RESEARCH HIGHLIGHTS

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NATURE'S GIFT OF REMEDIES

Discovering the revolutionary healing properties of plants

The increase of awareness on climate change and the strong emphasis on health among the general public gave rise to the popular fad of organic products and plant-based diets. Whether it is to save the planet or to promote general health, the all-natural nutrition market has seen an unexpected boom. Food labels that carry the mark "organic" and "natural" are priced twice the amount of products that do not contain terms as such. Consumer Reports, a US-based non-profit consumer organization, confirms through their analysis that organic food is reported to be 47% more expensive than regular food. A common preconceived notion among consumers is that natural products are not only safer but also provide health benefits, unlike their counterparts, genetically modified and processed food items. Perhaps this long-held belief stems from the use of plants and herbs as primary sources of remedies during ancient times. The practice of using botanical products to treat diseases or maintain health dates back thousands of years remains relatively popular even with the establishment of modern medicine today. Some common examples of phytomedicines are Gingko Biloba, which is used to treat blood disorder and Echinacea, which is conventionally sorted out to help fight the common cold. With modern technology, researchers have expanded the boundaries of plants' healing properties to serve more than just maintaining general health or fighting minor illnesses. Presently, the medicinal properties of plants can even be potentially used in the treatment of chronic diseases such as cancer and diabetes.

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Cancer Cures

Kaempferol in the Autophagy of Liver Cancer Cells

The next time you enjoy some tomatoes and strawberries, or your side dish of broccoli or cabbage, think about the phytoestrogen, kaempferol. This flavonoid compound, found in a variety of vegetables and fruits, is also found in Chinese traditional medicine such as Aloe Vera. Kaempferol is believed to possess many biological functions, including inhibition of inflammation. Besides, kaempferol is proven to have anti-cancer activity in various human cancer cells, like breast cancer, lung cancer and oral cancer. Perhaps, the two most prominent beneficiary functions of kaempferol are as an inherent antioxidant and an effective anti-cancer agent. Taken by an interest in kaempferol's anti-cancer function, Professor Shih-Chang Tsai's team investigated the anti-tumor effects of kaempferol in human liver cancer cells. Tsai's interest primarily revolves around the biological functions of microRNAs in cancer cells and drug designing, which led him to publish his findings on the role of kaempferol in autophagy in the International Journal of Oncology (2013). Autophagy or cellular self-digestion plays a crucial role in normal human physiology. In the process of autophagy, damaged and unnecessary components of the cells are removed, including misfolded proteins. Numerous studies have reported that the autophagy process has anti-cancer roles. The outcome of Tsai's study demonstrated that kaempferol does indeed induce the autophagy process in human liver cancer cells, namely the SK-HEP-1 cells. Besides inducing the autophagy process, kaempferol is also reported to induce cell cycle arrest in the cancerous SK-HEP-1 cells. In cell cycle arrest, all cellular processes like genome duplication and cell division are halted. This further strengthens the role of kaempferol in eliminating cancerous liver cells. Tsai's findings firmly suggest the possibility of using kaempferol in developing anti-cancer drugs for human liver cancer cells.

Berberine in Preventing Skin Cancer Invasion

The color of a ripe lemon on a wonderful sunny day, the color of sunshine, hope and happiness; the color yellow is often associated with all things cheerful and high spirits. This bright color is also the color of the chemical compound, berberine, is commonly found in several plants, including the European Barberry, goldthread, goldenseal and tree turmeric. Berberine is widely sold in capsule form as supplementary nutrition, especially among patients who suffer from diabetes, high cholesterol, and high blood pressure. Berberine is primarily known for its ability to regulate blood sugar levels in the body. Besides that, it is also said to exhibit anti-microbial, anti-inflammatory, antioxidant, and even anti-cancer properties. Several scientific studies have asserted that berberine is effective in decreasing the cell number of various human cancer cells through the induction of cell cycle arrest or cell apoptosis (cellular suicide). Professor Wen-wen Huang and her team decided to further explore the role of berberine in cancer by focusing on the inhibition of cell migration and invasion in human melanoma cells. Melanoma is a lethal type of skin cancer and is prevalent in the white population compared to other ethnic groups. It also occurs more frequently in the male population. In her study, Huang analyses the exact molecular mechanism of berberine in inhibiting the cell migration and invasion of the specific A375.S2 melanoma cell in vitro. She discovered that berberine prevents both processes by interrupting the signal pathways first. Berberine also decreased the number of cells and inhibited the mobility of cells in these skin cancer cells. By blocking cancer cell migration and invasion, the cancer cells remain localized and can be easily targetted. Huang's study is vital in preventing the spread of cancerous cells to other parts of the body – the spread is a process also known as metastasis, which is often challenging to address and is a leading cause of cancer-related death. The findings of her study were published in the journal Molecules in 2018.

