

**FIRST ANNUAL CONFERENCE & WORKSHOP OF
THE CARIBBEAN DIASPORA FOR SCIENCE TECHNOLOGY & INNOVATION
AND THE CARIBBEAN SCIENCE FOUNDATION**



Research in Science and Technology in the Caribbean: An Overview

Poster Summaries

*...Mobilizing the Diaspora for Caribbean Development
through Science, Technology and Innovation...*

**LLOYD ERSKINE SANDIFORD CONFERENCE CENTRE
BRIDGETOWN, BARBADOS
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POSTER 1

REIGNITING INTEREST IN SCIENCE EDUCATION IN THE PRIMARY AND SECONDARY SCHOOLS IN GUYANA

M. Goolsarran and P. Punalall-Jetoo

Ministry of Education, Guyana

1.0 Objectives of Research

The Ministry of Education has embarked on numerous interventions to increase students' interest in Science Education. The main objectives of this research are to determine (1) what the interventions are, (2) what is the status of implementation and (3) impacts of the interventions

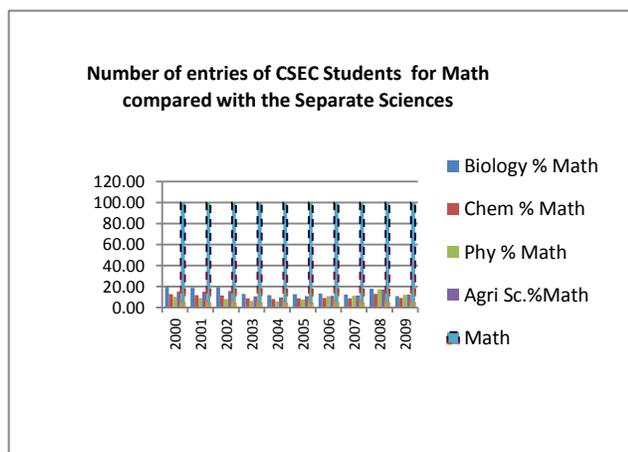
2.0 Methodology used in research

(a) Nonprobability sampling was used targeting key stakeholders within the Ministry of Education who were involved in the development of the strategic plan 2008-2013. These stakeholders included the Minister of Education, the Permanent Secretary, Chief Education Officer, Chief Planning Officer, the Assistant Chief Education Officers – Primary and Secondary.

(b) As part of the data collection process a documentation review was conducted and an analysis of the number of entries of students in the single sciences at the CSEC level. In addition a review of activities of the Science Unit was conducted.

3.0 Summary of Results

3.1 Less than 20 % of the number of students that enter for CSEC Math enters for the single sciences (analysis of entries 2000-2009). See Figure below



3.2 Interventions to increase interest in science include: the crafting of a national science and technology policy (supported by UNESCO), the reformation of teacher training programs at the Cyril Potter College of Education and the University of Guyana, development and implementation of the nongraduate and CPD courses for science teachers, investigation of the design and implementation of online courses, introduction of microscience kits in hinterland schools (supported by UNESCO), in collaboration with the Caribbean Academy of Sciences (CAS) trained teachers in the inquiry based science education (IBSE) method which was successfully implemented in Chile. Implement IBSE in 2011-2012 in selected number of Primary Schools (supported by UNESCO), development of a televised series on Biodiversity Awareness and Climate Change for Grades 9-12 students (supported by Conservation International – Guyana), development of interactive booklets and teacher's guide on climate change to facilitate infusion into the curriculum at the Primary level (supported by UNICEF), promote science and technology for national development through science and technology fair and symposium, the launch of the Guyana Learning Channel which airs science programs.

4.0 Impacts for Guyana and the Region

There is need to raise the level of national scientific literacy. The development of scientific literacy by students and teachers will ensure that Guyana harnesses its resources to alleviate poverty and raise the standard of life not only for its citizens but realize its potential as the 'bread basket of the Caribbean'. Scientific literacy will aid the development of knowledge societies which would improve the competitive advance of the region. The implementation of Guyana's Low Carbon Development Strategy to stabilize the impacts of climate change will require the use of science, technology and innovation. With rising oil prices and threats to food security Guyana is well positioned with its vast amount of untapped natural resources to feed the region. But first we must reignite interest in science education.

