جامعة السلطان قابوس
Sultan Qaboos University

Oman Animal & Plant Genetic Resources Center

حديقة القرآن النباتية
QUR'ANIC BOTANIC GARDEN
عضو في مؤسسة قطر
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Research Abstracts Book

First International Conference on Frankincense and Medicinal Plants: Recent Advances in Research and Industry

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Introduction by Dr. Rahma Al-Mahrooqi
Deputy Vice-Chancellor for Postgraduate Studies and Research
Sultan Qaboos University - General Supervision

Medicinal plants have long played an important part in the history of human development. Their efficacy in treating diseases and allowing people to maintain physical and psychological well-being has ensured that their use continues to be widespread, even in the current era. In addition to the growing popularity of traditional medicines, which often heavily rely on the use of medicinal plants, there has been a renewed level of interest worldwide in both herbal medicines and plant-based drugs. This interest is associated with both an understanding of the potential advantages of herbal medicines, whether as a complement or alternative to modern drugs, and the need to develop new drugs from medicinal plants that can treat diseases that we still struggle to contain. The use of medicinal plants not only has the potential to offer alternative approaches to drug development and the treatment of disease, but also has applications in cosmetics and various other industries. It also often has significant cultural and historical value associated with the preservation of living heritage and tradition. One prime example of this is the place that medicinal plants, and, in particular, frankincense, has played in Oman's history over the course of thousands of years. The Sultanate of Oman is blessed with a high degree of biological and environmental biodiversity that includes a wide range of medicinal plants. It is due to this diversity that, for hundreds of years before the advent of Oman's modern era in 1970 and the subsequent introduction of a universal health care system, medicinal plants played an important role in the lives of people and communities across the sultanate.

Even now, with the impressive progress that Oman has made towards modernization, medicinal plants continue to play an important role in the lives of many people around the country. Examples of this are many, and include the traditional medicinal uses of aloes, clove, cinnamon bark, bitter apple, garlic and so on for a variety of ailments ranging from colds and fevers to stomachaches and insect bites. However, perhaps the natural substance that is most commonly associated with Oman is frankincense. The history of frankincense, including its use as an incense, in perfume, to repel insects, and in traditional medicines, both within Oman and in nations all over the world, is closely tied with the history of the country itself. In this booklet, readers will find abstracts from presentations to be made at the First International Conference on Frankincense and Medicinal Plants: Recent Advances in Research and Industry, organized by Sultan Qaboos University, the University of Nizwa, the Oman Animal and Plant Genetic Resources Center, and Qatar's Qur'anic Botanic Garden. The conference was held at Sultan Qaboos University from the 30th of October to the 1st of November, 2018. The presentations, which are divided into the tracks of Traditional Use, Taxonomy, Horticulture, Conservation, and Harvesting, and Chemistry, Biology, and Health Aspects, contain a great deal of information about the many opportunities and challenges associated with the production, preservation, and use of medicinal plants, while also underlining the cultural, economic and environmental value of these plants, including frankincense, for producing countries such as Oman. I hope that this booklet will be of benefit to academics, producers, businesspeople, consumers, and all other stakeholders who share an interest in field-related developments and directions, and will promote the exchange of information and knowledge about these valuable resources.

Introduction By Prof. Ahmed Al-Harrasi
Vice Chancellor for Research, Graduate Studies & External Relations
University of Nizwa - Conference Chairman

The organizing committee of the The First International Conference on Frankincense and Medicinal Plants has planned this conference to be a premier technical event for the advancement of medicinal plants research with an emphasis to frankincense. This inaugural conference assembles nationally and internationally recognized experts from more than 25 countries in one venue in medicinal chemistry, micro- and molecular biology, horticulture and medical sciences as well as frankincense-based industries.

This conference is taking place at a time of increasing global economic and medical attention in this area, and at a time of growing research interest in natural products in order to examine their potential uses and sustainability. Frankincense has played a pivotal role in many world civilizations, and has been described in the largest medical manuscripts and pharmacopeias. Now, the interest in frankincense is rising again because of the exceptional medical importance of this great substance. The sultanate boasts a huge variety of medicinal and aromatic plants that are distinguished by the unique environmental diversity of the Omani environment; however, frankincense remains foremost amongst these in terms of importance. It is for these reasons that the two universities and other participating organizations have decided to establish this international conference to discuss the latest scientific, medical, physiological, chemical and the historical aspect of frankincense and medicinal plants.

Keynote Speakers

Name: Prof. Anne Osbourn
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Title: Harnessing Plant Chemical Diversity

Abstract:

Plants produce a wealth of natural products that are valuable as industrial or pharmaceutical products. The growing reliance on chemicals from plants is driving demand for green, environmentally friendly and sustainable feedstocks across industrial sectors in order to enable us to reduce our dependence on products derived from chemical refineries. Importantly, many of the natural products that are produced by plants are structurally complex and beyond the reach of chemical synthesis. These compounds are commonly extracted from plant material either growing in the wild or in cultivation. Availability is limited by difficulties in accessing and cultivating source species, low yield and problems of purification. The scale of the economic opportunity for improving the supply of high value products from plants is therefore enormous.

The vast majority of the natural product diversity encoded by plant genomes remains as yet untapped. The explosion in plant genome sequence data, coupled with affordable DNA synthesis and new DNA assembly technologies, now offer unprecedented opportunities to harness the full breadth of plant natural product diversity and generate novel molecules in foreign hosts using synthetic biology approaches. The recent discovery that genes for the synthesis of different kinds of natural products are organised in biosynthetic gene clusters in plant genomes opens up opportunities for mining for new pathways and chemistries. This advance, in combination with powerful new transient plant expression technology, is enabling the development of rational strategies to produce known and new-to-nature chemicals tailored for particular applications. This presentation will focus on our work on developing a translational synthetic biology pipeline for rapid preparative access to plant natural products and novel analogs using synthetic biology approaches, with particular emphasis on triterpene biosynthesis.

Name: Dr. Efim Rezvan

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Title: Arabian Spices and Rites of Passage

Abstract:

Arabian frankincense has a wide range of useful properties that are important for the treatment of diseases of the respiratory system, digestive system, and skin diseases. It has a strong anti-inflammatory effect, a beneficial effect on the human nervous system and so on. However, these properties are not enough to explain the fact that for millennia people were willing to pay huge amounts of money for frankincense. Meanwhile, a series of ancient sources report the use the various types of frankincense primarily in rites of passage. The latter are a series of ritual ceremonies accompanying the transition of a person from one state to another, from one world (cosmic or social) to another.

The ancient sources indicate two key ceremonies in which Arabian frankincense was used – this is the birth of a person and their death. The birth of a child is the death of the fetus. In the opinion of a number of leading specialists, the "expulsion" of the fetus from the mother's womb is the main trauma that determines the development of neuroses. Today, a number of specialists consider to be practically proved the influence of the mother's psychological and physical state and her experience during pregnancy and childbirth on the subsequent behavior of the offspring (at the genetic and hormonal level), not only in the first generation, but also in the future. The leaving of life was also unthinkable without these substances (primarily myrrh).

The Gospel story of the Magi gifts who, as we now know, came from Dhofar and offered Jesus "gold, incense and myrrh" (in fact, the incense of spring assembly, the incense of autumn assembly and myrrh) is called to bring to us the age-old wisdom of mankind.

Name: Prof. Ermias Dagne

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Title: Comparative Chemical Study of Resin and Bark of African and Arabian Frankincense

Abstract:

Boswellia species (Family Burseraceae) are excellent sources of culturally, medicinally and commercially important frankincense resins. North Eastern Africa and the Arabian Peninsula are the centers of origin of *Boswellia* species.

B. *carteri* of Somalia, previously considered as a distinct species, is now found to be botanically the same as B. sacra of the Arabian Peninsula. Hence, the new name for both species is B. sacra syn. B. carteri. In our research group, qualitative and quantitative analytical methods were developed using Camag TLC Scanner and NMR methods to compare marker compounds of eight Boswellia species. Our results show the closeness of the constituents of the Omani resin B. sacra with that of the African B. *carteri*.

The unique resin B. papyrifera occurring in Ethiopia and the Sudan yields exceedingly popular incense when burnt. We have found in the EtOH extract of this resin the two most potent anti-inflammatory and anti-cancer compounds, namely 11-keto-ß-boswellic acid (1, 8%) and 3α-acetyl-11-keto-ß-boswellic acid (2, 14%). Both compounds are also the main bioactive constituents of the resin of B. *serrata* which is widely used in Ayurvedic medicine in India.

It is interesting to note that extensive information in the scientific literature is found for the Indian B. serrate. However, our chemical studies confirm the presence of the main bioactive compounds of the Indian species in the Arabian B. sacra syn. B. carteri and the African B. *papyrifera*. These results clearly show that the African and Arabian Boswellia resins can also be put to similar use as the Asian B. *serrata.*

Name: Mr. Jason Eslamiah

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Title: Preservation through Horticulture – Propagation, Hybridization, and Selective Breeding for Designing Frankincense

Abstract:

A brief analysis of Boswellia in habitat, the absence of regeneration and why, the losing proposition of demand and supply. A discussion on the viability of farming for frankincense, as perhaps the only alternative to meet the ever-increasing demand of the global market. An understanding of what it takes to propagate, cultivate, and farm Boswellia to meet industry needs - whether it is for essential oil, pharmaceuticals, or the perfume industry. The opportunity for hybridization and selective breeding producing new species by design so that their resin output meets specific needs in holistic medicine or beauty products.

Name: Prof. K. Husnu Can Baser

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Title: Global Trade and Potential of Essential Oils

Abstract:

Essential oils are a complex mixture of volatile chemicals mainly found in plants. Animals, liverworts, mosses, microorganisms and marine organisms also bear natural volatiles. Essential oils can be liberated from their matrix by distillation (e.g. water distillation, water and steam distillation, steam distillation) or expression in the case of citrus fruits. Supercritical fluid extraction and solvent extraction are used to extract aromatic extracts which are not technically considered essential oils.

Essential oils are ingredients of flavour and fragrance materials for use mainly in food and beverage, perfumery, cosmetics and toiletries, wellness and aromatherapy, spa and relaxation, healthcare, pharmaceutical and chemical industries. They also possess various biological activities and, in recent years, their use in feeds as antibiotic substitute and growth promoter is on the rise.

The global market of essential oils stands at $6.5 billion, with a projected rise by 8.4 to 11.3% to $14 to 15.8 billion in 2024-2025. Orange oil tops the list of most globally traded essential oils constituting ca. 22% of the global market revenue followed by lemon, lime, peppermint, corn mint, citronella, spearmint, geranium, clove leaf, eucalyptus, jasmine, tea tree, rosemary, lavender oils, etc. Europe dominates the market with Brazil, China, USA, India, Indonesia, Mexico, Morocco, Egypt, Guatemala, etc. as major producing countries.

The special case of frankincense in this trade shall also be discussed.

Name: Prof. Rene Csuk

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Title: How to Improve the Cytotoxicity of Beta-boswellic Acid? A Case Study

Abstract:

Natural products remain one of the best sources of drugs and drug leads. They possess enormous diversity being unsurpassed by any synthetic library. They are evolutionary optimized as drug-like molecules. Among natural products, triterpenes play a special role, and more than 20,000 of them have been isolated so far. Triterpenes and triterpenoids are often bioactive and present a huge therapeutic potential. One of the most interesting scaffolds is represented by pentacyclic ß-boswellic acid – an ursane-type triterpene. This molecule can be extracted from frankincense and larger amounts of acetyl-keto-ß-boswellic acid (AKBA) can be synthesized in good yields from commercial frankincense. While the parent compound is of minor cytotoxicity, simple derivatization led to analogs being highly cytotoxic for a variety of human cancer cell lines while being significantly less cytotoxic for non-malignant cells.

Bioactivity-driven optimization finally led to analogs acting as mitocans and showing nano-molar EC_{50} values as well as to analogs whose cytotoxicity can be switched on/off at will. The presentation will provide a roadmap for the synthesis of highly active compounds including structure-activity relationships.

Name: Dr. Sabina Knees

Affiliation: Royal Botanic Garden Edinburgh, UK

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Title: *Boswellia* Roxb. ex Colebr: Taxonomic Challenges Presented by Biodiverse Genera with Large Geographic Distributions

Abstract:

Boswellia is a genus of ca. 25 species with a wide distribution in NE Africa, the Arabian Peninsula and on Soqotra, with widespread tropical taxa in Africa and one or two species in India. Centres of species diversity are focused on Soqotra and NE Africa, including many local endemics that are spatially restricted. Boswellia sacra is the principal source frankincense, but high quality resins are also harvested from the Somaliland species B. frereana, in addition to B. serrata from India, and some Soqotran species The taxonomy of the genus is complex and various floristic accounts have concentrated on local geographic areas rather than examining the genus in its entirety. Recent molecular phylogenetic work has shown that the Soqotran taxa are all one clade and that by using certain molecular markers the species can be more or less distinguished from each other. The results conclude that they are very closely related and it is likely that they only arrived and speciated on Soqotra during the last 2 million years. The Soqotran taxa are very variable - they exist as tall trees, procumbent shrubs and also as cliff-dwelling trees with root holdfasts that anchor them to the substrate. The leaves can take many forms, the flowers are different colours, and it is likely that there are a number of potential hybrids occurring between species in places where they grow together. This paper will discuss the importance of understanding the taxonomy and biogeography of complex taxa with large geographic ranges and how this underpins research in other diverse but related disciplines such as conservation, biochemistry and pharmacology.

Name: Prof. Nicolas Baldovini

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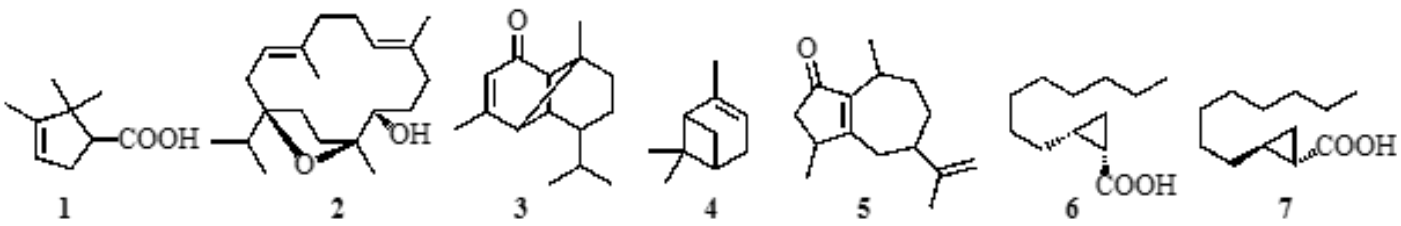
Title: Analytical Study of Commercial Frankincense Essential Oil. The Quest for its Odor Active Constituents

Abstract:

The determination of the most important olfactory contributors of a fragrant natural raw material can be an extremely long and complex task which requires the combination of very efficient analytical techniques. Indeed, the main odoriferous contributors are often strongly potent odorants contained only in trace amounts, and therefore, their identification requires an exhaustive analysis of the whole mixture. Consequently, there is still a lack of accurate knowledge about the key odorants of many natural raw materials, even those widely used in the flavor and fragrance industry.