Emodin in Deterring Head and Neck Cancer (HNC) Spread

While the stalk of edible rhubarbs may serve as a special ingredient in baking recipes, the root of its relative species, Chinese rhubarbs, is recognized as an inferior remedy in the oldest Chinese herbal books. The roots of medicinal rhubarbs contain a chemical compound termed emodin. Emodin is an active component of several plants in Traditional Chinese Medicine (TCM). It is usually extracted neatly from Chinese rhubarbs, a plant widely used as a laxative in the field. Emodin is also found to influence biological activities akin to kaempferol and berberine, namely, anti-inflammatory, anti-microbial, antioxidant, and anti-cancer activities. Past studies have shown that emodin exerts apoptosis (cellular suicide) effects in ovarian, lung, leukemia and tongue cancer cells. Professor Tzong-Der Way and his team decided to investigate head and neck squamous cell carcinoma (HNSCC) and how emodin can inhibit the spread of these cancerous cells. Primarily focused on cancer biology and drug discovery, Way's current study is different from previous studies as it centers on the epithelial-mesenchymal transition (EMT). EMT is a critical process in cancer cell migration and invasion. It has been linked to the progression of several types of cancer. EMT enables the tumor cells to leave the primary tumor environment and migrate to distant sites. Inducing EMT in HNSCC has been shown to enhance the growth of cells with tumor-initiating abilities which suggest the possibility of tumor invasion. Published in the European Journal of Cancer, 2014, Way's study discovered that at physiologically relevant doses, emodin is seen to reduce EMT by suppressing signaling pathways. Nonetheless, emodin also attenuates tumor-initiating abilities in cancer cells. Cancer cells with tumor-initiating traits are often resistant to treatments, such as chemotherapy and radiotherapy; thus, increasing tumor recurrence. In the case of HSNCC, tumor recurrence is one of the biggest challenges and often leads to incurable diseases. The discovery of emodin's role in inhibiting the growth of a new tumor is vital as treatment may not be able to eradicate the subpopulation of resistant tumor cells. Emodin may then be utilized in the development of new drugs to preclude the possibility of cancer cell regeneration.