POSTER 2

BACTERIAL INDICATORS OF FAECAL POLLUTION IN TROPICAL WATERS

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Since Snow and Budd first linked the incidence of gastrointestinal illness with faecally contaminated water, there has been an ongoing quest to find the ideal indicator organism of faecal contamination. The Caribbean is highly dependent on tourism as a source of revenue and the beaches that the islands boast are their greatest asset. The ability to monitor and maintain the water quality of these beaches is of great importance. It is therefore of equal importance that the indicators used in determining the recreational water quality in the region are reliable at detecting faecal contamination and thereby indicating possible public health risk. The main objectives of this study were to determine the water quality of the most visited beached in Barbados and the Winward Islands, and to assess the suitability of the traditional indicator organisms (Faecal coliforms, *E. coli* and *Enterococci*) alongside two prospective indicator organisms (*Clostridium perfringens* and *Bacteroides*), for use in this tropic region. Water samples from the four islands were collected and transported to the laboratory for analysis following the guide lines outline in Standard Methods 2005. The faecal coliforms as well as the pathogens (*Salmonella*, *Shigella* and *Yersinia*) were detected and enumerated using Standard Methods 2005. The detection and enumeration of *E. coli* and *Enterococci* was done using the USEPA methods. This sampling and analysis was done both during the wet and dry seasons in each island. The results were compared to that of the USEPA standards for recreational water and the water quality of the beaches sampled was determined for the duration of the study. The correlations between each indicator and the pathogens were determined. These correlations were used in deciding which one of the indicator organisms most accurately predicts faecal contamination and thus possible public health risk.

There was no distinctive difference between the water quality during the dry and wet seasons for all the islands. Most of the beaches were safe for use based on the USEPA guidelines except for a few which were located near river discharge points. There was consistently a stronger correlation between the prospective indicators – *C. perfringens* and *Bacteroides* and the pathogens, than the traditional indicators and the pathogens. Based on these findings, it is likely that *C. perfringens* and *Bacteroides* may be better indicators of faecal contamination than the traditional indicators.

POSTER 3

ANTIMICROBIAL SUBSTANCES FROM SPONGES AND MARINE BACTERIA IN BARBADOS

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The increase in antimicrobial resistance prompted search of new inhibitory substances. In this study, marine bacteria and ethyl acetate extracts from sponges were tested for their antimicrobial activity against different bacterial indicators and one yeast. Thirty percent (6/20) of the sponge extracts were active against Gram-positive bacteria only and were subsequently found to be haemolytic. Only 0.9% (3/335) of the marine bacteria isolated produced inhibitory substances. These substances were active against Gram-positive and Gram-negative bacteria and against *Candida albicans*. The producing isolates were identified as *Alteromonas luteoviolacea*, *A. rubra*, and *Aeromicrobium marinum*. The substance produced by *A. rubra* was detected in liquid cultures. The three substances are resistant to heat (60°C, 30 min) and proteolytic enzymes (proteinase K, papain, pepsin, and trypsin). They are not haemolytic. The wide activity spectra of these substances against bacterial pathogens, their thermo-resistance, and the fact that one is easily obtained in liquid stimulates the interest for further studies.

Funded by The U.W.I. Cave Hill Graduate Studies.

POSTER 4

ANTIMICROBIAL SUBSTANCES FROM MARINE BACTERIA

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The arsenal of effective antibiotics used in clinical medicine is decreasing in the face of emerging antimicrobial resistance mechanisms. Thus, there is increasing need to find new sources of inhibitory substances. One such source is the marine environment, with its abundance of organisms that would undoubtedly have developed unique metabolic and physiological capabilities that ensure survival in diverse habitats. These capabilities offer the potential to produce metabolites that would not be observed from terrestrial microorganisms. A total of 373 isolates obtained from marine samples (sea weed, sea water, coral and sponge) were screened and of these isolates, 55 (15%) produce an inhibitory substance active against at least one indicator microorganism (*Micrococcus luteus*, *Staphylococcus aureus*, *Escherichia coli*, *Salmonella enteritidis*, *Enterococcus faecalis* and *Candida albicans*). However, only 5 (9%) isolates produce their inhibitory substance in liquid medium. These results clearly show the marine environment to be a source worth investigating for potentially novel inhibitory substances.

