine the extraction efficiency using ethanol and aqueous solvents. Additionally, cytotoxic effects on cervical cancer cells and molecular docking analysis were performed to understand the biological activities and binding interactions of lycopene. The proximate analysis revealed the food samples' moisture content (0.44 to 0.54%), ash content (71.82 to 73.52 %), crude protein content (8.41 to 18.10 %), crude fiber content (3.787 to 6.547 %), crude fat content (0.10 to 8.72 %), carbohydrate content (0.628 to 6.193 %), and total energy content (87.012 to 136.892 kcal). The pH values ranged from 6.6 to 7.2, indicating slight acidity variation. Titratable acidity values ranged from 1.44 to 23.00 (lactic acid %), demonstrating a decrease in acidity. Bulk density analysis revealed values ranging from 0.44 g/cm³ to 0.59 g/cm³. Trace metals analysis showed a high iron (Fe) concentration, with no significant presence of lead (Pb) or cadmium (Cd). Yield quantification of the concentrate demonstrated higher extraction efficiency using 70% ethanol solvent compared to the aqueous solvent. Cytotoxicity testing on cervical cancer cells revealed that the ethanol extract of tomatoes exhibited the highest cytotoxic inhibition (40.28 %), followed by the aqueous extract (35.21%), while carrots displayed minimal cytotoxic effects. Furthermore, lycopene extract exhibited dose-dependent cytotoxicity, with the highest concentration (1000 µg/mL) showing remarkable inhibition (74.2%). Molecular docking analysis suggested favourable interactions between lycopene and the pro-apoptotic protein (BAX 1), indicating its potential to induce apoptosis in cervical cancer cells. However, the chemotherapeutic drug Camptothecin demonstrated stronger interactions. Molecular dynamics simulations confirmed the stability of lycopene-protein complexes throughout the 100-ns simulation, supporting their potential as anticancer agents. Overall, the study highlights the cytotoxic effects of tomato-carrot food extracts and lycopene on cervical cancer cells. The ethanol extract of tomatoes and the lycopene extract exhibited notable cytotoxicity, while the aqueous extract and carrots showed minimal inhibition. Molecular docking analysis revealed the potential of lycopene to promote apoptosis through interactions with the pro-apoptotic protein BAX 1. The stability analysis of lycopene-protein complexes further supported its anticancer properties. These findings contribute to our understanding of the molecular processes behind lycopene's anticancer activities and provide insights for future research on innovative chemo preventive treatments for cervical cancer. More so, the nutritional and physicochemical properties of the tomato-carrot food mix, along with its hydroethanolic extract as an efficient extraction medium for bioactive compounds, hold promise for its application in the food industry.

Keywords: *Antioxidants, Cervical Cancer, Nutraceuticals, Lycopene, Tomato-carrot blend, Prophylactics*