Even if some authors described frankincense as one of the first aromatic materials used by humans[1], the literature concerning its main odor-active constituents is rather poor and somewhat contradictory. Obermann reported that some of its monoterpenic acids possessed a characteristic olibanum odor[2], and De Rijke mentioned that α-campholytic acid 1 had a "rather strong odour, reminiscent of the oil"[3]. More recently, Hasegawa mentioned that the diterpenic constituents such as incensole 2 were important odor components[4] and finally, Niebler et al.[5-6] published detailed Gas Chromatography-Olfactometry (GC-O) analyses of several samples of Frankincense gum resin. The most important identified odorant constituents were mustakone, α-pinene, and rotundone (3-5 respectively).

Our GC-O investigations on frankincense essential oil[7] led to the characterization of (+)-cis- and (+)-trans-olibanicacids(6-7),twonewhighlypotentodorantconstituentsofFrankincense.Theirstructures were confirmed by synthesis, and these results bring complementary data to the works published so far.



Main frankincense odorants reported in the literature

Featured Speakers

Name: Dr. Shahina A. Ghazanfar

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Title: Medicinal Plants of the Middle East

Abstract:

The recorded uses of plants as medicinals in the Middle East dates back to over 5000 years to the earliest known civilizations, the Sumerians in southern Mesopotamia (modern day Iraq). Uses of plants such as laurel, caraway and thyme were described for treating diseases and ailments. The use of castor oil, coriander, garlic, indigo, mint and opium has been recorded by the Egyptians from about 1000 BC; the Chinese herbals from about 2700 BC, and the uses of turmeric have been described in Indian Ayurvedic medicine as early as 1900 BC. Plants (and animals and minerals) have been used by the ancient Greeks who also developed the principles of diagnosis and use of plants which eventually became the basis of modern medicine. The concepts of Greek medicine were acquired by the Arabs, developed and adapted by Muslim scholars into the Islamic system of medicine. The earliest Muslim scholars in the 9th and 10th centuries, such as Ibn Sina, wrote many medical texts on medicine, which later became standard medical texts in European medical practices up until the 17th century.

In the Middle East, over 200 plants are known to be used as herbal medicines. These are used as carminatives, laxatives and anti-diarrhoeals, anthelmintics, to relieve muscular pain and swollen joints, skin disorders, burns, wound, insect stings and bites, as diuretics and for urinary disorders, in childbirth and pre- and post-natal care, for cold, coughs, fever, headaches and as health tonics. Several plants have certain cultural values and are also used in herbal medicine.

It has been investigated that medicinal plants are not distributed randomly across lineages, and that closely related taxa have significantly more uses than those that are evolutionarily isolated. Thus, using a phylogenetic comparative approach, along with traditional knowledge of plant uses can be helpful in identifying new taxa with medicinal uses in the Middle East.

Name: Prof. Hala Al-Easa

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Title: Qatar's Natural Pharmacy

Abstract:

Plants, in addition to their appealing value, constitute the major natural source of the food we eat, the air we breathe, and the medicine to cure our many diseases. The relationship between man and plants has always been a very close one throughout the development of culture; no doubt, the herbalist is probably one of the first professionals in the evolution of human cultures. In historical times, the significance of medicinal plants is evident in all major civilizations of antiquity. The importance of the herbalist to humans during our long history is immense. Many drugs, considered entirely synthetic, are somehow, somewhere rooted in botanical history in the old time use of some sort of crude plant drug. In contrast to the many preceding centuries, herbal medicine has for decades seemed to take a distant back seat to the numerous synthetic drugs available. The last two centuries have witnessed a tremendous boom in the synthetic drug industry. Fortunately, the health planning strategies of many countries are now taking into account the serious evaluation of traditional medicine. This motivation stems from the present realization of the importance of medicinal plants, particularly after the spectacular successes in this field in China and India.

The wild flora of Qatar consists of 397 species belonging to 239 genera and 57 families distributed in its different localities that vary in type of soil and environmental conditions. From these, 129 species belonging to 42 families were reported to have medicinal use in Qatar. Medicinal plants have an important role in human natural health and serve as essential raw materials to manufacture modern medicines. These 129 species were studied to identify the main biologically active secondary metabolite and to separate and identify the structure of these active compounds. The role of medicinal plants in therapeutics is evident where more than 75% of the prescriptions written worldwide contain at least one natural plant origin ingredient.

Name: Dr. Frans Bongers

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Title: The Future of Frankincense in a Changing World

Abstract:

Frankincense, the famous resin from Boswellia trees, has been traded for millennia, mainly from the Arabian peninsula and the Horn of Africa. Boswellia papyrifera is currently the main producing species and it occurs in large extensions in the Horn of Africa. Currently the dry forests in which Boswellia thrives are under serious threat from conversion to agricultural land, cattle grazing, fire and intensive exploitation for wood, fodder and frankincense. FRAME is a multidisciplinary project aimed at evaluating possibilities for more sustainable use and management of frankincense trees and their forests.
We analysed many populations in Ethiopia, Eritrea and Sudan, and found that regeneration is practically absent, that adult trees have high mortality rates and that populations are declining fast. In 50 years populations have halved. Frankincense yield varies between 50 and 1800 g per tree per year and area-based production will be halved in 15-20 years at current population decline rates. Production management strategies are diverse and depend on the region and the alternatives for lively-hoods. The change from a highly centralized concession system to a decentralized, cooperative-based concession system has adverse effects as lease times are shortened and as a result use intensities are increasing. Climate change may aggravate the situation. If wet season decreases in length, carbohydrate reserves will decrease and following dry-season frankincense production may collapse. The waiting in the underground strategy – young plants that for many years invest in belowground structures before producing a permanent aboveground stem – is ideal to cope with uncertain dry periods, but may only lead to sapling regeneration if a number of years with adequate environmental conditions without strong adverse conditions (e.g. fire, cattle and goat grazing) will occur.

Under the current socio-economic and environmental conditions, the frankincense tree population will continue its decline and jeopardize future frankincense production.

Oral Presentations

Name: Tony Cunningham

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Title: *Boswellia frereana* Birdw: Balancing Harvest and Trade

Abstract:

Boswellia frereana is a slow growing deciduous tree species that is endemic to a small area of the Horn of Africa. The only Range States are north-eastern Somalia and the neighbouring self-declared state of Somaliland. B. frereana trees are wild harvested for the most valuable type of frankincense (or olibanum), known as maydi (or meydi) in Somalia or Coptic frankincense in Europe. Internationally, B. frereana resin is considered the most expensive type of frankincense (Zhang, et al., 2013). It is also prized as an incense in both Islam and in Christianity, such as by the Coptic Church of Egypt. Because B. frereana resin is not bitter (unlike resin from Boswellia sacra) it is also popular as a "chewing gum" in the Arabian Peninsula (Thulin & Warfa, 1987). Saudi Arabia is the largest importer of maydi frankincense. The essential oils distilled from B. frereana resin are also used as a component of perfumes/fragrances and flavours, medicinal products, cosmetic and body care products, soaps and detergents, incense and aromatherapy. In the European Union, B. frereana resin is also used in cosmetic products for its skin protectant function. B. frereanafrankincense is exported alongside the major export of livestock from Somalia directly to Saudi Arabia (ITC - Eastern Africa, 2006a). Although superficially similar to other resins, B. frereana frankincense is characterized by lupeol and 3-epi-lupeol, together with triterpenes and dammarane. In addition, B. frereana contains almost no boswellic acids. The population dynamics and impacts of harvest on B. frereana are very poorly known in comparison to B. papyrifera or B. sacra. There is anecdotal evidence of declines in B. frereana populations to a combination of factors, including high intensity, destructive tapping coupled to grazing of seedlings and saplings.

Name: Arunava Goswami

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Title: Developing Novel Nano-Tools for Enhancement of Anti-insecticidal and Anti-viral Efficacy of Secondary Metabolites of Medicinal Plants

Abstract:

Indian medicinal plants are used traditionally for controlling stored grain pests in ecologically safe way. However, their efficacies are usually very low compared to commercial chemical alternatives. Since 2008, systematically ~3000 Indian medicinal plant extracts were initially screened for their efficacy against stored grain pests and 100% lethal silkworm virus, BmNPV (silkworm nuclear polyhedrosis virus). 15 of them were selected for further trial. Myristica fragrans Houtt. and Cuminum cyminum L. derived plant lipids were found to be most active against store grain insect, Sitophilus oryzae at 1,000 and 1,500 ppm. The activity of the aforesaid plant lipid extracts could be further enhanced by 60% using ecologically safe novel hydrophilic nano-silicon dioxide molecule.

Similarly, Bombyx mori nuclear polyhedrosis virus (BmNPV) was taken as a model system to study antiviral activity of a nanoparticle-cinnamon-extract complex. The hydrophobic silica nanoparticle (SNP) provides a large surface area to adsorb active lipid molecules of the crude extract of cinnamon (CEC) while keeping their activity intact. Our experimental findings reveal that CEC alone can approximately double the lifespan of BmNPV infected silkworm larvae though no larva could complete the lifecycle. When treated with the SNP-CEC complex, more than 70% of infected larvae completed their life-cycle.

Name: Najeeb Rehman

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Title: New α-Glucosidase Inhibitors from the Resins of *Boswellia* Species with Structure-Glucosidase Activity and Molecular Docking Studies

Abstract:

Phytochemical investigation of the oleo-gum resins from Boswellia papyrifera afforded one new triterpene, named 3α-hydroxyurs-5:19-diene (1) together with twelve compounds including eight triterpenoids (2-9), two diterpenoids (10 and 11) and two straight chain alkanes (12 and 13). Similarly, ten compounds were isolated from the resin of Boswellia sacra including one triterpene (20) and nine boswellic acids (14-19 and 21-23). The complete NMR assignment of 2 is reported, to our knowledge, for the first time as a natural product while compounds 3-11 are known but reported for the first time from the resin of B. papyrifera. The structure elucidation was done by advance spectroscopic 1D and 2D NMR techniques viz., 1H, 13C, DEPT, HSQC, HMBC, and COSY, and NEOSY, ESI-MS and compared with the reported literature. All compounds were evaluated for their α-glucosidase inhibitory activity and as result eight of them 1, 3, 10, 11, 15, and 17–19 were found significantly active against α-glucosidase with an IC50 value ranging from 15.0 ± 0.84 to 80.3 ± 2.33 μM while 21 exhibited moderate activity with IC50 of 799.9 ± 4.98 μM. Furthermore, two compounds 24 and 25 were synthesised from 16 and 17 to see the effect of carboxyl group in structural-activity relationship (SAR) study. Compounds 24 and 25 retained good α-glucosidase inhibition as compared to 16 and 17, indicating that carboxylic group play a key role in SAR. In addition, the aforementioned activity of all the active compounds is reported, to the best of our knowledge, for the first time. The molecular docking studies showed that all the active compounds well accommodate in the active site of the enzyme. Moreover, pharmacokinetic properties of the compounds were predicted in silico, suggesting that the compounds possess drug like properties and excellent ADMET profile.

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Title: Assessment of Threat-Factors of Growth of *Boswellia Sacra* (Frankincense) Trees Under Influence of Anthropogenic Activities in Oman

Abstract:

Use of frankincense trees' resin (i.e., luban), harvested from different trees belonging to 20 species of genus Boswellia, was popular since before 3000BC to the present time. Historically, luban was used in ancient ceremonies, worship, and funerals worldwide, and is widely used in religious ceremonies. Now, it has become more important and is also being used to prepare cosmetics and perfumes, anti-inflammatory, sedative, anti-hyperlipidemic and antibacterial traditional and modern medicines, which have shown promising results in patients with rheumatoid-arthritis, chronic-colitis, ulcerative-colitis and bronchial-asthma and other diseases. Thus, its production and export of frankincense resins have become an economic priority for Oman. On the other hand, it has been observed that several anthropogenic factors have caused serious threats to Boswellia/Sacra trees and their regeneration (source to produce frankincense resin) in Oman. Consequently, it was anticipated that these species could be irreversibly eradicated within the near future, if in-time intervention is not taken. A research study was conducted for assessment of the geological and climatic environments, hydrogeological setup, weathering trends of rock terrains, growth frequency of the Boswellia trees and some details regarding over-exploitation of frankincense, over-taping of Boswellia trees, changing land use, attacks of destructive-beetle, over-browsing by herbivores and other salient factors. Results of the study in the form of customized models provided well defined factors causing deterioration of the frankincense trees. Based on study's results, it was also identified that Boswellia/Sacra, commonly known as Frankincense, trees are the 'index plants' from the geobotanical point of view. These trees do not grow in the world anywhere except in Oman, Yemen and Somalia under specific climate and geologic structural and lithologic conditions, which are considered imperative for their growth-sustainability. Some recommendations were made for possible sustainable growth of frankincense trees and production of luban/olibanum-resin in Oman.