Funded by The Caribbean Health Research Council (CHRC).

POSTER 5

ANTIMICROBIAL RESISTANCE AMONG FAECAL COLIFORMS ISOLATED FROM CARIBBEAN RECREATIONAL WATERS.

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The contamination of recreational waters and its implications are of utmost importance in the Caribbean; especially since the islands rely heavily on tourism to generate revenue. This reliance on tourism makes the identification and determination of antibiotic resistance of faecal coliform bacteria a must. The main objectives of this research were: - identification of faecal coliform bacteria in recreational waters from the islands of Barbados and St. Lucia and the determination of the incidence of antibiotic resistance among them. Beach water samples were analyzed within 24 hours of their collection using the Membrane Filter technique. Two "presumptive" colonies from each membrane confirmed as faecal coliforms using EC broth were purified by streaking twice or thrice on mFC agar. The purified isolates were maintained on nutrient agar. The identity and antibiotic susceptibility of the isolates were determined using Vitek™ GNI+ V1316 and Vitek™ GNS-618 V4423 respectively, according to the manufacturer's instructions. A total 101 faecal coliforms were isolated: 18 from recreational freshwaters in St. Lucia and 83 from recreational marine waters in both St. Lucia and Barbados. Similar distribution patterns of the species identified as faecal coliforms were observed in marine samples obtained from both islands. However, more non- *E. coli* isolates were obtained from St. Lucia. All the isolates were resistant to at least one of the antibiotics tested. A proportion of 91% of the faecal coliforms identified were resistant to at least two of the antibiotics tested and some were resistant to nine. The distribution of resistance to different antibiotic classes was similar in both islands with resistances to cephalosporins, penicillin derivatives and nitrofurans being the most frequent. This corresponded to the antibiotics most frequently used in clinics for both countries. Some of the isolates (three *E. coli* and three *K. pneumoniae*) were determined to be extended-spectrum β -lactamase (ESBL) producers as detected by the Vitek™ system. There are high levels of antibiotic resistance among the isolates. Since antibiotic resistance can be transferred among the coliform bacteria, the treatment of water-borne diseases will be increasingly difficult and taxing. The prevalence of multiple antibiotic-resistant strains among the coliform bacteria isolated from recreational water can have a detrimental impact on the tourism industry.

POSTER 6

BIOACTIVE PRINCIPLES FROM TILLANDSIA RECURVATA: A POTENTIAL DRUG FOR ANTI-CANCER & ANTI-HIV ASSOCIATED CANCERS

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Background

The vast diversity of medicinal plants in the Caribbean, most of which are indigenous to the region, has tremendous potential to treat not only basic health care problems but more so several of the major chronic diseases worldwide. Some examples are cancer, diabetes, and HIV/AIDS. One such medicinal plant is the Jamaican *Tillandsia recurvata* species commonly called Ball Moss or Old Man's Beard, which is being fully investigated scientifically and has demonstrated powerful anti-cancer properties *in vitro* and *in vivo*. Jamaica is fortunate to have 85 of the approximately 185 well established major medicinal plants of the world.

Aim

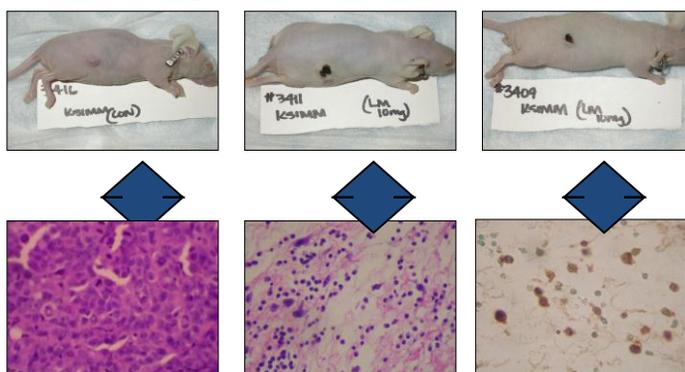
The scope of this study was to investigate the anti-tumor and anti-HIV effects of Ball Moss extracts, isolates and synthesized molecules both *in vivo* and *in vitro* in five histogenic cell lines: Melanoma, Prostate, Breast, Kaposi sarcoma and B16-Lymphoma cancer cell lines.