Chinese rhubarb roots

Bacterial Barricades

Huang Qin & Zhi Zi herbs in Preventing Salmonella Infection

Huang Qin (Scutellariae radix) and Zhi Zi (Gardeniae fructus) are common herbs used in Traditional Chinese Medicine (TCM). Scutellariae radix is derived from the roots of Chinese Skullcap and is usually yellow in shade and hard in texture. This dried-roots preparation is traditionally used to treat inflammation, cardiovascular diseases and respiratory and gastrointestinal infections. On the other hand, Gardeniae fructus is the ripe fruits of the popular Gardenia ornamental shrub, which are also dried in the herbal preparation. It takes on a reddish-orange color and is bud-like in shape. The Gardeniae fructus is traditionally prescribed to reduce inflammation and is also known to treat liver and gall-bladder disorders such as hepatitis and jaundice. A 2013 study conducted by Professor Yuan-Man Hsu also discovered that both Scutellariae radix and Gardeniae fructus could prevent Salmonella infection. Salmonella infection is a food-borne disease and is usually the main culprit for "food-poisoning" in humans. The pathogen responsible for the infection is generally transmitted from animals to humans when humans consume raw, undercook meat of the animals. As Hsu's interest lies in improving the immunity and digestive abilities of animals by using a combination of probiotics and herbs as feed additives, one of her studies focused on the efficacy in preventing Salmonella infection of seven herbal plants in swineherd. Both Scutellariae radix and Gardeniae fructus were found to reduce bacteria shedding and decrease inflammation in swine significantly. The bioactivities of both herbs were also found to be enhanced when combined with the mix-LAB (lactic acid bacteria) strain. The LAB strains are were also found to improve the immunity of livestock. Although Salmonella infections in humans can be easily treated with an antibiotic prescription, the emerging risk of antibiotic-resistant bacteria poses a serious concern (Evidence-Based Complementary and Alternative Medicine, 2013). Hsu's study proposes a better alternative of lowering the risk of transmission to human consumers by preventing the risk of Salmonella infection at the primary hosts – animals – level. This can be done by simply adding both herbs and LAB mixture as feed additives.

Baicalin & Baicalein in Treating *H. pylori* Infection

Do the terms baicalin and baicalein remind you of propane and propene or methane and methanol? The latter compounds are usually almost similar in their chemical structures yet share distinct chemical properties. If you presume that Baicalin and Baicalein are related in the same manner, then you are correct in your assumption. Baicalin is a flavone glycoside, and when administered orally, it is hydrolyzed by the gut microbiota into aglycone (baicalein). Baicalein is the primary form absorbed in the intestine. These flavonoid compounds are bountifully found in a type of garden herb, namely, the Chinese Skullcap (Scutellaria baicalensis). The Chinese Skullcap is a member of the mint family and is commonly used in Traditional Chinese Medicine (TCM) to treat inflammation and insomnia. The anti-inflammatory potential of baicalin and baicalein is reported in the treatment of respiratory diseases, cardiovascular diseases and hepatitis. These compounds are also said to possess antiviral, antibacterial and anti-cancer effects. Professor Yuan-Man Hsu is a researcher focused on analyzing natural chemical compounds in treating mainstream bacterial infections, mainly Helicobacter pylori (H. pylori) and Salmonella. Previously in 2013, Hsu studied the effects of probiotics and herbs from Traditional Chinese Medicine (TCM) in curbing Salmonella infection in swineherd. Extending from her 2013 study, Hsu's team studied the potential healing properties of baicalin and baicalein in treating H. pylori infections. The H. pylori is a common pathogen with half of the world's population having been infected one time or another. This pathogen causes chronic gastritis, although generally, most infected patients remain asymptomatic. Previous studies have shown that H. pylori are also closely associated with gastric cancer. The eradication of this bacteria is one of the most direct and effective ways of lowering the risk of cancer. In Hsu's study, the effects of baicalin and baicalein on the bacteria are tested alongside the probiotic, Lactobacillus spp. They discovered that baicalin and baicalein could indeed successfully treat H. pylori infections. In fact, these compounds offer similar therapeutic effects as antibiotics but do not disrupt the balance of the gut microbiota. While the efficacy of antibiotics in eliminating H. pylori is extraordinary, there are known side effects of antibiotics that throw the gut's natural environment off balance. The more considerable concern is also on the development of antibiotic-resistant superbugs. The outcome of Hsu's 2018 study, published in the Journal of Food Science, offers an alternative strategy that yielded much lesser side effects in comparison to antibiotics used in treating the H. pylori infection.

left-Zhi Zi (Gardeniae fructus); center-Huang Qin (Scutellariae radix)