Name: Ahmed Al-Busaidi

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Title: Application Effect of Signal Transduction Substances to Wounded Bark on Frankincense Production in *Boswellia Sacra* Trees

Abstract:

Ethylene (ET), jasmonic acid (JA) and salicylic acid (SA) are well recognized as important signal transduction substances, controlling signals pathways involved in defense reactions of damaged plant organs against the secondary attack of insects and pathogens. Frankincense production on the wounded bark of Boswellia species is a typical phenomenon of defending and recovering reaction. However, there is little information about the physiological mechanism of frankincense production in relation to roles of ET, JA and SA and their interactions. In this study, effects of the application of those three substances and their combinations to wounded stems on frankincense production in B. sacra trees were studied. In March 17, 2018, six different B. sacra trees (32 years old) having more than 8 stems were selected from the Agricultural Experiment Station, Sultan Qaboos University, Oman. Eight different lanolin pastes including 1% ethrel, an ethylene releasing compound, 1% methyl jasmonate, 10% sodium salicylate and their combinations, were prepared. Small circular bark segments were taken off with a leather punch (15mm in diameter) to make stem wounds on each of 8 stems per tree. Each lanolin paste was applied to one of the bark-peeled wound. In total, 6 replications were made for each treatment. After 22 days, secreted frankincense from each treatment was harvested and weighted. The combination of 1% ethrel and 1% methyl jasmonate greatly enhanced frankincense production in the B. sacra trees. Such phenomenon was also observed in gum Arabic production as a gummosis in Acacia seyal trees in another experiment in Sudan. Those findings indicate that the interaction of both ethylene and jasmonic acid is more effective in frankincense production than ethylene or jasmonic acid alone, suggesting a high possibility of artificial enhancement of frankincense production by hormonal application in Boswellia species.

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Title: Exploration of New Synthetically Modified Derivatives of Acetyl-11-Keto-Boswellic Acid (AKBA) Isolated from Omani Frankincense as Tumor Sensitizing Agents

Abstract:

The Number of annual deaths due to cancer is dramatically increasing despite advances in treatment strategies. Boswellic acids derivative Acetyl-11-Keto- Boswellic Acid (AKBA) has shown to be an effective anti-cancer agent against several cancer cells and are promising future candidates for cancer treatment. The aim of this study is to synthesize derivatives of AKBA, test the potency and selective toxicity against breast and prostate cancer, and identify AKBA mechanism of actions. A new series of 11-keto-b-boswellic acids were synthesized by modification of hydroxyl and acid functional moieties of boswellic acids. The structures of these analogs were confirmed by spectral data analysis (1H, 13C NMR and mass). Identified novel mechanism of AKBA was identified using proteomic profiling using LC-MS-MS (Orbitrap Q-exective instrument). Identified targets were confirmed via western blotting. This study proves that the introduction of C-24 amide group or a heterocycle at C-2, 3 positions effectively improved the potency. Also, amide substituted AKBA derivatives displayed more anticancer potential activities than AKBA. Proteomic profiling of AKBA treated cells revealed a new role of AKBA in cancer treatment via induction of mitophagy through binding of SQSTM1 protein. This finding was confirmed by Rt-PCR, western blotting, electron microscopy and flow cytometry analysis of mitochondrial dysfunction.

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Title: Protective Effect of Gum Arabic in Dextran Sulfate Sodium-Induced Murine Ulcerative Colitis

Abstract:

Ulcerative colitis (UC) is characterized by chronic inflammation of the colonic mucosa, and in advanced stage it may also involve the submucosa layers. Fibrotic damages post-inflammatory phase results disturbed colonic functions associated with poor quality of life. In the present study, the effect of Gum Arabic (GA) was evaluated in a mouse model of acute experimental colitis induced by dextran sulfate sodium (DSS). Seventy mice were divided into three groups: control, post- GA and pre-GA. Macroscopic and microscopic parameters analysis was carried out to determine the effect of GA on disease activity and on inflammatory markers during the disease progression of UC. We showed that GA effectively facilitated recovery of pathologic changes in the colon, as evidenced by a significant less body weight reduction, decrease of disease activity index and decreased histopathological features of colitis. However, this was not explained by pro-inflammatory/anti-inflammatory markers profile. Interestingly, we observed fewer colonic strictures post-recovery in mice given GA evidenced by less reduction in colon length and also by histological analysis of collagen depositions. Furthermore, we found that intake of GA continuously provide higher intestinal epithelial regeneration as well as less fibrotic markers that indicate a major role of GA in fibroblast function regulation. Our present findings suggest that GA has both preventive and protective effect on inflammatory damages in colon and have direct effect on fibrotic signaling pathways. Further mechanistic study is needed to study effect of GA on fibroblasts. Moreover the compound(s) responsible for the observed actions has to be identified and their structures elucidated and study micro-biota metabolic products from GA.

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Title: Status and Means for Sustainable Frankincense Production by *Boswellia Papyrifera* in Ethiopia

Abstract:

The dry forest resource occurs in more than 70% of the land surface of Ethiopia and is inhabited with a great diversity of life forms of both animals and plants. It specifically harbors economically important non-timber forest products that provide enormous economic, social and ecological importance, such as frankincense obtained from Boswellia papyrifera. Frankincense obtained from Boswellia papyrifera is the main commercialized natural gum product representing more than 70% of the country's natural gum export volume. The production, processing and marketing of the product provide cash income and contribute to food security for many people. Despite the multifaceted role of the resource, it is repeatedly reported that severe deforestation and forest degradation occurring in the last decades is threatening the resource base and volume of frankincense production. The tree species often suffer from poor regeneration, which is explained by its uni-modal population structures. Studies made on population dynamics, population structure, ecological physiology, growth dynamics and trends in population dynamics indicated that Boswellia papyrifera population is declining at alarming rate and will disappear in 5-6 centuries and the volume of frankincense production is expected to halve in 15-20 years if the current management practices continue as is. Active management practices, like exclosures, integrated pest management and enrichment planting that enhance the population growth and guarantee development of seedlings to sapling and strongly reduce adult mortality, is highly recommended to sustain frankincense production in the country. In addition, the restoration of degraded resources and use of other natural gum bearing tree species is an added activity for sustainable natural gum production in Ethiopia.

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Title: Frankincense: Chemistry, Biology and its Value-Added Products

Abstract:

Frankincense (also known as olibanum, al-lubān) is an aromatic resin used in incense and perfumes, obtained from trees of the genus Boswellia in the family Burseraceae, particularly Boswellia sacra, B. carterii, B. frereana, B. serrata (Indian Frankincense), and B. papyrifera. The resin contains essential oils and acid resin (~56%), soluble in alcohol. The main components in essential oil is α-pinene and used in perfumery and aromatherapy. The Boswellic acid from the resin has medicinal properties and is used as an anti-inflammatory and anti-cancer. Industrialists produce absolutes, essential oils, isolates and Boswellic acid from the resin of frankincense and use these in perfumery and pharmaceuticals.

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Title: Can Frankincense Oil be Produced Sustainably? Lessons Learnt from the Dhofar Region of Oman

Abstract:

There is an increasing global concern as to the effect on the future of several species of boswelia. As frankincense oil becomes more popular in both East and West, it is probable that CITES may list certain Boswelia species as endangered. The Dhofar region of Oman is one of the first, and still the only, place in the world that has invested in the propagation and development of the sustainable cultivation of Boswelia sacra. This talk will review the progress made so far and the challenges still to overcome, in order to make Omani frankincense sustainable.

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Title: Diversity, Indigenous Uses and Conservation of Medicinal Plants of Oman

Abstract:

The Sultanate of Oman, occupying the south eastern corner of the Arabian peninsula, is a regional biodiversity hotspot for flora, with southern and central Oman being identified as one of the world's 35 key biodiversity hotspots. Oman is endowed with a total floristic diversity of around 1407 plant species, of which 448 species are medicinal plants. The centres of medicinal species richness in Oman are the southern coastal mountains of Dhofar, the northern range of Jabal Al Akhdar, Musandam, the island of Masirah, and Bani Jabir mountains. 448 species of medicinal plants belonging to 283 genera and 95 families have been recorded. These plants has been traditionally used to cure many ailments by local people. Leguminosae with 53 species and Asteraceae with 23 species have the maximum number of medicinal species among them. The other families include Asclepiadaceae (20 spp), Euphorbiaceae (16 spp), Lamiaceae (16 spp), Solanaceae (15 spp), Boraginaceae (14 spp), Malvaceae (13 spp), Amaranthaceae (12 spp), Convolvulaceae (12 spp), and Moraceae (10 spp each). This study is focused mainly on medicinal plants from the Ascleapiadaceae, Euphorbiaceae and Solanaceae family. With currently no in situ protected area that actively conserves medicinal plants diversity in Oman, this communication also aims at emphasizing the importance of setting up conservation priorities and development of in-country commercialization of medicinal plants.

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Title: An Evaluation of Threats to the Useful Wild Plants of the Western Hajar Mountains (Jabal Sahms and Jabal Asarah) Northern Oman

Abstract:

Pastoralists in the Western Hajar Mountains depend on wild plants and their products to survive and fulfill their needs and their livestock alike. These wild species still play an essential economic-social role in the life of the many pastoralists inhabiting this area. Furthermore, pastoralists have developed unique and rich ethnobotanical knowledge of wild plants, their utilization and management. However, there have been very few ethnobotanical studies documenting the useful species in the area. This study aims to document ethnobotanical data about uses of, and threats to, most useful wild plants in the Western Hajar Mountains (Jabal Shams and Jabal Asarah). The data were collected in May-June 2012 by using semi-structured group interviews. Altogether 41 wild plant species corresponding to 21 plant families were documented as being used for different purposes. Shrubs represent 25%, trees 22%, sub shrubs and large shrubs 20% and 15% respectively, grasses 8%, and climbers and herbs the least (each with 5%). 97 different uses were recorded for all 41 identified species: medicinal uses (30%), fuel (14%), fodder (12%), food (9 %), nectar for honey (7 %), shade and shelter (6%), and utilitarian, tools and weapons and livestock care (each with 4 %). A few species were recorded for dyes, perfumes and cosmetics, less than 3% for each. The perceptions of informants regarding the factors causing threats to wild plants in their area were evaluated. 100% indicated that drought was the main reason for threats, expansion of roads network 85%, infrastructure developments (70%), population growth, dust and lack of regeneration each 50% and overgrazing 40%. The results indicate that the wild plants in this area are still used by local people and at the same time are under accelerating threats due to the socio-economic and ecological changes that have increased in the area over the last three decades.

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Title: -5-epi-Incensole and Incensfuran: Synthesis, X-ray Crystal Structures and Absolute Configurations by Means of ECD and VCD Studies in Solution and Solid State

Abstract:

Incensole (1) and its acetate (2), found in incense, demonstrate interesting biological activities. Incensole acetate (2) was prepared on a large scale by employing the Paul and Jauch protocol from the crude extracts of Boswellia papyrifera Hochst. 5-epi-Incensole (3), obtained as colorless crystals, was prepared from incensole acetate via three steps: deacetylation, oxidation and reduction. The structure of 5-epi-Incensole (3) was elucidated by means of spectroscopic data analysis, and the absolute configuration was established by single crystal X-ray analysis in combination with electronic and vibrational circular dichroism. In particular, the applicability of the solid-state ECD/TDDFT protocol to a compound with only two non-conjugated alkene chromophores was verified. The structure of incensfuran (4) was elucidated by 1D and 2D NMR study, and its absolute configuration was determined by single crystal X-ray diffraction analysis and electronic and vibrational circular dichroism spectroscopy (ECD, VCD). Moreover, semisynthesis of incensfuran (4) was achieved after treatment of incensole (1) with $BF_3.OEt_2$.

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Title: Chemical Variation in Essential Oils from the Oleo-gum Resin of Boswellia carteri

Abstract:

Frankincense, the oleo-gum resin of Boswellia species, has been an important element of traditional medicine for thousands of years. Frankincense is still used for oral hygiene, to treat wounds, and for its calming effects. Different *Boswellia* species show different chemical profiles, and B. *carteri*, in particular, has shown wide variation in essential oil composition.

In order to provide insight into the chemical variability in authentic B. carteri oleoresin samples, a hierarchical cluster analysis of 42 chemical compositions of B. *carteri* oleo-gum resin essential oils has revealed at least three different chemotypes: (I) an α-pinene-rich chemotype, (II) an α-thujene-rich chemotype, and (III) a methoxydecane-rich chemotype.

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Title: Physiology and Genomics of *Boswellia sacra*

Abstract:

Boswellia trees – incised with wounding or tapping to harvest resin that is defense signaling cascade to avoid tissue damages and pathogenic, herbivory and insect attacks. Both the tree physiology and resin biosynthesis pathway are not yet fully understood, whereas nothing is known about the genomics of B. sacra. It has been found that wounding response of B. sacra in terms of biochemical modulation has been significantly higher through the regulation of endogenous phytohormones (gibberellic acid, salicylic acid, abscisic acid and jasmonic acid), essential amino acids, and related gene expression. This suggest that defense related biochemical pathways are activated to cope wounding stress. In case of genomic analysis, B. sacra is a haploid genome, with a chloroplast genome size of 160,543 bp, with typical quadripartite structure comprising inversted repeats (26,763 bp), large single copy (88, 055 bp) and small single coy (18,962 bp). The cp genome comprises of 114 genes with 83 protein-coding regions. Whole genome sequencing and transcriptomic data of B. sacra provides some essential information on genetic makeup of this tree during wounding stress.

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Title: Antimicrobial Activity of Omani Frankincense (*Boswellia Sacra*) Oil and Smoke

Abstract:

Frankincense is one of the cultural symbols of Oman. Throughout history, it has been used to enhance the wellbeing of individuals, in medicine and in perfumes. Omani frankincense is mainly graded into Hojari, Nejdi, Shazri and Sha'bi grades. This study investigated the antimicrobial activity of steam-distilled essential oils of Hojari and the Sha'bi frankincense and the antimicrobial activity of frankincense Hojari smoke. The antimicrobial activity of the oils against Staphylococcus aureus (NCTC 6571), Bacillus spp., Escherichia coli (NCTC 10418), Pseudomonas aeruginosa (NCTC 10662), Saccharomyces cerevisiae, Candida albicans, Aspergillus flavus, A. ochraceus, A. niger, Penicillium citrinum, Alternaria alternata and Fusarium solani was screened using a well diffusion method. Minimum inhibitory concentrations (MIC) and minimum bactericidal/fungicidal (MBC/MFC) concentrations of the oils were determined using a mico-well dilution method. MICs were determined both visually and spectrophotometrically. The antimicrobial activity of frankincense smoke was preliminary determined against S. aureus (NCTC 6571), E. coli (NCTC 10418) and against some airborne microbes (three bacteria, one yeast and one mould). The number of colonies of bacteria/yeast or the diameter of the growth of the mould was compared before and after exposure to Hojari frankincense smoke in a closed cupboard for 2 hours. The Hojari and the Sha'bi oils possessed broad spectrum antimicrobial activity. The largest growth inhibition zones were obtained with S. cerevisiae and F. solani. An MIC of 1.56% (v/v) was found with E. coli, S. cerevisiae and F. solani. There was almost a complete inhibition of the tested airborne bacteria, yeast and mould by frankincense smoke. It was concluded that Hojari and the Sha'bi frankincense oils had similar broad spectrum antimicrobial activity. The frankincense smoke was a potent inhibitor of the tested airborne bacteria, yeast and mould which motivates more research to be conducted on frankincense smoke in future.