Methodology/Experimentation

The bioactive compounds from Ball Moss were first extracted, isolated and identified. The fresh plant material was collected from power lines in Jamaica after which it was thorough washed, dried in a steam oven at 70°C, then milled and extracted with methanol (MeOH). Isolation of the bioactive compounds was done in two phases. Firstly, isolates from the crude extract was isolated by column chromatography and sub-fractions processed by bio-guided fractionation. During phase two, advanced separation technologies, including HPLC, supercritical fluid chromatography and capillary electrophoresis, were used followed by LC/MS and finally NMR.

Results

Utilizing the bioassay-guided fractionation process, the bioactive moiety was isolated at 98% purity. This purified compound tested *in vitro* demonstrated to be highly effective at a rate of in excess of 95% cell kill in the 5 different histogenic cell lines. The *in vivo* studies were equally impressive utilizing the crude extract. All 5 different tumors responded to the treatment by reducing the tumor size from 0.4mm X 0.4mm to almost non-existent on gross examinations of tumor cell lines (Figures 1a and 1b). While the histological assessment using immuno-histochemical staining revealed that 90 to 95% of the tumors had undergone cell death which was due to apoptosis. There were no observations in the animals of any indications that there were any toxicity in the *in vivo* studies. The images below show a representative sample of gross tumors from a xenograft of the growth of Kaposi Sarcoma in nude mice and the histological results showing extensive necrosis following the use of Ball Moss extract and the immune-histochemistry demonstrating apoptosis. It is to be noted that the treatments of all five (5) cancer cell has demonstrated the same level of bioactivity. Ethical approval was granted from the University Of Maryland School Of Medicine Ethics Committee.



Discussion/Conclusion:

The findings from this study strongly indicate that these newly extracted compounds have significant anti-cancer / anti-HIV properties. More importantly, the newly isolated compound may serve as an excellent new anti-cancer drug for both women with breast cancer and men suffering from prostate cancer in the Caribbean. To date, one patent has been granted by the USA Patent Office and three (3) other patents related to isolated and synthesized compounds have recently been filed with the US Patent Office. Further developmental work is being undertaken for the ethical drugs from the isolates and synthetic molecules through collaborations with the National Cancer Institute, USA.

Funding for some of the research was provided by the Environmental Health Foundation of Jamaica.

POSTER 7

IN VITRO MODELS OF ENHANCED MESENCHYMAL STEM CELL HOMING TO BRAIN TUMORS

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Introduction

Brain cancer is a devastating ailment, leading to more than 1,300 deaths in the United States each year. Glioblastoma (GB) is the most common and aggressive type of primary brain cancer in adults. Despite the use of standard treatments, such as radiation, chemotherapy, and surgical resection, GB displays characteristic recurrence, followed by swift fatality within two years. In the search for more effective therapies, recent studies have specifically targeted multipotent adult mesenchymal stem cells (MSCs) to brain tumor (glioma) microenvironments. MSCs have obtained significant interest as drug delivery tools due to their intrinsic tropism for tumors *in vivo*. The ability of MSCs to breach the blood brain barrier (BBB) provides the unique potential to treat brain disorders, namely brain cancer. However, delivery of MSCs to specific tissues, especially to the brain, has faced some limitations in efficiency for reasons not fully understood. We hypothesize that modulation of MSCs can enhance their delivery to the brain.

