Proceedings from the 2nd International Conference on Appropriate Technology

Bulawayo, Zimbabwe
July 12-15, 2006

Hosted by the National University of Science and Technology (NUST)

Theme

Sharing the Knowledge from Research and Practice in Appropriate Technology, with a focus on Health-Related projects

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Sharing the Knowledge from Research and Practice
In Appropriate Technology with a Focus on Health-Related projects

The theme of our second international conference on 'Appropriate Technology' is designed to:

1) Facilitate the management, assessment, archiving and tracking of appropriate technology research and practical projects through the use of state of the art knowledge management practices
2) Focus on increasing the productivity and visibility of health related projects in a sustainable fashion, while being inclusive of all areas related to appropriate technology.

Background

Underdeveloped countries throughout the world face the most serious health issues. However in Africa, more money is spent on servicing foreign debt than providing health care. This is a serious problem. Malaria, while practically eliminated in developed countries is a major cause of death in underdeveloped countries. Africa is suffering from a pandemic due to the spread of HIV/AIDS. A major multi-discipline investigation employing appropriate technology is needed to address these and other health issues. To be effective this process of technology implementation must be sustainable, and culturally and environmentally sensitive.

The international and local planning committees were organized in June 2005 and the international call for papers was issued in July 2005. Work, submitted by over 50 authors, was reviewed for consideration. All papers were subject to a double blind peer review process. The following 18 papers reflect the international standard of this conference. At this second conference we expanded the poster session. The abstracts of posters presented are included in these proceedings.

Papers are organized in six broad categories: 1) Health related; 2) Knowledge Management; 3) Energy and Physics; 4) Water and Agriculture; 5) Environmental; and 6) Architecture and Small-scale industry.

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Keynote Address

Role of Natural Product Research to address Health Problems in Africa

Berhanu M. Abegaz, Department of Chemistry, University of Botswana, Private Bag 00704, Gaborone, Botswana. E-mail: abegazb@mopipi.ub.bw

The research efforts of natural product research in Africa still remains connected more to the global R&D than to the local needs and priorities. As a result there is, understandably, considerable difficulty to initiate sustained support to such research from local authorities. Research done so far has undoubtedly served to train young people on a relevant subject. It has led to a better understanding of cultural practices of how we use plants as medicinal, preservative, flavor, fragrance and even as poison. Many compounds have been tested for various biological properties, but the criteria used to assess these activities have been heavily influenced by the interests of multinational drug companies. The latter are not interested in developing products that do not guarantee huge profits. Consequently, these companies have a tendency to judge many of our research results as unworthy for further development. It is, therefore, up to the African institutions to make sure that the research work done in their institutions, are of the right quality and relevance. Scientists should also double their efforts to overcome their isolation and establish inter-institutional and cross-boarder collaborative programs with other scientists in their regions.

The author is a strong believer in intra-African cooperation and has been collaborating with scientists in many African countries. The Department of Chemistry of the University of Botswana has excellent research facilities for Natural Products Research. These facilities have been made available to other African scientists under the auspices of the Network for analytical and Bioassay Services in Africa. This effort has led to the promotion of intra-African cooperation on Africa-specific problems. This lecture will reveal results of such cooperation with scientists in Cameroon, Zimbabawe and South Africa. Our interest is in finding bioactive substances, especially anti-infective agents. Accordingly, evaluation of plant extracts and natural products for anti-plasmodial activity has resulted in the isolation and characterization of many dimeric chalcones [1], flavonoids [2], quinones [3], sesquiterpenes [unpublished results]. Plants belonging to the families Anacardiaceae, Asphodelaceae, Asteraceae, and Moraceae have yielded several metabolites which have shown significant antiplasmodial properties. Typical examples include the novel biflavonoids: Rhuschalcone III IC_{50} 0.44 μg/ml, Rhuschalcone IV with IC_{50} 0.26 μg/ml, sulphated phenyl anthraquinone IC_{50} 4.13 μg/ml., trimeric catechins IC_{50} 7.9 μg/ml and some dimeric sesquiterpenes which show even more remarkable antiplasmodial activities than even chloroquine. Some of these compounds offer good potential to contribute to the fight against malaria. Aspects of phytochemistry and biological activities of these compounds will be presented.

We are also interested in discovering natural products that can reverse the resistance of the *Plasmodium falciparum* parasite to chlorquine. Chloroquine is an inexpensive and safe drug that is now considered almost useless due to resistance. Some preliminary results from this effort will also be presented.