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Title: A comparison of the Resin Volatile Oil Chemistry and Botanical Characteristics of Commiphora Confusa – A New Frankincense Producing Species, and Boswellia Neglecta, a Known Frankincense Producing Species

Abstract:

Resins of Boswellia neglecta and Commiphora confusa in the Burseraceae family are important to the local economy in both Ethiopia and Kenya. The resins of both species are sold as frankincense and are often mixed together. This study is to establish the botanical identity and the chemical profile of the essential oils of the two species.

The essential oils obtained by hydro-distillation of resins of B. neglecta and C. confusa from Ethiopia and Kenya, were analyzed by GC and GC/MS. The essential oils of B.neglecta samples, collected from Ethiopia were characterized by α-thujene (8.1-19.0%), α-pinene (42.2-84.7%), β-pinene(1.3-13.7%) andterpinen-4-ol (0.5-19.4%) as major components, while the samples of B.neglecta from Kenya were found to have α-thujene (12.8–21.2%), α-pinene (17.8-49.2%), p-cymene (11.4-13.7%) and terpinen-4-ol (7.6-20.6%). The monoterpenes, α-thujene (17.6-23.1%), α-pinene (43.5-57.1%), β-pinene (9.5-11.6%) were predominant in the essential oil of C. confusa samples from Ethiopia, where as those samples from Kenya were dominated by α-thujene (11.9-18.7), α-pinene (16.3-38.4%), β-pinene (11.5-17.5%), p-cymene (6.6-11.7%) and terpinen-4-ol (2.5-13.7%). The chemical profile of the two species is similar and corroborates the community's claim to sell the resins of both C. confusa and B. neglecta as frankincense.

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Title: Value Added Products from Frankincense – For Use in Perfumery, Medicinal, Cosmetic and Aromatherapy

Abstract:

Frankincense – Aromatic Gum resin / dried resinous gum harvested from Boswellia trees.
Family : Burseraceae / Genus : Boswellia / Species – B. Sacra etc

Frankincense (B. Sacra etc) - is a native tree of the Arabian Peninsula (Oman & Yemen). This gum resin is harvested from trees in the wild, from mountainous regions, sorted in different grades and then shipped for use. It is mostly distilled by old technology of hydro-distillation but the advanced technology of steam distillation gives 3 products: Best quality oil for perfumery, hydrosol for medicinal/cosmetic use, and recovered frankincense for cultural and religious use.

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Title: Socioeconomic Importance of Some High Value Wild Medicinal Plants from Lebanon

Abstract:

Lebanon is a home for a breadth of native medicinal plants recognized as an integral component of the cultural and natural wealth of the country. The traditional gathering and use of these plants continue to provide benefits for healthcare, income and support to livelihoods of rural regions of Lebanon. This study aims to contribute to the documentation of ethnobotanical traditional knowledge and assessment of the socioeconomic potential of important wild medicinal plant species. During 2014-2016, traditional knowledge, collection and trading practices of medicinal plants in 25 villages in different ecoregions of Lebanon were gathered. Herbalists, traditional healers, elderly villagers, and shepherds were interviewed using a semi-structured survey questionnaire. Knowledge and data on plant species, collection practices, medicinal uses and means of administration, quantities collected, and selling prices were collected. Based on the Use Value and Cultural Importance and market economic analysis, findings revealed several highly socioeconomic important species used for the treatment of a range of diseases with a few of which also serve as food condiments. Among these cited plants, Artemisia herba-alba; Ferula hermonis; Fibigia clypeata; Matricaria aurea; Micromeria nervosa; Origanum syriacum; Rheum ribes; Salvia fruticosa and Teucrium capitatum qualified as the most socioeconomic valuable species. The study highlights the potential of these plants to enhance rural livelihood and community resilience and calls for the integration of medicinal plants in conservation and development strategies.

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Title: Saffron (*Crocus sativus L.*) Flowers with Augmented Number of Stigmata in Alkharj, Saudi Arabia

Abstract:

Saffron (*Crocus sativus L.*) is an important spice and medicinal plant that is cultivated in Asia, Europe, North Africa and North America. Its morphological and biochemical parameters, such as the changes of the floral parts (6 tepals, 3 stamens, 3 stigmata) and biomass, are primarily affected by environmental conditions. The detection of new mutations in saffron flowers with increased number of stigmata has been reported, and the other mutants in floral whorls were discussed.

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Title: Inhibitory Effects of Omani Herbs Against Fish Pathogens

Abstract:

The Omani government has been encouraging the aquaculture industry. Efforts are continuously being made to increase aquaculture sites but there is a very little effort to reduce the risks of pathogen to farmed fish. For achieving the national strategy to increase fisheries production through aquaculture, there is a parallel requirement to identify potential threats to the health of existing commercial fisheries to take appropriate steps to minimize economic loss. Due to the potential consequences on human health posed through the use of chemotherapy on fish intended to enter the food chain, safe, cost effective, and environmentally friendly alternatives are required. The present study investigated the antibacterial effects of natural Omani herbal extracts against pathogenic bacteria isolated from fishes, and their probability of replacing traditional chemical treatments especially antibiotics. This study was focused on using native Omani herbs, Henna (Lawsonia alba Lam), Sidaf (Pteropyrum scoparium), Bitter apple (Solanum incanum), Rosy dock (Rumex vesicaria), Lemon (Citrus limon), and common sage (Salvia officinalis), that are well-known in traditional medicine to have antibacterial effects against various diseases. The total of 4 bacteria species isolated from wild and farmed fish and used in the present study were Vibrio harveyi, V. anguillarum, V. alginolyticus and Mycobacterium marinum. After assessment of antibacterial activity of bioflavonoid by agar diffusion method with different concentrations of six plants (5%, 2.5%, and 1%), 5% henna and sidaf extracts showed the best antibacterial efficacy against all bacteria species. In the second experiment, two best extracts were selected to determine whether they were bacteriostatic or bactericidal using a spectrophotometer. As a result, henna was strongly bacteriostatic against all tested bacteria strains whilst sidaf showed varying results. Results from the study show that there is a possibility in utilizing traditional Omani natural herbal plants against fish bacterial diseases instead of antibiotics to improve the practice of future aquaculture.

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Title: National Conservation Efforts of Medicinal Plant Genetic Resources in Oman

Abstract:

Oman is a rich country in plant genetic resources (PGR), especially those that are classified as socioeconomic important species. There are more than 1400 plant species; more than 70% of these species are classified as having socioeconomic importance. These could be divided into two classes, which are food and agriculture purpose such as grains, legumes, vegetables, and fruits, which are mostly cultivated. While the other class includes medicinal plants (MP), forestry and ornamentals, and Crop Wild Relatives (CWR) are wildly grown. However, conservation efforts in form of ex situ or in situ that are taken by the country are not fully taken at the national level, especially for the second class. In this study, we aimed to develop and plan a conservation strategy for MP species. The strategy based was on records of geographical distribution of the MP species and information on conservation of each plant species gathered from research publications or reports. Gap analysis of conservation for each MP species was established. The results presented in the study indicated that most of MP species were in the Dhofar region in the southern part of the country and Jabal Al Akhdar and Musandam in the northern part. Projected climate change showed that conservation and use of MP is strongly impacted, especially in the long term. The study concluded for activities for conservation and use. This study provides an overview and analysis of Oman's PGR diversity, the challenges it faces and their causes.

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Title: Effect of Gum Arabic on the Disease Activity in Experimental Ulcerative Colitis

Abstract:

Background: Inflammatory bowel disease (IBD) is a chronic inflammatory disorder that affects the gastrointestinal tract. It includes both Crohn's disease (CD) and ulcerative colitis (UC). UC lesions mainly involve the mucosal layer, but in the advanced stage it may also involve the submucosa layers. The aims of this work were to study the effect of Gum Arabic (GA) on disease activity in an UC model and to measure the effect of Gum Arabic on inflammatory markers during the disease progression of UC.

Methods: Seventy mice were divided into three groups and treated for twenty-six days as follows: control, post GA and pre GA. The weights of the 70 mice were monitored for five days. Then colitis was induced in mice from day five to day ten. All mice were kept for recovery until day 26. The severity of colitis and the recovery were assessed by various parameters; macroscopic and microscopic. Body weight, presence of blood in feces, feces consistency and disease activity were the macroscopic parameters, while microscopic parameters were fibrosis, histology scoring and inflammatory markers.

Results: It was found that the group given GA before induction of colitis had less body weight reduction, less disease activity index and less histology scoring. In addition, they had less fibrotic markers indicating a major role of GA in regulation of fibroblast function.

Conclusion: GA has better preventive effect rather than therapeutic effect on mouse model of UC.

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Title: Novel Protective Role of Omani Edible Wild Plants Against Experimental Colon Carcinogenesis

Abstract:

Background: Oxidative stress plays a pivotal role in the development of different types of cancer malignancy, including colon cancer. The protective role on natural plants protects against oxidative stress-mediated carcinogenesis is mainly dependent on their content of phytochemical compounds. The Omani edible wild plants [Rumex vesicarius (Hummad), Oxalis corniculata (Muhammad), Pteropyrum scoparium (Sidaf), Moringa peregrine (shu'a), and Caralluma Arabica (Addaja)] exert beneficial health effects in several human chronic diseases, yet the mechanism was not elucidated in relation to colon carcinogenesis. **Objective:** This study investigated the antioxidant properties and chemoprevention effect of these plants extracts in an experimental model of colon cancer. **Methods:** Azoxymethane (AOM) drug was used to induce colon cancer in Sprague Dawley rats which were fed for 12 weeks with a diet supplemented with one of the five different Omani edible wild plants. By the end of the experiment, all rats were sacrificed; colon tissues were excised and used for biochemical measurements of: oxidative DNA damage, glutathione (GSH), and total antioxidant capacity (TAC). Histopathological examination for colon tissues was also examined. **Results:** AOM promoted an oxidative stress environment in rat colon as evidenced by GSH depletion, TAC impairment, increased MDA, as well as the formation of aberrant crypt foci (ACF). The five examined Omani edible wild plants showed a comparable level in combating the AOM- induced oxidative insult to the colon tissue and attenuating the colonic ACF formation. **Conclusion:** This study revealed that the Omani edible wild plants acted as a potent antioxidant and provided colon protection against AOM-induced oxidative stress and carcinogenesis. These plants extracts might be used as a functional dietary ingredient in the context of phytoremediation for colon cancer.

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Title: Application of Plant Bioreactor Systems for the Industrial Scale Production of Valuable Phytochemicals in Different Plant Cells

Abstract:

Plant cells are producing a wide range of phytochemicals to protect themselves from the various adverse condition; those extracted phytochemicals are now used for different human welfare such as drugs, food flavour, colour, as the antioxidant and different disease management. The bioreactor is an automated culture system to provide a controlled environment in order to achieve optimal conditions for cell growth to form a product. Plant Bioreactors are the vessels containing the liquid medium, in which the plant cells, shoots and embryos are cultured in completely submerged conditions. Plant tissue culture technique has been successfully applied as a prospective alternative for more efficient mass propagation method. Large-scale plant cells production is another attractive alternative to the traditional method of plantation using bioreactor. Somatic embryogenesis is a potential target that offers a suitable system for large-scale plant propagation for the extraction platform of valuable natural products on an industrial scale.

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Title: Propagation and Cultivation of *Boswellia Sacra* (Luban) Eng.

Abstract:

Boswellia sacra (Frankincense) is a species in the Burseraceae family. It is dominating in north Somalia and also dominant in the desert-woodland mountains in Dhofar in Southern Oman (IUCN Red List, 2017). Frankincense propagated sexually by seeds and vegetatively by cuttings, layering and whole plant by tree rescue. All of these methods had been proven to be successful but with variation. The seed propagation is the most used method for botanical purpose or for conservation by which the plant conserves its genetic variation. In the Oman Botanic Garden, we had been using this method science 2006, and it was successful but with variation in the germination percentage. Using fresh ripen seeds showed the higher germination rate compared to the seeds collected from the previous seasons. Cutting is the most successful method of frankincense propagation and the success rate can reach 99%. In this method, semi-hard and hard-wood is used. Oman botanic garden propagation team also tried air layering in the wild. In this method, air layering was done on big trees and in different branches. This method is also successful. This method can be efficient to save trees that declined in the wildness. Frankincense tree rescue is also one of the efficient ways of propagation and conservation of frankincense trees. This method showed a success rate of nearly 90%. The cultivation of frankincense is not easy because of the sensitivity of the plant. For any movement of the plant either from pot to pot or from pot to the ground, the plant shed its entire leaves and it will take time to re-sprout. The media used in cultivation of the frankincense has to be with good drainage capacity. The plant growth is very slow and it takes years to get to its typical form.

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Title: A Study on the Distribution of Enthomedicinal Seagrasses in Chidiyatapu, Andaman Island and its Awareness Among the Local People

Abstract:

The qualitative study on distribution of seagrasses in Chidiyatapu (11° 29' 30" to 11° 30' 34" N and 92° 35' 10" to 92° 42' 30" E) was carried out for a period of three months i.e. December 2012 to February 2013. A total of three seagrass species Thalassia hempirichi, Halodule uninervis, Halophila ovalis where identified. Among them, T. hempirichi, and H. ovalis found in this study was reported to have the ethnomedicinal value from Tamil Nadu coast. In the present study, communication among the local people exposed unawareness about the medicinal as well as nutritional values of seagrasses. Our findings provide the first case study on the traditional knowledge of seagrasses as an ethnomedicine from South Andaman. The aim of this study is to assist the local people in conservation efforts regarding seagrasses through identifying Traditional Ecological Knowledge (TEK) from depth and breadth of local knowledge systems of seagrasses for a particular ecosystem that is in peril. A strong and well-planned awareness should be done in order to utilize the benefits of these marine angiosperms and for conservation for the next generation.