Methods

Our studies employ commercial and primary-cultured human adipose-derived mesenchymal stem cells (hAMSCs), which benefit from less invasive isolation than bone marrow-derived cells. We characterized these cells through marker expression (flow cytometry) and differentiation analyses. Utilizing novel micro- and nanotechnology, e.g. microfluidics and patterned cell substrates, we developed intricate *in vitro* models to analyze the multi-step process by which hAMSCs reach tumors. Our experiments have specifically investigated the putative MSC homing steps of firm adhesion, endothelial invasion, and migration. We analyzed effects on these processes by soluble factors in glioma-conditioned medium (GCM), and by immobilized extracellular matrix (ECM) proteins. GCM was harvested following overnight (≥ 18 hours) culture of monolayers of human GB cells in serum-free medium.

Results

We have established the identity of adipose cells from primary and commercial sources as mesenchymal stem cells. We demonstrated expression of established mesenchymal markers (CD70, 90, 103) and lack of endothelial markers (CD31, 45) by hAMSCs. In addition, we observed their multi-lineage differentiation to adipocytes, osteocytes, and chondrocytes. Through exposure of hAMSCs to soluble and immobilized proteins, we have observed enhanced homing *in vitro*. hAMSC adherence to blood vessel endothelium, measured by numbers of flowing cells that attach to endothelial monolayers, is improved following exposure to GCM ($p \leq 0.05$). hAMSCs also demonstrate transmigration towards GCM through models of the basal lamina and the BBB ($p \leq 0.05$). Other results show enhanced migration (measured by speed, alignment, and persistence) of hAMSCs exposed to GCM and grown on the ECM protein, laminin ($p \leq 0.05$).

Conclusions

Our results suggest that specialized culturing methods can enhance specific elements of the MSC homing process, which may lead to *in vivo* applications. This approach mirrors previous reports that have improved engraftment to other target tissues, e.g. the heart. Uncovering methods to improve tissue-specific MSC localization could revolutionize drug delivery for various diseases.

Funding Support: UNCF-Merck Graduate Science Research Dissertation Fellowship

POSTER 8

CHEMOPREVENTIVE PROPERTIES OF JAMAICAN PLANTS

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Objective

To investigate Jamaican plant extracts for cytochrome P450 activity and anticancer properties. The inhibitory effect on human liver microsomes and recombinant cytochrome P450 (CYP)1 family of enzymes for potential chemopreventive properties, and potential drug-herb interactions.

Introduction

The island of Jamaica is home to a diverse flora and fauna, some of which are endemic to the island. Historically, the extracts from plants grown on the island have shown bioactivity, ranging from anti-helminthic, anti-bacterial to fungicidal. Knowledge of Jamaican plants anti-cancer properties, or drug-herb interactions are not well known. Our studies examine novel and known plant extracts for any anti-cancer properties and their interactions with common drug metabolizing enzymes.

Method

Plant extracts were investigated for their inhibition of the activities of heterologously expressed CYP microsomes (CYPs 1A1, 1A2, 1B1, 2C19, 2D6 and 3A4) and human liver microsomes using a fluorescent assay.

Results

Some the plants extracts examined showed potent inhibition of CYP1A1 and CYP 1A2, that is ($IC_{50} < 1\mu M$) while, others gave moderate inhibition ($IC_{50} > 10\mu M$). Compounds displaying moderate to potent inhibition were further analysed to determine whether they interacted competitively or non-competitive with the enzymes CYP1A1 and CYP 1A2. Further characterization of these compounds with the major drug metabolizing enzymes; CYPs2C19, 2D6 and 3A4 showed weak to moderate inhibition. Plants displayed potent inhibition to CYP 1family of enzymes, were those having high antioxidant properties, and some traditionally used as teas and in concoctions. When these plant extracts interacted with human liver microsomes using CEC as a substrate, IC_{50} value were in the $< 1\mu M$ range.

Conclusions

The potent and selective inhibition against CYP1A1, CYP 1A2 using both HLMs and recombinant CYPs indicate plants with high antioxidant properties, and traditionally used in teas have potential for *in vivo* chemopreventive properties.

Funding: UWI Graduate Studies grants and EFJ.