Heart Health

Cafestol in Deterring Heart Disease

Coffee, the strong yet comforting substance, is a breakfast staple for many. Some swear that they would not be able to function without their daily dose of caffeine. Despite this, the view of coffee from a health standpoint remains negative. Coffee is said to be responsible for many side effects, from aggravating anxiety to causing ulcers. However, recent studies have shown that moderate coffee consumption is associated with a reduced risk of cardiovascular death. Coffee contains several natural compounds such as phenolic compounds and flavonoids, which are reported to have anti-inflammatory properties. This anti-inflammatory property is perhaps the major factor in the positive relationship between coffee consumption and a lower cardiovascular death rate. The development of cardiovascular diseases such as atherosclerosis and hypertension are often due to endothelial dysfunction exacerbated by chronic inflammation of the endothelial cells. Noting this, Professor Po-Yuan Chen and his team decided to explore the role of cafestol on vascular endothelial cells. Cafestol is one of the natural compounds found in coffee. It is a diterpene molecule found in the cherries of arabica coffee and is claimed by various researches to possess anti-inflammatory and antiangiogenic properties. In his study, Chen specifically studied the effect of cafestol on the secretion of inflammatory molecules induced by cyclic strains in vascular endothelial cells. Findings demonstrated that cafestol reduced the total expression of inflammatory molecules in endothelial cells through multiple mechanisms. The responsible mechanisms involved include the upregulation of HO-1 and Sirt1 expression and the suppression of cyclic-strain-induced ICAM-1, MCP-1 IL-8 secretion. This result of this study expands further the knowledge of cafestol's anti-inflammatory property and its possible usage as a treatment option in inflammation-dependent disorders. Also, this study provided valuable insights into molecular pathways that may facilitate a better understanding of the proper effects of cafestol. Chen's study was published in Oxidative Medicine and Cellular Longevity in the year 2018. His lab works focus mainly on the functional genomic analysis of natural products.

Momordicine I in Suppressing Diabetes-Associated Heart Complication

Although bitter in taste, the bitter melon or bitter gourd is a popular ingredient in the preparation of various dishes in Asia. Usually stir-fried in Chinese cuisines, bitter gourds are also often sautéed in other Asian cuisines to offset its bitterness. This fruit, which has vegetable properties, is said to contain a wide variety of vitamins, minerals and antioxidants. In many cultures, the bitter melon is recognized for its medicinal value, especially in lowering blood sugar levels since ancient times. Hence, bitter melon is commonly associated with the treatment of diabetes. Diabetes is a rapidly increasing and widespread disease in many nations. This disease can cause severe complications in patients, including cardiovascular complications. Cardiovascular complications are reported to be the leading cause of morbidity and death in diabetic patients. Professor Po-Yuan Chen seeks to establish an understanding of this claim in his recent 2018 study published in Oxidative Medicine and Cellular Longevity. The aim of his study was specifically focused on the impact of momordicine I in decelerating the condition of diabetic cardiomyopathy - a cardiovascular complication induced by high glucose. Momordicine I, a major bioactive component in bitter melons, is reported to have antioxidants, anti-cancer, antioxidant, antidiabetic, hypoglycemic, and anti-inflammatory properties. Chen discovered that momordicine I plays a significant role in reducing cardiac fibrosis triggered by high glucose levels.

The attenuation of cardiac fibrosis occurs when momordicine I block the TGF-β1/Smad pathway; thus, inhibiting the fibroblast proliferation and collagen production through Nrf2 activation. The results of the current study confirmed the contribution of momordicine I in treating diabetic cardiomyopathy, suggesting that it may be a potential therapeutic source of future drug development. Furthermore, this study also shed some light on the molecular pathways in clinical applications for the use of momordicine I in treating diabetes-associated cardiovascular complication. These insights provide an avenue for future researches to establish further the underlying molecular mechanisms in high-glucose-induced fibroblast activation and cardiac fibrosis.