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Title: A Novel Superlative Methodology for Magnification of *Boswellia* Essence

Abstract:

Several Boswellia species yield genuine frankincense resin. However, each of species of Boswellia produces different grades of frankincense. It is a difficult task to produce similar quality essential oil from different grades of even a single species. This commercial problem led to the planning of the present study. Essential oil from boswellia species was extracted using hydro-distillation, steam distillation and supercritical fluid extraction. The comparison of chemical composition of essential oils isolated at different extraction methods have shown that the concentration of β-pinene, myrcene, α-thujene, camphene, m-cymene and cis-verbenol was higher in steam-distilled essential oil as compared to hydro-distilled and supercritical fluid extracted essential oils. Not only extraction methodology affected components of essential oil but various grades of same species also. To obtain desired and consistent concertation of various grade essential oils a high vacuum fractional distillation technology and carbon dioxide supercritical fluid methodologies were used and found very effective.

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Title: Exploring the Bioactive Potential of Selected Medicinal Plants of Soon Valley of Pakistan

Abstract:

The Soon Valley of Pakistan hosts a huge reservoir of medicinal plant biodiversity. The average elevation reaches above 750 m and the Sakesar top is the highest point reaching 1500 m above sea level. The indigenous community of the area has utilized the natural sources of medicinal plant origin for years in their local remedies against various diseases. A systematic approach was employed in search of the secondary metabolites of different classes from various plant species. Acacia arabica, Acacia modesta, Tecomella undulata, and Moringa oleiferawere selected based on a wide variety of pharmacologically useful biological activities as well as the ethnopharmacological importance. One of the common features of all the selected plants is their tolerance against drought and survival in as little as 20mm annual rainfall. Thus, we were prompted to investigate the comparative biological potential of this natural treasure. The crude methanol extracts of all the plants were separated in n-hexane, chloroform, ethyl acetate,n-butanol, and aqueous fractions by solvent solvent extraction. The resultant fractions were then tested against antibacterial, anti-fungal, cytotoxic, phytotoxic, antioxidant and brine shrimp lethality bioassays. Thus, we were able to get some bioactive fractions through the screening process for further phytochemical and biological evaluations. The results of all these experiments were included in the present paper.

Name: M. Nadir Sidiqi

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Title: Phytochemicals: Natural Alternative in Prevention Inflammation

Abstract:

Understanding and discovering natural products have recently brought more attention among scientists and researchers, especially plant-phenolic compounds (alkaloids, sterols, terpenes, flavonoids, saponins, glycosides, cyanogenics, tannins, resins, lactones, quinines, volatile oils etc), to matching these to specific disease prevention. Medicinal plants played an important role in healing and sustaining the health of past generations as well as current and future generations. Indeed, medicinal plant products play a significant role in the prevention of diseases in developed countries, and also especially in developing countries. Demand for natural products, especially from plants to use as a medicine as well as foods (nutraceuticals), is increasing worldwide. For instance, St. Jon's Wort (Hypericum perforatum), is used in the treatment mild to moderate depression, And Ginkgo biloba is used in the treatment impairment memory and anxiety especially in elderly people. Chamomile (Chamomilla recutita) flower heads are used for the treatment of mild gastrointestinal problems and as an anti-inflammatory agent, and the leaves and pods of Senna (Cassia spp) are used for constipation. However, the aim of this study is to focus on phenolic compounds and how important it is to understand their role in the prevention of inflammation and improvement of health quality and well-being.

Name: Kamla Al-Salmani

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Title: A Preliminary for Mechanisms of Action and the Genes Involved in the Actions of AKBA in Ovarian Cancer Cells Lines

Abstract:

High grade Epithelial Ovarian Cancer (HG-EOC) is the most common type of ovarian cancer. The vast majority of patients present with advanced stage disease. Despite the recent advances in management, almost all patients develop resistance to cytotoxic chemotherapy and the median survival remains dismal. There is an unmet need to identify novel agents for treatment, especially for chemo-resistant disease. This study examined the biologically active component of Frankincense, 3-O-acetyl-11-keto-β-boswellic acid (AKBA), its mechanisms of action and the genes involved in the actions of AKBA HG - EOC. OVCAR4 cell line was exposed to different concentrations of AKBA. Microarray and qPCR were used to study the specific apoptotic proteins expressions. After the analysis of each of these genes functions, using the gene card website, 50μM AKBA was found to induce significant ($P<0.001$) gene expression in different pathways. Genes controlling 9 different pathways, including apoptosis, cell cycle, DNA damage and repair, DNA synthesis, metabolism, response to stress, intracellular signalling, transport and cell adhesion and metastasis were either up- or down-regulated, and the majority of these pathways are known to be directly or indirectly linked to apoptosis pathways.

AKBA is cytotoxic to ovarian cancer cells at pharmacologically achievable concentrations. It induces multiple gene expression in different biological pathways in ovarian cancer cells. AKBA may form the basis of a novel anticancer treatment for ovarian cancer perhaps alongside conventional chemotherapy.

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Title: Bio-Piracy and Frankincense: The Intellectual Property Issues Related to Frankincense in Terms of Patents, Genetic Resources and Traditional Knowledge

Abstract:

Over the past decade, a growing international interest in frankincense and its bioactive compounds has lead to a surge of patents associated with this precious plant. The findings from the patent databases highlight the dramatic growth of the frankincense trade and current measures in Oman allow it legally due to the absence of intellectual property protection measures as a genetic resource and the commercial utilization in terms of patents or traditional knowledge. The successful granting of patents claiming frankincense as geographical indications for other countries and using it as a genetic resource in several industries worldwide require attention by the Omani authorities to the intellectual property of frankincense. This misappropriation and patenting of frankincense as genetic resources and knowledge without consent, called "Biopiracy", negatively affects the environment and the economy of Oman.

This paper reviews the spectrum of intellectual property issues that requires attention in the frankincense industry. The accusations of biopiracy lead to the necessity of a reassessment of the frankincense trade and the legal framework of access and benefit sharing.

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Title: Contribution to the Knowledge of Traditional Perfumery of the Sahara

Abstract:

This article presents a socio-cultural study on traditional perfumery of some parts of the Algerian Sahara, formerly recognized by the trans-Sahara trade. It is by the axes of these trade route roads, crossing the desert from North to South and from East to West through the oasis, that allow the formation of different ethnic groups and cultures and, thus, a social society was created in the heart of the Sahara. At the level of this indigenous society, the local knowledge related to the aromatic products and their uses contribute to the appearance of a region-specific perfumery.

A field survey conducted in the Tidikelt, the Touat, Gourara and Tamanrasset, shows the different preparations of perfumes, incense and herbal creams. Ten plants (leaves, gum, resin, wood, roots) composed of aromatic, tinctorial plants and local and/or introduced spices, build the identity of each region. Their naming as well as their diverse imported oily and alcoholic scents identify their trademark. These preparations are used to enhance the heavy atmosphere of social gatherings (weddings, the seventh day of birth, religious holidays, and evening tea breaks).

We also notice that these products are frequently used in aromatherapy. Some indigenous women use a fragrant cream “El Khamara”, “El Maajouna”, “El atria” or ‘Akouade” as antispasmodic, a therapeutic remedy, mainly used for rheumatism.

Among the imported and highly appreciated ingredients, we can cite roots of Corrigiola telephiifolia, resin of Pistachier lentisque and Crocus sativusproducts that can be locally developed.

Name: Ms. Fatma Saleh Al Khulaifi

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Title: The Conservational Roll of the Qur'anic Botanic Garden of Medicinal and Tropical Plants

Abstract:

The scientific program of the Qur'anic Botanic Garden (QBG) is concerned with Agricultural, Conservational, Biotechnology and Medicinal fields. The QBG not only focuses on the study of the plants mentioned in the Holy Qur'an and Hadith, but also the endogenous plants of the flora of Qatar and potential medicinal plants of the Arab world. In the Hadith, the Prophet's Sayings, there are more than 20 plants mentioned in the occasions of cosmetic or medicinal uses.

The garden is conserving special kinds of plants that are collected from different parts of the world to be restored at one place for preservation and study purposes. Both ex-situ and Ex-site conservational programs have been designed to collect and conserve plants inside and outside their natural habitats. The QBG plant nursery, herbarium, and seeds units are the main components of the Qur'anic Botanic Garden that produce and preserve the plants at QBG.

More than 59 plant spices are preserved from three different geographical zones: desert, Mediterranean and tropical zones. By following the Islamic principles of conservation, the QBG highlights these conservational ethics and explains them for all people.

The garden is also collecting and preserving those traditional entities from the entire world in order to be exhibited in the Botanic Museum of the Qur'anic Botanic Garden.

Name: Debra Enzenbacher

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Title: Frankincense Tourism: Creating Healthy Multisensory Visitor Experiences to Maximise Benefits from Oman's Premier Natural Product

Abstract:

The medicinal and health benefits of frankincense continue to be investigated and therefore, better understood. Less investigated are the economic, social and cultural dimensions of this natural product in Oman's tourism domain. At present, frankincense is viewed rather narrowly in relation to the country's tourism. This view needs to change if greater benefits are to be derived from this vital resource, shared amongst more stakeholders and tourists are to experience the full benefits of this important natural product.

Underpinning this study is the notion that creating healthy sustainable tourism products and services from Oman's frankincense may help preserve and protect this crucial resource along with its associated cultural heritage, production and harvesting techniques and local economies. This research explores the social, cultural and commercial potential of Oman's frankincense in a tourism context. It demonstrates the value chain for frankincense within the country's tourism industry. Methods employed in this study include desktop research, case study, observation and trend analysis.

Sensory input plays an important role in the tourism experience. There is general agreement that the more senses that are involved in a given tourism experience the more memorable it may become. Humans have long been drawn to the many health-enhancing and sensory properties of frankincense. Increasing and enhancing the sensory dimensions of frankincense tourism in Oman offers the prospect of developing further this form of tourism in places where the precious product is produced.

Findings highlight the current state of tourism's links with frankincense in Oman and explore the growing trend for some tourists to seek highly memorable, personalised, sensory experiences when they travel.

This beneficial natural product is underused at present and holds enormous potential for healthy multisensory and other valuable spin-off tourism products and services. The study proposes a range of new tourism products and services drawing on Oman's frankincense which will help develop new economic pathways for the industry, help protect, preserve and promote local culture along with this natural product's heritage and production value chain as well as foster greater cooperation between stakeholders within Oman.

Further research is needed to examine more fully the relationship between frankincense and Oman's tourism industry in order to deliver greater results in relation to the Gavernment's economic diversification strategy and better spread the health and sensory benefits of this fascinating natural product.

Name: Salah Eldin Agieb

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Title: Frankincense Conditions Conservation and Rehabilitation Application (2016-1992) in Dhofar

Abstract:

Boswellia sacra, It is the well-known economical tree in Dhofar internationally since ancient times to the most famous ancient and civilizations of the world, these trees grow in fairly restricted habitat in the arid zone behind mountains & beyond the reach of the monsoon rain but within the reach of the cool foggy winds which blow steadily from the south-west towards the northeast during this season, although it is found in some humid zones in Dhofar. The current conditions of this frankincense lands call the miscellaneous national institutes to participate in the conservation and the rehabilitation of this sector.

The Ministry of Agriculture and Fisheries has started some essential applications in the fields by establishing a forest nursery and the production of many local trees seedlings which include frankincense seedlings and distribution to different agencies, rural citizens and farmers, to encourage the planting awareness of these trees, but there are limited applications in the research aspects, some planting programs were performed in different Directorate General of Agriculture enclosures in different areas. Approximately 20,000 frankincense trees were planted.

Name: Susan Curtis

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Title: Innovative Sustainable Boswellia Extract in Cosmetics Enables a Holistic Approach to Ageing-Well

Abstract:

The use of sustainable resources is a pressing issue in all industrial fields and even more so in the cosmetic industry. The use of waste materials, either of botanical origin or from the food industry, is opening new possibilities in the development of raw materials and finished goods that are not only efficacious, but also more sustainable, renewable and green.

On the other side, there is a strong movement towards products that favour a better and more gracious ageing process with a strong focus on both looking good and feeling good, and natural cosmetics is an important aspect of this.

A case study will be presented showing how the use of an innovative and sustainable ingredient derived from waste material of the distillation of Omani Boswellia sacra resin enabled a more holistic approach to skin ageing.

Name: Sue Canney Davison

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Title: Sustainable Frankicense: Creating the most effective Multi-Stakeholder Global Burseraceae Alliance

Abstract:

Dr. Sue Canney Davison will start this session with a brief presentation on the current structure of effective African Alliances, highlighting the specific challenges for Burseraceae and proposing a possible structure. She will summarise what she has heard in the conference so far. Each table will then discuss and share their ideas in a plenary discussion and participants can volunteer to be part of a core working group to take this forward.

Name: Mehdi Jaaffar (On behalf of Dr. Mohsin Al-Amri / mohsinamri@gmail.com)

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Title: A Preliminary Economic Analysis of the Production and Manufacture of Omani Frankincense

Abstract:

The absence of scientific standards to measure the cost of Omani frankincense production and manufacturing in Oman represents the problem to be resolved in this research. In Dhofar, frankincense was the main source of income and the only exported production from the province. Omani frankincense has been known since the sixteenth century BC as the main source of olibanum in the old world, yet the Omani literature lacks scientific research that traces the frankincense cost and income. The research aims to measure the economic analysis of production costs and the net profit from the marketing and manufacture of Omani frankincense. The study is based on field information taken directly from frankincense harvesters in the four regions of the Governorate of Dhofar, known to produce frankincense. We then followed frankincense price costing from the field through middlemen to the end users. The results show that frankincense marketing passes through four channels before it reaches the last consumer, the profitability from one ton of olibanum is 10,837 O.R. if frankincense is used for industry. 23.6% is for tree harvesters, 4.8% goes to commercial dealers, 6% for the wholesaler, while 65.3% of frankincense is the profit of oil extractor. As much as 7,000 O.R is the value if the frankincense is sold in a local market, 46% of which goes to the dealer. There are two main factors that maximize sale profitability: seasonal khareef visitors and local frankincense manufacturing. It is important to organize the harvesting time so as to avoid unfair competition. The just-in-time technique of production is regarded as one of the best modern costing systems that is applicable to olibanum manufacturing and can maximize the overall market value and, hence, profitability and ideal tree exploitation. One way to maximize profitability is through a frankincense manufacturing process to add to other industries, not just frankincense and extracts of oil in order to create more value added.