POSTER 9

SYNTHESIS OF BIODEGRADABLE COPOLYMERS FOR ANTIMICROBIAL APPLICATIONS

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Contamination by microorganisms is of great concern in a variety of areas, such as medical devices, healthcare products, water purification systems, hospitals, dental office equipment, food packaging, food storage, household sanitation, etc. Antimicrobial agents are materials that have the ability to kill pathogenic microorganisms. Development of antimicrobial agents based on polymer research presents great current interest and have not received much attention yet. Compared to the environmental problems associated with synthetic non degradable polymers, Green Polymers are very good alternatives for the above applications. Synthesis of green biodegradable polymers is quite attractive due to their unique properties such as excellent biodegradability, non-toxic and capable of chemical modifications. In the present work we have synthesized a novel biodegradable copolymer DL-maleic acid- tartaric acid through thermal polymerization of DL-maleic acid (MA) and tartaric acid (TA) followed by direct bulk melt condensation technique. Antibacterial properties of copolymer of maleic acid based were investigated as a function of tartaric acid content and compared with homopolymer. Results showed that inhibition properties increase with increasing copolymer dose. The obtained copolymers were characterized by Fourier transform infrared spectroscopy (FTIR). The antibacterial activity of copolymers against bacteria *E. coli* was investigated. The copolymers showed excellent antimicrobial activities against the microorganisms and the results indicated that the above copolymers may be used as antibacterial agents.

POSTER 10

NOVEL SODIUM ALGINATE–ACRYLIC ACID INTERPENETRATING NETWORK (IPN) MEMBRANES FOR PERVAPORATION DEHYDRATION OF ACETIC ACID

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More recently, the conventional separation methods have been supplemented by processes that utilize semi permeable membranes as separation barriers. Although membranes and membrane processes were first introduced as an analytical tool in chemical and biomedical laboratories, they developed very rapidly into industrial products and methods with significant technical and commercial impact. Membranes have gained an important place in chemical technology and are being used increasingly in a broad range of applications. Pervaporation has been accepted as a promising membrane technology because of its energy-saving, one-step separation process compared to distillation, especially for the fractionation of liquid mixtures such as azeotropes, close-boiling mixtures, heat-sensitive compounds. The present work demonstrates the synthesis of IPN membranes for PV separation of water-acetic acid mixtures, for the first time. Novel interpenetrating polymer network (IPN) membranes based on sodium alginate (NaAlg) and acrylic acid was prepared by free radical polymerization. Further the membranes were crosslinked with glutaraldehyde as the cross linking agent in presence of water-acetone mixture (30:70). The membranes were applied for pervaporation (PV) separation of water/acetic acid mixtures of varying feed compositions. IPN Membrane containing 10 wt. % of acrylic acid exhibited the highest selectivity 8991 with a moderate flux at ambient temperature.

POSTER 11

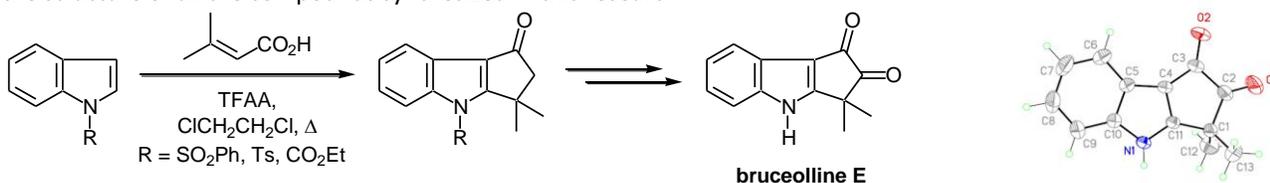
THE FIRST TOTAL SYNTHESIS OF BRUCEOLLINE E

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Our interest in the cyclopenta[b]indolone natural products such as scytonemin¹, nostodione² and bruceolline E³ has mainly stemmed from their unique structural arrangements and their potential medicinal properties.⁴ As such, we have investigated the use of a tandem acylation/Nazarov cyclization, first utilized by Song and co-workers,⁵ with indoles bearing protecting groups. It was pleasing to observe that the cyclization occurred with electron-withdrawing protecting groups, with the highest yield being observed with ethyl indole-1-carboxylate (R = CO₂Et). The natural product, bruceolline E, was then generated using a selenium dioxide oxidation protocol⁶ to install the α -diketone functionality followed by deprotection. Spectroscopic analysis (NMR, UV and IR) and X-ray crystallography were used to unequivocally determine the structure of all the compounds synthesized in this research.