Bitter melon

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Where Tradition Meets Innovation

The field of health and medicine has improved by leaps and bounds since the days where herbal concoctions were probably the only form of disease treatment. Today, traditional medicine encompasses health practices, approaches, knowledge, and beliefs, incorporating plant and mineral-based drugs, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illnesses or maintain well-being. The public's perspectives on traditional medicine interventions remain divided into two extremes. On one end is the encampment of fervent traditional medicine practitioners who shun modern medicine as artificial and to a certain extent, evil. The other end of the spectrum is a community of scientifically educated individuals who adhere to logic and hence, view traditional medicine as mere superstition or an extension of folk medicine. The studies presented here are crucial evidence that both viewpoints are flawed and founded on the grounds of bias – that both traditional medicine and modern medicine go hand-in-hand and are intrinsically related. The benefits of traditional plant-based medicines can be explored scientifically, while advanced technology can maximize the benefits of these customary remedies. By integrating the best of both worlds – contemporary scientific data and traditional knowledge – researchers can work towards considerably improving the health and medical field through the development of novel disease therapy and management strategies, in line with achieving UNSDG 3: Good Health and Well-Being. The collaboration between researchers from both fields also supports research, development, and universal access to affordable vaccines and medicines since it can potentially allow for more affordable treatments to be made widely available to the general public. Hence, reconciling both tradition and innovation is feasibly the best way forward in conserving medical conventions and implementing health inventions. Consequently, these drug discoveries also aid in enhancing vital scientific research, encouraging innovation, and substantially increasing the number of research as well as public and private research and development spending. While the findings of these studies support the creation of new knowledge, it can also encourage economic growth. This can be achieved through the export of these traditional medicinal plants, whether for treatment or research purposes, inevitably increasing the Gross Domestic Product (GDP) of the country/countries where these conventional herbs are widely grown and harvested. By positively impacting the economy of these countries, these research drug innovations also indirectly encourage UNSDG 9: Industry, Innovation and Infrastructure.

FRESHWATER FINDINGS

Exploring the ecosystem of lakes and wetlands

The water we consume daily has likely been on Earth, in one form or another, since the prehistorical times even before the Stone Ages. While Earth's population continues to increase steadily, the amount of fresh water available remains relatively constant over time. Freshwater is the sole natural source of water fit for consumption and sustenance. It makes up a mere 2.5% of Earth's water, where only less than 0.01% of the planet's water can be used to ensure the survival of the entire world population. This small fraction of freshwater forms some of nature's most substantial features like the Yangtze River, the Lake Baikal and the Amazon's swamp forest. Historically, rivers, lakes and wetlands are often the birthplaces of early civilizations. Often considered as strategic, focal locations, communities thrive economically and physically of these freshwater sources. Besides directly sustaining livelihoods, the importance of freshwater is contained in its unique ecosystem, where it supports an enormous amount of biodiversity as well as the Earth's climate balance. Despite its indisputable role in nature, the implication and application of preserving the already limited freshwater sources are often overlooked and confined to research labs and classrooms.

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From Land to Lake

A common source of freshwater, lakes are not only dynamic habitats for various species but also serve as breeding grounds and migration stops for many wildlife. For humankind, lakes provide a variety of uses, from crop irrigation to recreational purposes. In addition to these, lake ecosystems are exceptional indicators of climate change as they are very receptive to changes in rain, temperature and organic matter input. This also indicates that lakes play a crucial role in the carbon cycle which is a major determiner in serious environmental issues such as global warming. Professor Jeng-Wei Tsai has always taken a special interest in studying the influence of natural/anthropogenic disturbances on the function of freshwater ecosystems. Additionally, his research work also includes the bioavailability and trophic transfer of xenobiotics in the aquatic food web under the changing environment and how these changes relate to the health of humans and wildlife. A recent study by Tsai and his team investigated the relationship between altered rainfall and terrestrial dissolved organic matter (tDOM) on the carbon flux and ecosystem metabolism in two subtropical lakes. This study, published in Science of the Total Environment in 2020, engendered interesting evidence on the role of lakes as an environmental indicator as well as the interdependence between land and lake. It was reported that after a year of drought, the lakes transformed from being a carbon sink, a system that absorbs more carbon than its emission, to becoming a carbon source. This naturally impacts climate neutrality as the role of these lakes as natural carbon sinks are now detrimentally reversed instead. It was also found that the decreased rainfalls and drought spells profoundly affected both the carbon flux and ecosystem metabolism of the lakes. Carbon flux was also more responsive to drought in a clear, mesotrophic lake. Tsai also discovered that a major underlying factor that drives carbon flux in drought is the load of dissolved organic matter from land (tDOM). His research, which is part of the Global Lakes Ecological Observatory Network (GLEON), implies that ecosystems are intrinsically reliant on each other. Conditions that take place above the surface, on land such as reduced rainfall impact circumstances beneath the surface, in the lake such as carbon cycle disruption.