Poster Presentations

Name: Tarig Abdelrahman Bilal

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Title: Evaluation of Nephroprotective Activity of Methanolic Extract of *Ambrosia maritima* Leaves against Rifampin Induced Nephrotoxicity in Rats

Abstract:

Rifampicin (RIF) is the first line drug for the treatment of tuberculosis and can cause nephrotoxicity in human beings and animals. Nephroprotective effect of methanolic extract of, Ambrosia moritima leaves was studied in healthy albino rats (1.25-1.75 kg) of either sex. This plant is a flowering plant in the family Asteraceae, they are distributed in the tropical and subtropical regions. It is used in traditional medicine for the treatment of renal failure, inflammation of kidney and other diseases. The renal toxicity was produced by administration of rifampin at dose rate of 70 mg/kg I/p for 28 days. The plant extract was given by simultaneous oral administration of methanolic extract of Ambrosia moritima leaves at a dose rate of 300 and 600mg/kg for 28 days. It was found that the induced toxicity was inhibited by the administration of the extract. The decreased levels of serum urea, creatinine, sodium (Na) and potassium (K). Histopathological examination revealed protection of the kidney from the marked necrosis of renal tubules that induced by rifampin.

Name: Khalid Al Farsi

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Title: Conservation of Traditional Knowledge through Plant Conservation: Investigating the Potential of Re-establishment of Juniperus Trees in the Northern Mountains of Oman

Abstract:

Juniperus seravschanica (English name "Juniper" and Arabic name "Al Alan") is a key component of the high mountain woodlands in Northern Oman. Throughout their natural range, juniper trees have retained a vital ecological, cultural and socioeconomic value. For centuries human populations have utilized the trees' inherent medicinal properties to treat a wide range of ailments, including diarrhea, diabetes, stomach aches, and ulcers. Leaves are a rich source of antioxidants.

Through a combination of human assisted degradation (animal grazing, cutting for fire and construction wood) and changing climate conditions, the trees in Northern Oman are currently under significant stress and show serious signs of extirpation, particularly at lower altitudes where almost zero levels of regeneration are occurring. With the loss of these trees comes the loss of cultural knowledge, particularly knowledge and understanding of traditional medicinal practices.

The main aim of this research was to identify the cause of the decline and propose viable conservation strategies to restore already degraded juniper woodland. The research involved a range of experiments which tested the potential for augmenting existing populations with the reintroduction of planted seeds, 2 year-old and 5 year-old saplings. Field and nursery experiments tested a range of reintroduction strategies - examining the effects of varying irrigation levels, altitude and age of transplanted trees and seed stratification. Results showed a complex interaction between the measured parameters and demonstrated that a reintroduction strategy requires a multifaceted approach with careful consideration given, in particular to the age of reintroduced saplings and planting altitude. Details of the results and conservation recommendations will be discussed in the presentation.

Name: Ahmed Al-Rawahi

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Title: Rhizospheric Microbial Communities associated with Wild and Cultivated Frankincense Producing *Boswellia sacra* Tree

Abstract:

Boswellia sacra, a frankincense producing endemic tree, is well known for its cultural, religious and economic values. However, the tree has been least explored for the associated microsymbiota in the rhizosphere. The current study elucidates the fungal and bacterial communities of the rhizospheric regions of the wild and cultivated B. sacra tree populations through next generation sequencing (MiSeq, Illumina). The sequence analysis showed the existence of 1006±8.9 and 60.6±3.1 operational taxonomic unit (OTUs) for bacterial and fungal communities, respectively. In fungal communities, five major phyla were found with significantly higher abundance of Ascomycota (60.3%) in wild population and Basidiomycota (52%) in cultivated tree rhizospheres. Among bacterial communities, 31 major phyla were found, with significant distribution of Actinobacteria in wild tree rhizospheres, whereas Proteobacteria and Acidobacteria were highly abundant in cultivated trees. The diversity and abundance of microbiome varied significantly depending upon soil characteristics of the three different populations. In addition, significantly higher glucosidases, cellulases and indole-3-acetic acid were found in cultivated trees' rhizospheres compared to wild tree populations which are very crucial for these plants to survive the harsh arid-land environmental conditions. The current study is a first comprehensive work and advances our knowledge about the core fungal and bacterial microbial microbiome associated with this economically important tree.

Name: Lokman Zaibet

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Title: Building Bridges between Science and Industry: The Process and Impacts of Agricultural and Food Research

Abstract:

The innovation process at universities start with research and ended by generating revenues to reinvest in research activities. The process involves intellecual property disclosure to technology transfer institutions and related industries. The fit between innovation at early stages up to the field is measured by the "Tecchnology readiness levels" (TRL) which turned out into an operational methodology defining the general features of the process of technology transfer. While the TRL is innovative as an operational methodology, the process of TT also needs innovation. SQU has s highly recognized record of research outputs in general and in the fields of agriculturae and functional foods in particular. These outputs are expected to lead to innovations, such as medicinal and other functionalities to contribute to business and job creation. These "expected" outcomes and and impacts are neither well documented not actually measured. This paper uses a sample of selected research projects in agriculture and food to understand the current research-innovtion process and to make a firsthand assessment of impacts or potential impacts of such outputs. Our aim is to develop a comprehensive model of innovation applicable to functional foods and that builds the "missing" links between science and industry.

Name: Mohammad Akhtar

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Title: Formulation and Evaluation of Herbal Cream Containing Curcumin from *Curcuma longa*

Abstract:

Curcuma longa is a member of the Zingiberaceae family, commonly called turmeric. The purpose of this study was to formulate curcumin containing moisturizing conditioning cream. Curcumin (95%) was isolated from the rhizomes of Curcuma longa collected from Barka Al Jabar farm, Oman. Identification of curcumin was done by UV, TLC and HPLC methods. The herbal cream was formulated by using primary emulsion method. This method was followed to ensure stability and prevent incompatibility.

The formulated curcumin cream was evaluated for several physiochemical tests like appearance, homogeneity, determination of pH and test for microbial growth. The results were found good and matching with the standard values.

Name: Adil Khan

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Title: Chloroplast and Nuclear DNA Barcodes of *Teucrium* Species

Abstract:

The genus Teucrium (Lamiaceae) includes c. 270 species that occur all over the world. In Oman, one of Teucrium species is endemic and another is endemic to the Arabian Peninsula. The current study aims to assess the species discrimination between four closely related species viz. Teucrium mascatense Boiss,Teucrium stocksianum Boiss. Subsp. stenophyllum R.A.King, Teucrium stocksianum Boiss. Subsp. stocksianum and Teucrium nummularifolium Baker by implying molecular barcodes and phylogenetic relationships. We used five barcodes including chloroplast genes, ribulose-bisphosphate carboxylase (rbcL), Maturase K (matK), a β subunit of RNA polymerase coding gene (rpoC1), intergenic spacer region (trnH-psbA) and Internal Transcribed Spacer (ITS2) a noncoding region of the nuclear genome. The detailed PCR and sequencing analysis showed highest success rate of ITS2, rbcL andmatK to discriminate among species (~90%). Phylogenetic relation on the basis of sequencing of ITS2, matK and rbcL showed that the two subspecies are closely related but forming a distinctive clade with T. mascatense and T. nummularifolium. In conclusion, the results reveal that ITS2show high polymorphic site, inter-specific distances, and competent phylogeny for Teucrium barcoding.

Name: Sajjad Asaf

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Title: First Reported Chloroplast Genome Sequence of *Punica granatum* (cultivar Helow) from Jabal Al-Akhdar, Oman

Abstract:

Pomegranate (Punica granatum L.) is one of the oldest known edible fruits. It has grown in popularity and is a profitable fruit crop due to its attractive features including a bright red appearance and its biological activities. Scientific exploration of the genetics and evolution of these beneficial traits has been hampered by limited genomic information. In this study, we sequenced the complete chloroplast (cp) genome of the native P. granatum (cultivar Helow) cultivated in the mountains of Jabal Al-Akhdar, Oman. The results revealed a P. granatum cp genome length of 158,630 bp, characterized by a relatively conserved structure containing 2 inverted repeat regions of 25,466 bp, an 18,686 bp small single copy regions, and an 89,015 bp large single copy region. The 86 protein-coding genes included 37 transfer RNA genes and 8 ribosomal RNA genes. Comparison of the P. granatum whole cp genome with 7 Lagerstroemia species revealed an overall high degree of sequence similarity with divergence among intergenic spacers. The location, distribution, and divergence of repeat sequences and shared genes of the Punica and Lagerstroemia species were highly similar. Analyses of nucleotide substitution, insertion/deletions, and highly variable regions in these cp genomes identified potential plastid markers for taxonomic and phylogenetic studies in Myrtales. A phylogenetic study of the cp genomes and 76 shared coding regions generated similar cladograms. The complete cp genome of P. granatum will aid in taxonomical studies of the family Lythraceae.

Name: Adil Khan

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Title: DNA Barcoding of Two Endemic Species of the Genus *Boswellia* from Oman and Yemen Using Nuclear and Chloroplast DNA Sequences

Abstract:

Family Burseraceae is a moderate-sized family of 19 genera and about 540 species. There are approximately twenty Boswellia species. Among them, Boswellia sacra and Boswellia elongata are endemic to Oman and Yamen. Both the species are producing oleo-gum resin, where B. sacra is more famous for high quality and fragrance. Little is known about molecular marker analysis for future barcoding of these two species. The current study aimed to perform molecular barcoding of B. sacra and B. elongata using one non-coding nuclear region internal transcribed spacer (ITS2) and four from plastid coding regions including RNA polymerase subunit encoding gene (rpoC1), Hypothetical chloroplast reading frame 5 (ycf5), ribulose-bisphosphate carboxylase gene (rbcL) and Maturase K (matK). A modified DNA extraction method was developed to avoid the resin interference with nuclear material, which was amplified through extensive polymerase chain reactions and sequenced. The sequences were aligned and assessed for polymorphism. A high number of variable site was recorded for ITS2 barcode (36) compared to rbcL, matK, ycf5 and rpoC1 (3, 4, 4 and 3) respectively. Nucleotide diversity was estimated for all of the recorded barcode and a high number of nucleotide were shown by ITS2 (0.11842) barcode and very low valve was recorded in the case of the coding region, rbcL gene of the plastid due to its conserved nature. The results showed higher genetic divergence by ITS2 (0.1298 + 0.0219) than the other four barcodes viz. rbcL, matK, ycf5 and rpoC1 from the plastid region. Phylogenetic analysis showed that all the barcode made one monophyletic clade for the genus Boswellia. In conclusion, the current study evaluated the potential utility of both nuclear and chloroplast genome regions for identifying and discriminating species based on representative samples.

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Title: Chloroplast Genome Sequencing of the Frankincense-Producing Endemic Boswellia sacra Tree

Abstract:

Boswellia sacra (Burseraceae) is an endemic, economically and culturally important tree, growing in the extreme climate of the Dhofar region of Oman. This tree is famous for producing oleo-gum resin through wound incisions. Resin from Boswellia has been traded from the southern coast of Arabia to the Mediterranean region for more than a millennium, and this resin is typically burned to produce fragrant smoke. Considering the importance of the B. sacra tree, an understanding of chloroplasts is essential, as these organelles perform photosynthesis and generate the basic mechanisms required for plant growth. In the present study, the chloroplast (cp) genome of this tree was sequenced for the first time. The results revealed a cp genome size of 160,543 bp with 37.61% GC content. The cp genome showed a typical quadripartite chloroplast structure with inverted repeats (IRs 26,763 bp) partitioned by small single copy (SSC; 18,962 bp) and large single copy (LSC; 88,055 bp) regions. In the coding region, the B. sacra cp genome contains 114 unique genes with 83 protein-coding regions. Twenty genes related to photosystems I and II, seventeen genes related to ATP synthase NADH dehydrogenase, six genes associated with the cytochrome b/f complex, a large subunit rbcL, two ORF, and other important genes related to the ATP-dependent protease/ATP binding subunit (clpP), maturase K (matK), translational-initiation factor (infA), envelope-membrane protein (cemA), subunit of acetyl-CoA carboxylase (accD), and c-type cytochrome synthesis gene (ccsA), were identified during de novo sequencing and annotation. The phylogenetic and syntenic analysis revealed that the B. sacra genome is closely related to the cp genome of Azadirachta indica, differing only in the trnH-GUG-psbA coding regions. The cp genome of B. sacra revealed a novel assembly of genes essential for the existence and growth of this tree under extreme environmental conditions.

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Title: Endophytic Fungi from Frankincense Tree Improves Host Growth and Produces Extracellular Enzymes and Indole Acetic Acid

Abstract:

Boswellia sacra, an economically important frankincense-producing tree found in the desert woodlands of Oman, is least known for its endophytic fungal diversity and the potential of these fungi to produce extracellular enzymes and auxins. We isolated various fungal endophytes belonging to Eurotiales (11.8%), Chaetomiaceae (17.6%), Incertae sadis (29.5%), Aureobasidiaceae (17.6%), Nectriaceae (5.9%) and Sporomiaceae (17.6%) from the phylloplane (leaf) and caulosphere (stem) of the tree. Endophytes were identified using genomic DNA extraction, PCR amplification and sequencing the internal transcribed spacer regions, whereas a detailed phylogenetic analysis of the same gene fragment was made with homologous sequences. The endophytic colonization rate was significantly higher in the leaf (5.33) than the stem (0.262).

Name: Omar AL-Sudairy

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Title: Comparison of Endogenous Phytohormones and Essential Metabolites in Preserved and Incised *Boswellia sacra* Tree Populations

Abstract:

Boswellia sacra trees are subject to man-made incisions during commercial frankincense production. The resulting wounding stress affects regeneration capacity, whilst nothing is known about the tree's physiological responses. Here, we investigated the physio-chemical responses and related gene expressions of incised and preserved B. sacra trees population to wounding. We found that wounding results in a two-fold increase in calcium/magnesium oscillation and reduction in essential macronutrients (nitrogen, carbon, and hydrogen) levels. The total amino acid content was also reduced by 1.74-fold; however, levels of g-amino butyric acid, hydroxyl-proline, sarcosine, and b-alanine were significantly higher (~1- to 2.2-fold). In contrast, the fatty acids g-linolenic, palmitic, stearic, and linoleic acid were higher in the preserved trees. Endogenous jasmonic acid was also significantly higher (67%) in the incised trees, as was the expression of the JA-related genes allene oxide synthase and allene oxide cyclase. A similar two-fold increase in stress-responsive abscisic acid was observed in the wounded trees. Meanwhile, salicylic acid was down-regulated, and the pathogenesis related genes PR1 and PR3 exhibited varying responses in the wounded trees. The presence of physiologically active gibberellins (GA1, GA4, and GA3) and inactive (GA12, GA19, and GA20) in both the wounded and preserved trees suggested a biosynthesis trend of B. sacra as ent-kaurenoic acid to GA3. Both GA4 and GA3 were synthesized significantly, which were also buoyed by the increased expressions of ent-copalyl diphosphate synthase, cytochrome P450 monooxygenases, and gibberellin 20 oxidases in the incised tree population. In conclusion, the B. sacra responds to incision by regulating essential endogenous hormones and related transcripts, which in return retard tree growth and development.