Acknowledgements

Financial support from the UWI and the Government of Barbados is gratefully acknowledged.

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POSTER 12

HPLC ESI MS CHARACTERIZATION OF FLAVONOIDS AND PHENOLIC ACIDS FROM CARIBBEAN ASTERACEAE AND LAMIACEAE PLANTS WITH BIO-ACCUMULATOR POTENTIAL

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Flavonoids, polyphenols, are receiving increasing attention by analytical chemists in an effort to elucidate structure profiles and investigate their physiological potential related to oxidative stress. Their antioxidant potential is implicated in the mitigation of cellular degeneration initiated by free radicals. They are ubiquitous in the plant kingdom where they provide functions critical for survival including promotion of growth, protection from invasive species and enhancement of tolerance to abiotic stressors. Improvements in analytical techniques including separation protocols and spectroscopic methods of analysis have led to resurgence in the quest for novel flavonoids. As part of an exchange technology program between the government of Barbados and Environment Canada, extracts from species selected from the flavonoid rich plant families of Asteraceae and Lamiaceae, were characterized using mass spectrometry. The species selected are part of the Caribbean Pharmacopoeia and are used for a variety of health issues including diabetes and hypertension. The link between longevity and the use of these, and related species, in medicinal teas in Caribbean territories is being explored. The extracts were investigated for structure elucidation of flavonoids, identification of any chemical taxonomic profile and evidence for bio-accumulator potential.

The Asteraceae species, *Chromolaena odorata* and *Pluchea carolinensis*, on analysis of mass spectral data including negative ion ESI MS², provided known flavonoids including, the very common, quercetin and its conjugate glycoside rutin, as confirmed with the aid of authentic standards. Interestingly, a number of isomeric flavonoid and phenolic acid conjugates were also indicated by their RT values and fragmentation patterns. Diacyl and triacyl chlorogenic acid conjugates were identified by the successive loss of moieties of mass 162 from the [M-1]⁻ ion. The structure profile provided for *P. carolinensis* is valuable as this particular species has not been extensively investigated for flavonoid content. The Lamiaceae species, *Plectranthus amboinicus*, was chemo-taxonomically different, as expected, with no predominance of isomeric flavonoid conjugates detected. However, evidence of methoxylation at the flavonoid rings was significant with the detection of [M-1-CH₃]⁻ and [M-1-CH₃-CH₃]⁻ ions. The flavonoid and phenolic acid, composition was similar in both methanolic and aqueous extracts but some difference in percentage composition was evident from peak intensities. The trend of conjugate formation could have relevance for the bio-accumulator potential of the Asteraceae species. Recent studies have shown that flavonoid conjugates are frequent constituents of many salt-tolerant and water-stress resilient plants. There is a tendency for glycosidic derivatives being acylated to acids such as caffeic, ferulic and p-hydroxybenzoic. This suggests that there is potential for the bioaccumulation of acids, such as naphthenic acids from oil sands, by these species.

Funding for this research was provided by the National Council for Science and Technology, Barbados, and the Water Science and Technology Directorate, Aquatic Ecosystem Protection Directorate, Environment Canada

POSTER 13

MECHANICALLY INTERLOCKED SUPRAMOLECULAR ASSEMBLIES – THE FAMILIAR [4]SUITANE AND THE NEW KID ON THE BLOCK, THE INVERTED SUITANE

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Pseudorotaxanes are supramolecular species consisting of a macrocyclic portion (typically rich in hydrogen-bond acceptors) through which a linear molecular axle (featuring a hydrogen bond donor) threads and forms a stable complex. Here we discuss the use of pseudorotaxanes as precursors to more complex systems – namely “Suitanes”.^{1,2} The first suitane was synthesized by Williams *et al.* in 2006 through the combination of template-directed pseudorotaxane formation and mechanical bonding via dynamic imine formation.¹ All suitanes isolated thus far consist of a rigid scaffold bearing the cationic component and functionalized macrocycles which can form stable complexes with the scaffold. Subsequent condensation with linking molecules (typically amines) yields the supramolecular structure.