A Wetland Shrimp Story

As its name suggests, a wetland is typically defined as an area of land which is immersed in water. Similar to lakes, wetlands host a large variety of species, including birds, fish and mammals, where wetlands function as nurseries. The role of wetlands extends beyond a productive habitat to a high-performing water purification system, an effective flood reservoir and a reliable defense against storm surges. As modern society enjoys nature and leisure activities at wetlands, more than 75% of fish and shellfish are known to be harvested from wetlands. A most common freshwater crustacean is the Atyid shrimp. This endemic species is a vital part of the aquatic ecosystem as fish and water-bird mainly feed on them. This trait of the Atyid shrimp alongside its high sensitivity to pollutants also makes it an ideal species to work with in lab experiments and field water quality monitoring. With that being said, metal pollution is becoming an increasingly rife global concern, especially since metal can be biomagnified to a harmful level in aquatic organisms. This may involve a risk of exposure to their predators, including human consumers. As a researcher whose work centers around the role of aquatic networks and exposure of risk assessment on the health of aquatic species and ecosystem, Professor Jeng-Wei Tsai considered the effect of ecosystem metabolism (EM) in the bioaccumulation of metal in Atyid shrimps. The ecosystem metabolism (EM) not only provides the overall trophic status of an ecosystem but also reflects the impacts of environmental changes on the structure and function of an ecosystem. In his recent study, Tsai found that EM does indeed mediate the accumulation of metal in these shrimps (Aquatic Toxicology, 2020). Different seasons and dissolved organic matters also triggered different rates of metal bioaccumulation. As with Tsai's other study, the finding of this research implies that factors on land such as altering the climate and land use do impact the aquatic ecosystem proving the interdependence between these ecosystems. These overall change in the ecosystems, in turn, affects the livelihood of every living creature, including human beings on land. Tsai hopes that his research works will foster a greater understanding of the relationship between ecosystem variations and human/wildlife well-being, especially under the stress of climate/environmental changes.

A Cycle of Interdependence

Whether it is the lakes or the wetlands, these studies on the freshwater ecosystems offer information beyond the interaction between freshwater organisms and their environment. They also significantly contribute to the strengthening of aquatic ecosystems' resilience besides acting for the restoration of these ecosystems in order to achieve healthy and productive waters. In line with UNSDG 14: Life Under Water, these studies directly provide some of the best available scientific information in the bid to conserve at least 10% of coastal and marine areas by the year 2020. The depiction of details presented in these studies extends past the uniqueness and importance of its elements. It prompts for further action in protecting and restoring water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes, subsequently achieving UNSDG 6: Clean Water and Sanitation. Although both studies may be largely attributed to the mere conservation of the biosphere, it is essential to note that the biosphere functions as the foundation for economic, societal growth and human health and well-being. Therefore, these studies can also assist in societal advancement by promoting society's good health. This is evident as these studies indirectly encourage the reduction of illnesses and deaths from hazardous chemicals and pollution as the conservation of coastal areas and freshwater ecosystems will significantly lessen water pollution. As a result, this will also lead to a decrease in mortalities caused by this environmental risk, as outlined in UNSDG 3: Good Health and Well-Being. Hence, both pieces of research presented here communicates a story of reliance and connection between each biological element – a cycle of interdependence — a cycle that foreshadows the future constructed by human hands presently on land. To keep the land, there is a need to care for the sea and vice versa. The future depends on the current actions of the human species. Ultimately, it is our call to maintain the equilibrium of this cycle or to allow disruption and, consequently, destruction.