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Title: Diurnal Wounding Stress to *Boswellia* sacra Influence Oxidative Stress Enzymes and Phytohormones

Abstract:

Boswellia sacra is an endemic tree to the Sultanate of Oman and is economically and culturally important for the local people. The tree is wounded with an axe to extract oleo-gum resin from the epidermal stem part of the tree. How the tree responds physiologically to such wounding has least been known. In the current study, we have applied wounding stress (0hr – control; 30 minutes; 3 hrs; 6 hrs; 12 hrs; 24 hrs and 3 days) to understand the oxidative stress enzymes and endogenous phytohormones. The results showed wounding stress significantly increased the activities of ascorbate peroxidase, glutathione reductase and catalase after 30min, 3hrs and 6hrs, 12 hrs, 24 hrs and 3 days of wounding, suggesting an activation of oxidant in site-specific incision. In case of phytohormones, we analyzed salicylic acid (known for systematic acquired resistance) which was highly significant in its contact during wounding stress, whereas the content varied greatly among different wounding treatments. A similar trend was also observed for jasmonic acid, showing that it responded with increased contents. The current study concluded that the frankincense tree responds to wounding by enhancing the activities of enzymes and phytohormones.

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Title: Chemical Composition and Antioxidant Activity of *Juniperus phoenicea* Essential Oil from Algeria

Abstract:

Essential oils from berries and stems of Juniperus phoenicea were obtained by electromagnetic induction heating assisted extraction and by hydrodistillation with a yield from (1.2 ± 0.3% to 2.4 ± 0.7 %) and from (0.6 ± 0.1% to 1.1 ± 0.1%), respectively. Forty-eight compounds were identified representing (97.2 – 99.7%) of the oil. α-pinene (40.3- 67.8 %) and δ-3-carene (13.5– 26.8 %) were the main detected compounds. Antioxidant activity was evaluated using three different approaches: inhibition of 2, 2-diphenyl-1-picryl hydrazyl (DPPH) free radical, reducing power and β-Carotene linoleic acid bleaching. The anti-oxidative potential of essential oils showed IC50 ranging from 67.6 ± 1.02µg/mL to 131.5± 0.8µg/mL for berries and from 98±1.2µg/mL to 166.8±0.29 µg/mL for the stems. Therefore the berries' oil show interesting.

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Title: Chemical Composition and Larvicidal Activity of *Thymus algeriensis* L. Essential Oil against *Galleria mellonella*.

Abstract:

The aim of the present study is to determine the chemical composition and evaluate the larvicidal activity of Thymus algeriensis L. essential oil (TAEO) against Galleria mellonella larvae. G. mellonella is a pest of the honey bee Apis mellifera. The extraction of essential oil from the aerial parts of Thymus algeriensis L. is performed by hydrodistillation at yield of 2.7% (w/w). The TAEO extracted was analyzed by gas chromatography coupled to mass spectrometry (GC/MS) and by gas chromatography (GC). 22 compounds representing 95.32% of the oil were identified. The main constituents were carvacrol (45%), γ -terpinène (12%) and p-cymène (11.87%). Four lots were constituted at the level of an apiary in order to study the dynamics of the G. mellonella and its host Apis mellifera, the lots were treated at different doses of TAEO (0, 1, 3, 5, 7 and 10%). TAEO has been used by spraying on the petri dish. The results obtained show that TAEO at 0.7% results in a decrease in the rate of infestation of G. mellonella, causing a mortality rate of 46% larvaes. The treatment carried out in early spring gives very encouraging results and oil could be used as a bio-acaricide

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Title: Steam Distillation of Frankincense Essential Oil - Advanced Steam Distillation for Best Quality and Yield of Oil

Abstract:

Frankincense – Aromatic Gum resin / dried resinous gum harvested from Boswellia trees.
Family : Burseraceae / Genus : Boswellia / Species – B. Sacra etc.

Frankincense (B. Sacra etc) is a native tree of the Arabian Peninsula (Oman & Yemen). This gum resin is harvested from trees in the wild, from mountainous region, and is sorted in different grades and then shipped for use. It is mostly distilled by the old technology of hydro-distillation but the modern technology of steam distillation gives the best quality and highest yield of frankincense oil.

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Title: Isolation, Characterization and Synthesis of New Triterpenic Monomers and Dimers as Potential Antiproliferative Agents and their Molecular Docking Studies

Abstract:

In the current investigation, natural products such as acetyl-keto-β-boswellic acid (AKBA), keto-β-boswellic acid (KBA), myrrhanone B, and lupeolic acid were isolated from Boswellia sacra and Cammiphora mukul. Synthesis of new monomers of myrrhanone B, boswellic acids and lupeolic acid were prepared via reaction of triterpenic acids with linkers in the presence of K2CO3. In addition, new bis-myrrhanone B homodimers, myrrhanone B-myrrhanol B heterodimers, and bis-myrrhanone β-boswellic acids heterodimer were prepared. Evaluation of these compounds on the proliferation of four different human cancer cell lines, viz., FaDu (pharynx carcinoma), A2780 (ovarian carcinoma), HT29 (colon adenocarcinoma) and A375 (malignant melanoma) has been performed. It is worth mentioning that compounds 4, 7, 8, 10, and 11 possess potent antiproliferative effect towards HT29 cancer cells with IC50 values of 8.1 mM, 5.4 mM, 8.8 mM, 6.8 mM, and 8.2 mM, respectively. In addition, these compounds display good to moderate antiproliferative activities towards A2780 and A375 with IC50 values ranging from 10.4 to 24.2 mM. Moreover, the molecular docking studies of most active compounds (4, 7, 8, 10 and 11) with six anticancer drug targets DHFR, VEGFR2, HER-2/neu, CDK6, hCA-IX and LOX also carried, in order to know the mode of binding interaction and energy of this class of compounds.

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Title: Total Flavonoids and Phenolic Content of Common Ethnobotanical Omani Plant Species

Abstract:

Background: Phytonutrients (phenolic compounds and flavonoids) are secondary plant metabolites. Their consumption in the diet has a significant role in the defense system against pathogens as well as protection from oxidative injury. They have significant antioxidant activity due to their potential to neutralize reactive oxygen species including peroxides.

Objective: This study aimed to screen aqueous extracts of different wild Omani plants for their total phenolic (TPC) and flavonoids content (TFC).

Material and Methods: Leaves from 20 plant species were collected from different regions in Oman and processed by a freeze-drying system to keep the integrity of the TPC and TFC. All plants extracts were dissolved powder in deionized, and the aqueous extract of each plant was obtained after centrifugation and/or filtration. TPC was measured using the Folin-Ciocalteu reagent; meanwhile TFC was determined according to the aluminum chloride colorimetric assay.

Results: TPC of all species ranged from 0.52 ± 0.06 to 65.14 ± 2.41 mg gallic acid equivalent (GAE)/g and total flavonoid content ranged from 0.07 ± 0.04 to 37.14 ± 0.76 mg catechin (CTE)/ g dry weight. Pteropyrum Scoparium (Sidaf) showed highest TPC of 65.14 ± 2.41 mg GAE/g and Dodonaea viscosa (Shahs) showed highest TFC 37.14 ± 0.76 mg CTE/ g. TPC and TFC had a significant positive relationship ($r = 0.79$, $P < 0.001$).

Conclusion: The results of our study revealed that few Omani plant species might be considered as potential sources for phenolic compounds and flavonoids. These plants can be propagated and their secondary metabolites may be utilized in food and nutraceutical industry. It is recommended to include these plants species in the food chain of the Omani population as a dietary intervention to combat oxidative stress-mediated human chronic diseases.

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Title: Development of Organic Hand Sanitizer with Herbs

Abstract:

Hand sanitizer often contains high level of alcohol, which acts as an active ingredient and works as an antiseptic. Even non-alcohol based commercial hand sanitizers contain an antibiotic compound called triclosan. Although they are usually not harmful, chronic use of hand sanitizers is likely to result in skin irritation, alcohol poisoning, hormone disruption, and weakened immune systems, especially in children. Therefore, there is a need to develop organic hand sanitizers using natural herbs available locally.

For in vitro test, 9 locally available herbs were extracted with 100% ethanol and pathogens were collected from unwashed hands, then each extract was tested against hand pathogens. A broad range of plants were effective against the pathogens tested but the most effective plants were 20% holy basil (Ocimum sanctum) and 20% sweet basil (Ocimum basilicum). Mint (Mentha spicata) was also effective against hand bacteria but only at 50% high concentrations.

For the next step, 20% of holy basil extract was mixed with glycerine 70%, soya oil 2.5%, almond oil 2.5%, sunflower oil 2.5%, and aloe vera 2.5%. Ten people were asked not to wash hands for 2 hours then randomly divided into two groups. The first group sanitized their hands with commercial hand sanitizer (Dettol) following public authority organization recommended methods, while the second group sanitized with the herbal sanitizer. Each group was asked press their hands gently on four agar plates each per person. The plates were kept at 37°C for 24 hours to compare pathogen growth for comparing efficacy of the two products. The growth of pathogens from the two products was similar; even less dense in the Dettol group. According to the results from the present study, the authors found the possibility of replacing high alcohol based hand sanitizers with low alcohol hand sanitizers containing natural herbs.

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Title: Boswellic Acid Sensitizes Gastric Cancer Cells to Cisplatin-induced Apoptosis via p-53mediated Pathway

Abstract:

Gastric cancer (GC) is the fourth most common cancer worldwide and the fifth in Oman. Although, Cis-di-amminedichloridoplatinum (CDDP), is an effective chemotherapeutic agent for treating GC, the majority of cases develops resistance against it. Such resistance occurs when CDDP fails to induce apoptosis by either activating pro- (i.e. p53) or inhibiting anti-apoptotic (i.e. Akt and NFkB) proteins. CDDP-resistance is a multifactorial process that can be partially overcome by additional agents with anti-cancer properties, one of which is AKBA (Acetyl-keto-beta boswellic acid) that has shown promising anticancer effects in certain types of cancer. However, its role in enhancing CDDP-induced apoptosis in gastric cancer and the underlying molecular mechanisms has not been studied. Therefore, this study aims to examine the effectiveness of AKBA on p53-mediated, CDDP-induced apoptosis in GC cells. To address such a role, AGS and NCI-N87 gastric cancer cells were treated with different concentrations of CDDP (0, 50, 100 μM) and AKBA (0, 25, 50, 100 μM). Apoptosis and expression of p53, Akt and NFkB proteins were assessed using flow cytometry and Western blot respectively while the role of p53 was determined by inhibiting its function through siRNA. In NCI-N87 cells, both CDDP and AKBA significantly induced apoptosis in a dose-dependent manner ($p=0.004$ and $p<0.001$ at 50 μM respectively) and decreased Akt and NFkB expression with loss of p53 expression. In AGS cells, similar effect of both drugs was seen in apoptosis induction and Akt and NFkB expression except for p53 protein which was increased. P53 down-regulation affected apoptosis induction by both drugs, suggesting its role in their mechanisms of action. Altogether, our findings suggested, for the first time, that AKBA enhances GC cell sensitivity to CDDP-induced apoptosis via p53-mediated pathway.

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Title: The Rose Attar and Other High Valued Products from Highland and Khareef Season Roses

Abstract:

Attar of roses, also called otto of rose, essence of rose, or rose oil, is a fragrant, colourless or pale-yellow liquid essential oil that is distilled and supercritical fluid extracted from fresh petals of Rosa damascena and Rosa centifolia especially adopted to highlands and the khareef season. Rose oils are used as a valuable ingredients in fine perfumes and drinks. They were also used for flavouring lozenges and scenting ointments and toilet preparations. Rosa damascena and Rosa centifolia yielded essential oil 0.04-0.05% and 0.02-0.03%, respectively. The chemical composition of rose oil is complex and contains more than 400 compounds, not all of which have been identified to date. The main chemical components of rose oil are listed as: citronellol, phenyl ethanol, geraniol, nerol, farnesol and stearpoten with traces of nonanol, linalool, nonanal, phenyl acetaldehyde, citral, carvone, citronellyl acetate, 2-phenylmenthyl acetate, methyl eugenol, eugenol and rose oxide. Similar varieties can be cultivated at Al Jabal Al Akhdar and Salalah.

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Title: Antioxidant Activity of Black Mulberry Extracts Fruit on the Genotoxicity of EMS in Male Albino Mice Mus Musculus

Abstract:

The present study was conducted to determine the antimutagenic action of the black mulberry fruits Morus nigra L. extract on the chromosomal aberrations and sperm abnormalities induced by Ethyl methyl sulfonate (EMS) because of its content of active components including phenols and anthocyanin. These components had potent antioxidant agents which are used for the treatment of many diseases.

Ethyl methyl sulfonate (EMS) was injected in the mice intraperitoneally in a single dose (200mg/Kg body weight) then, treating the mice with two different doses of black mulberry fruits extract (50, 100mg/ml/Kg) given with (EMS) for 3 weeks administrated orally. EMS has the ability to induce various types of chromosomal aberrations such as Chromatid break, Chromosome break, Pulverization, Dicentric chromosome, and sperm abnormalities such as defective head sperm, sperm without a tail, sperm without a head, and swollen head. According to our study, the black mulberry fruits extract has antimutagenic effect against EMS Genotoxicity by decreasing chromosomal aberrations and sperm abnormalities.