We are conducting studies aimed at the isolation of novel suitanes. Here we utilize the well-studied dialkylammonium recognition motif as the cationic portion of the supermolecule. These components are synthesized via reductive amination followed by protonation and counterion-exchange. Crown ether derivatives comprise the macrocyclic

component of the assembly. Dipyrido[24]crown-8 (DP24C8) forms more stable complexes with dialkylammonium species and in less time than the widely-used dibenzo[24]crown-8.³ Hence we utilize DP24C8 in our studies synthesized through a macrocyclisation reaction between a functionalized pyridine and di(ethylene)glycol. Once a stable pseudorotaxane is formed, dynamic imine formation allows isolation of the mechanically bonded species. Currently we are developing an anthracene-based suitane which may lend itself to application as an organic electroluminescence device and a porphyrin-based suitane which may be useful in the development of dye-sensitized solar cells or perhaps chemical-sensor applications. We have also proposed the synthesis of a sub-set of suitanes known as the inverted suitanes. Here we employ a reversed role of the recognition motifs where the macrocyclic component of the assembly is incorporated into a rigid scaffold to which cationic threads will bind - allowing mechanical bonding to be achieved through reaction between the functionalized cationic components and linking molecules.

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POSTER 14

An Initial Overview of the Caribbean WELCOME Project: Analysis of Results from Trinidad and Tobago Data

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While knowledge and innovation play increasingly important roles in achieving economic growth and competitiveness, like many elsewhere, the Caribbean research community struggles with limited capacity for leveraging science and technology research into solid and credible innovation. Innovation offers solutions to many regional challenges including energy and food security, climate change, poverty and health, wealth generation and sustainable job creation. Creating and transforming new knowledge into products, processes or services that meet national and regional market needs however, remains a critical but elusive target for both private businesses and public economic development agencies.

The ultimate goal of this tri-country, EU-funded research study was to strengthen the intra-Caribbean science, technology and innovation capacity to enable sustainable growth and development, particularly in Jamaica, St. Lucia and Trinidad and Tobago. The in-depth study used a structured questionnaire and interview protocol highlighting the application of the knowledge triangle concept of interactions between firms, research institutions and government and the public sector, to examine and/or understand (i) the quality and quantity of support services available for innovative activities in regional firms; (ii) the extent of industry-science relations; (iii) the barriers and drivers of such cooperation in the Caribbean, and (iv) the importance of inter-regional cooperation as a method of promoting innovative business development and transferring knowledge into Caribbean firms and organizations.

The results of the study of twelve (12) small and medium-sized firms (SMEs) and five (5) research institutions in Jamaica highlighted many research and innovation needs of local firms particularly in the areas of support and collaboration. Results suggest that companies' difficulty to innovate and achieve a competitive advantage in their prevailing market is due to barriers including financing, expertise and capacity. While organizations understand the need to innovate so as to attain business objectives, without the requisite support of knowledge triangle collaborations, companies find this goal beyond reach.

Overall research results make a powerful case for policies that focus on key sources of economic growth from innovation, particularly core policy action areas focusing on the role of universities and research institutions at the centre of the knowledge transfer and innovation process. The study results can help shape both policy and practice for stakeholders in the knowledge triangle for leveraging the output of science and technology research into solid and credible market innovations for business growth and sustainable development. Robust strategies can be developed for removing barriers and meeting support needs through policies and practices informed by actual, credible regional data. Companies along the entire value chain can pursue innovation as a broad business-led approach for the furtherance of commercial goals, and the fuel for economic growth. Specific research results also offer potential for improving both the environment for and funding of research for development, and the knowledge transfer process into innovations that spur entrepreneurial activities leading to economic growth.