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Title: Evaluation of the Cytotoxic Effects of -30-acetyl-11-keto-β-boswellic Acid in Ovarian Cancer Cells

Abstract:

Ovarian cancer causes significant mortality. The five year survival rate is very low compared to other cancers, and most of the cases are diagnosed late. Most of these cases relapse and develop resistance to first line chemotherapy; therefore, new strategies are urgently needed to overcome resistance. Extracts from Boswellia sp., used for centuries as herbal medicine in Asia, have known anti-inflammatory [1] properties and anti-cancer potential [2]. The active ingredients of Boswellia sp., boswellic acids, have many effects on various cancer cells including induction of apoptosis [3]. This study assessed the mechanism of action for the biologically active component of Frankincense, 3-O-acetyl-11-keto-β-boswellic acid (AKBA) to evaluate its potential cytotoxicity towards high grade serous ovarian cancer and its ability to subvert resistance to cisplatin.. Comet assay was used to detect the deoxyribonucleic acid (DNA) damage, AlamarBlue® to measure quantitatively the cell proliferation and viability, flow cytometry to examine the cell cycle arrest, Annexin IV/PI for apoptosis, and western blotting to confirm the specific apoptotic proteins expressions. 50μM AKBA induced significant ($P<0.001$) DNA damage (strand breaks and alkali-labile sites) immediately in all ovarian cancer cell lines compared to controls treated only with DMSO, whereas15 μM and 25 μM AKBA induced significant DNA damage after 16 hours or more. Significant cell death was observed at 15μM AKBA or higher, dependent on the exposure time, in all cell lines [OVCAR 4, UWB 1.289, A2780 and A2780-cis (cisplatin-resistant)]. OVCAR4 and A2780ciscell lines were significantly more sensitive to the cytotoxic effects of AKBA. AKBA is cytotoxic to ovarian cancer cells, at pharmacologically achievable concentrations. It induces DNA damage, cell cycle arrest which leads to cancer cell death (apoptosis). AKBA may form the basis of a novel anticancer treatment for ovarian cancer perhaps alongside conventional chemotherapy.

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Title: Anti-proliferating Effect of *Plantago ciliata* on Breast Cancer Cells

Abstract:

Cancer is an increasing epidemic worldwide. It was estimated that around 8.2 million individuals died in 2012 due to cancer. Breast cancer is the most common type of cancer affecting women worldwide. It has the second highest cancer mortality rate. The rate of breast cancer among Qatari residents and citizens is 39.41%, with a survival rate of 98% during early stages of diagnosis and 58% in the late stages. In 2015, 19% of cancer related death was due to breast cancer. Conventional treatments of breast cancer are hindered by systemic side effects and decreased quality of life for patients during the course of the treatment. Therefore, there has been a shift in interest in using complementary and alternative medicine (CAM), especially medicinal plants. This study was conducted to identify the anti-proliferative effects of crude extract isolated from Plantago ciliata, a Qatari medicinal plant, on breast cancer cell MDA-MB-231. The crude extracts from Plantago ciliate were prepared using 3 solvents: methanol, acetone, and water. These 3 extracts were then tested on MDA-MB-231 BC cells, and a dose-response curve was obtained. The results showed an inhibition of the proliferation of BC cells in a dose-dependent manner. Significant inhibition was obtained with a concentration of 60 mg/ml for water and 20 mg/ml for both methanol and acetone. In particular, water extract showed the most potent effect. The long-term objective of this study is to build a foundation for further research aiming towards a chemoprevention approach, to recognize a target that can guide anticancer therapeutic strategy.

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Title: Anti-proliferative Effect of *Ephedra foliata* on Prostate Cancer Cells

Abstract:

Prostate cancer (PC) is the most common non-cutaneous cancer in males with high mortality and morbidity rate. Although conventional medicine is widely used to treat PC, it has many drawbacks, which drives PC patients towards complementary and alternative medicine. Herbal medicine represents one of the most important fields of traditional medicine over the world. Plants contain bioactive compounds, which belong to various chemical groups known for their therapeutic effects. In particular, Ephedra foliate, a native plant found in Qatar desert is well known for its anti-microbial, anti-oxidant, hepatoprotective, and cardiovascular effects. However, its role in cancer cell proliferation is unknown. This study evaluates the antiproliferative effects of Ephedra foliata on DU 1455 PC cells. Crude extracts of Ephedra foliata were prepared using absolute methanol as solvent. The anti-proliferative effects of Ephedra foliata on DU 1455 PC cells were carried out using MTS cell proliferation assay. Results indicated a significant decrease of PC cell proliferation in a dose-dependent manner. Significant inhibition of proliferation is noted with a concentration greater than or equal to 0.125ug. These results suggest that methanol extracts from Ephedra foliata have potent anti-proliferative effects on PC cells. The long-term objective of this investigation is to lay the foundation for further research leading to the use chemoprevention approach to identify targets to guide the design of anticancer therapeutic strategies.

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Title: Preparation and Biological Evaluation of Palm Date (*Phoenix dactylifera L.*) Fruits Extracts

Abstract:

Natural products are good cure in the treatment of diseases as they are affordable and have no side effects compared to synthetic drugs which are expensive, alter genetic and metabolic pathways, and have adverse side effects. Date fruit is rich in phytochemical compounds like carotenoids, polyphenols especially phenolic acids, isoflavons, lignans, and flavonoids, tannins, and sterols that are used as therapeutic agents as well as starting material for the synthesis of drugs. Pancreatic stellate cells (PSCs) have been suggested as the main responsible factor in the fibrogenesis of the pancreas during the course of inflammation and cancer.

In this study, natural product has been extracted from the fruits of date palm tree (Phoenix dactylifera L.) of the Omani elite variety "Khalas" using different solvents including: water, ethanol, acetone, and ethyl acetate. The extract will be evaluated as anti-proliferation and anti-fibrotic activity of TNF activated PSC. The results demonstrate that the date extracts reduce the fibrosis and affect cell proliferation, especially ethyl acetate extract. This result indicate that date fruit has a compound or mixture of compounds which can be used for the treatment of fibrosis.

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Title: Management of Busulfan/*Cyclophosphamide* Induced Toxicity by Frankincense Derivative Compounds

Abstract:

Previous studies have shown anti-tumor properties of frankincense derivative compounds. The aim of this study is to diminish Busulfan/Cyclophosphamide (Bu-Cy) toxicity with the aid of derivative compounds in mouse model. In this study, chemotherapy a conditioning regimen was made on 25 (Female Balb/c) mice by treating them with 80 mg Busulfan and 200 mg cyclophosphamide per kg. Frankincense derivative compounds were extracted in chemistry laboratory and injected as 200 mg of essential oil (Ess), 10 mg of soxhlet oil (Sox) and 200 mg extract oil (Ext) per kg of chemo treated mice. Mice treated with Bu-Cy chemotherapy had a lower bone marrow count and spleen index compared to the control, whereas frankincense derivative compounds help reduce side effects and modifying the immune system and general health. Despite this, all three derivatives have decreased chemotherapy side effects.

Sox oil could simultaneously increase spleen index and bone marrow and also improve health in comparison with control group.

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Title: Phytochemical and In Vitro Pharmacological Evaluation of Alcoholic and Chloroform Extracts of Dhofari Frankincense

Abstract:

Background: Dhofari Frankincense or Boswellia species (Boswellia sacra) is the key ingredient in traditional Omani life as it is used for spiritual and medical purposes. **Aim:** This study aimed to explore the phytochemical and in vitro pharmacological activity of the polar and non polar extracts of Hojari variety, a finest quality of Dhofari Frankincense resin. **Methodology:** Dhofari Frankincense (Hojari) was purchased from the local market. The resin was powdered and macerated in ethanol and chloroform for seven days. The extract was filtered and the solvent was removed by using rotary vacuum evaporator to obtain the semisolid mass in good yield. The extracts were tested for the presence of phytochemicals by qualitative methods. The total phenolic content of the extracts was quantified by colorimetry using Folin ciocalteu reagent. The extracts were also investigated for several in vitro biological properties such as antimicrobial activity by agar diffusion method, antioxidant activity by DPPH method, anti-inflammatory activity by Albumin protein denaturation method and cytotoxic activity by brine shrimp lethality assay method. **Results:** The oilbanum extract showed the presence of triterpenoids, steroids, saponin, phenols and carbohydrates. The total phenol content in ethanol and chloroform extract was found to be 14.67 mg/g and 14.79 mg/g of gallic acid equivalent, respectively. Ethanol extract exhibited slightly better antimicrobial activity than Chloroform extract against E.coli. Both the extract displayed good antioxidant activity and the highest % inhibition was observed with concentration of 8 mg/ml. The extracts showed potent cytotoxic activity (100% mortality of brine shrimps) after 24 hours at a concentration of 1000µg/L. The anti-inflammatory activity of the extracts was comparable to the standard drug diclofenac. **Conclusion:** The study confirmed that the non polar fraction of frankincense is therapeutically more powerful than polar extract.

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Title: Complete Chloroplast Genomes of *Commiphora* (Frankincense and Myrrh Family) Species and its Comparative Analysis.

Abstract:

The family *Burseraceae* comprises 18 genera and about 700 species having pantropical nature. This family is best-known for its fragrant resin such as myrrh from *commiphora* species and frankincense from boswellia species. Some important timber trees also belong to this family. This family is known for producing fragrant resins which have medicinal, economic and cultural importance including frankincense myrrh and copal. Commiphora gileadensis are widely known in the mediterranean basin, especially on border of Oman, Saudi Arabia, Yemen and Somalia. Commiphora gileadensis is also known as balsam and is commonly used for the production of expensive perfumes.

Further, its sap, wood bark and seeds are used for medicinal purposes commiphora gileadensis yield in the production of very fragrant gum type resin when the bark of the tree is damaged. Previous studies of commiphora and related genera were weakly supported by molecular and paraphyletic taxa. Here, we report the complete chloroplast genome sequence of two complete chloroplast genomes, commiphora gileadensis and commiphora foliacea with related species commiphora wightii and boswellia sacra.

The chloroplast genome length of C.gileadensis, C. foliacea, commiphora wightii and B. sacra ranges from 156064 bp to 160543 bp. The average number of genes in C.Gileadensis total of 140 genes comprising 79 protein coding genes, 29 tRNA genes, and 4 rRNA genes were observed in three chloroplast genomes. The total number of SSRs was 198, 175, 153 and 191 in C.gileadensis, C.foliaceae, C. Wightii and B.sacra respectively. A comparison of coding genes and non-coding regions between C.gileadensis and C.folicea, C. wightii and boswellia sacra revealed divergent sites, with the greatest variation occurring ndhB region, ycf1 region and rpl22 regions. The complete chloroplast genome sequence information regarding the two genomes will be helpful for elucidating genus commiphora phylogenetic relationships.

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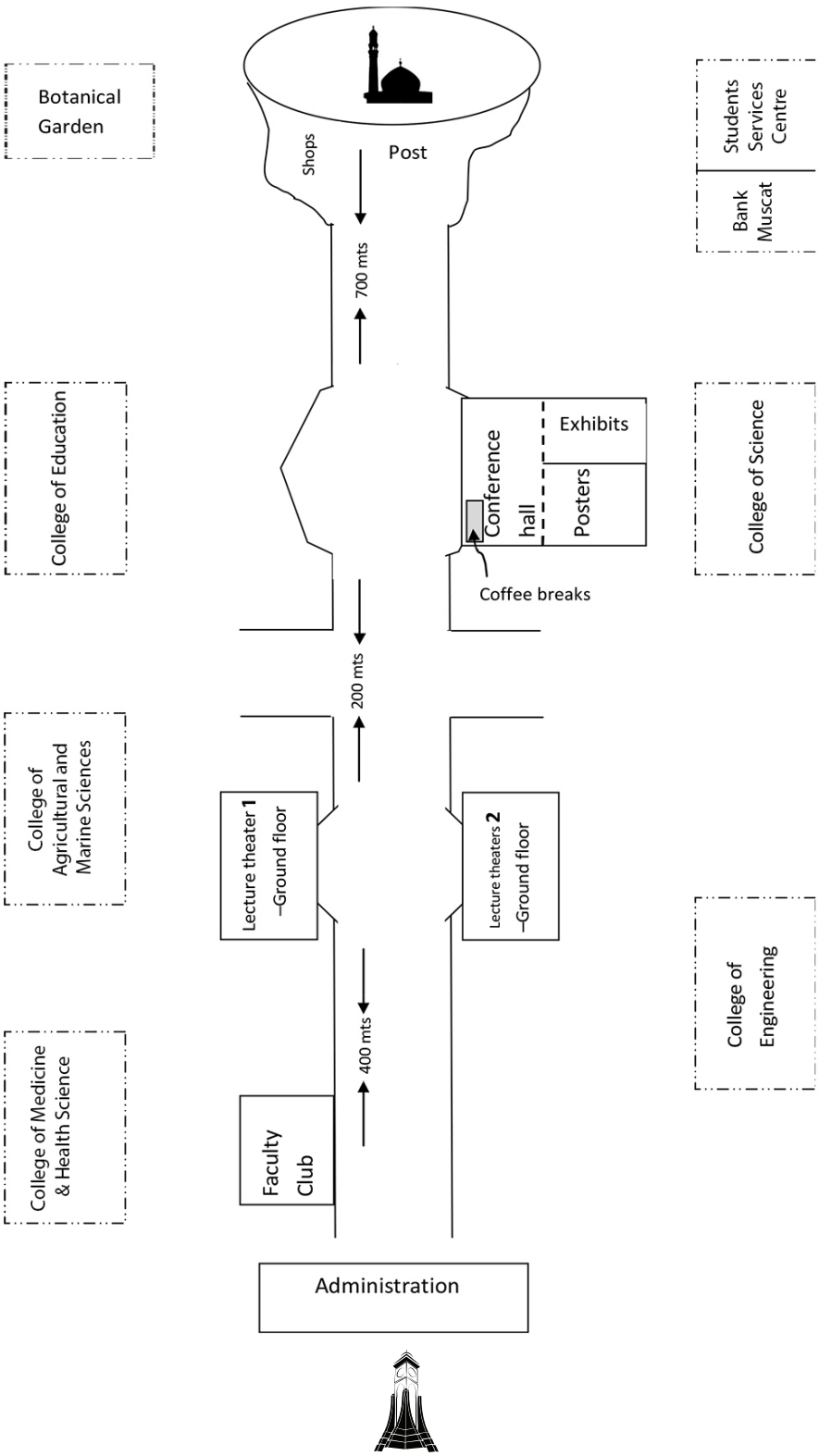
Botanical Garden
Shops
Post
Students Services Centre
Bank Muscat
700 mts
College of Education
Conference hall
Exhibits
Posters
College of Science
Coffee breaks
200 mts
College of Agricultural and Marine Sciences
Lecture theater 1 –Ground floor
Lecture theaters 2 –Ground floor
400 mts
College of Medicine & Health Science
Faculty Club
College of Engineering
Administration