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Production of Truly ‘Healthy’ Health Products

Arjun Bahadur Chhetri, Md. Safiur Rahman, and Md.Rafiqul Islam*
Faculty of Engineering, Dalhousie University, 1360 Barrington Street, Halifax, NS B3J 2X4, Canada
Phone: (902) 494 3980, Fax: (902) 494 6526 (direct) *Corresponding author Email:Rafiqul.Islam@dal.ca

Keywords: health products, toxicity, natural colorants

Abstract

Recently it has been revealed that commercial ‘health’ products are the source of various diseases. For instance, most cosmetic products have formaldehyde, which is considered to be carcinogen. Similarly, bodymists often contain butane and other hydrocarbon products, the harmfulness of which is well documented. Soap making utilizes a numerous chemical additives which are toxic and have serious health implications. The use of synthetic colouring pigments also makes the products harmful. The list of harmful chemicals used in these products is very long and includes practically all commercially available ‘health’ products used for skin care, facials, sun screens and others. In this paper, we studied the harmful effects of commercially available health products, focusing on cleansing products, general cosmetics (e.g. lip balm, lipstick, mascara, perfumes) and coloring agents (hair dye, shoe polish, bleaching agents). This paper presents a series of ‘healthy’ health products such as natural soap, non toxic shoe polish and sunscreen.

1. Introduction

Health products have been in use for thousands of years. In Persian, Egyptian or Chinese cultures, cosmetic use was common. What sets the modern age apart is the eruption of toxic chemical use in every application. Almost every product including health products, from toys to computers, carpet to clothes, furniture to washing powder are toxic. However, only recently has it become known that the list of toxic chemicals is very long and it is considered to be impractical to reverse the life style [1]. Most of them are manufactured petroleum derivates and other synthetic chemicals. Today’s society is built on the assumption of “chemicals are chemicals”[2]. Even though this approach is attributed to a Nobel Laureate and Peace activist, Linus Pauling, characterizing chemicals based on the most obvious features is not scientific. It is unscientific to infer that chemicals with similar chemical formula whether they are from natural or synthetic origin, behave similarly. The properties of chemicals will be entirely different from each other depending on the origin and the pathway they travel, during the manufacturing process. Conventional approach does not differentiate between the synthetic chemicals manufactured in an industry and chemicals that are derived from natural elements such as plants. For example, the impact of sodium, derived naturally from sea salt, is different from that of sodium, manufactured in a chemical plant. Synthetic sodium hydroxides are used in many health products including soap production. Similar statements can be made for organic farming and chemical farming; and for every natural process and simulated engineering process [3].

Petroleum products are used as base material or as an additive for almost every product. The petroleum derivatives are highly toxic chemicals and have severe impact on human health [1]. Perfumes contain very little original musk and mostly synthetic musk and petroleum-based chemicals. More commonly the original musk (fermented flower extract) is entirely replaced by artificial musk and is added to a chemical base. An artificial musk is used to replace natural aromas and is added to many products like washing agents, soap and cosmetics [4]. These compounds are generally polycyclic and evidence indicates that some musks can interfere with hormone communication systems in fish and mammals [5]. Moreover, cosmetic products also contain formaldehyde and dioxane which are considered to be carcinogen. The body mist contains butane and other petroleum based hydrocarbon ingredients which are highly toxic compounds. Hexachlorophene used in mouthwash and shampoo are also hazardous materials. Mouthwash destroys the essential bacteria and the products that emerge are toxic. In addition, mouthwash base (both alcoholic or non-alcoholic) are extremely abrasive to the delicate tissues inside the mouth and produces toxins from saliva (that otherwise is a natural bactericide). Shampoos are harmful for both hair fibre and the skin. Lipstick or lip balm usually contains aluminum, which is also a known toxin. It was reported that various types of oestrogenic chemicals used in cosmetics are the major sources for women's breast cancer [6].

Figure 1 shows the schematic of pathway of production of conventional health products. Synthetic chemicals are used for almost every health product. The use of these toxic catalysts and chemicals in oil refining result in the toxic contamination of personal care products. These products are eventually exposed to the environment causing water and air pollution. A number of toxic chemicals along with the various coloring pigments are used to make shoe polish. Certain toxic chemicals can be absorbed through the skin and or inhaled [7]. Some of these toxins are toluene (C_7H_8), aromatic hydrocarbons, trichloroethane, methylene chloride, nitrobenzene, and other chemicals**.** Trichloroethane is similar to chloroform. It is commonly used as a solvent and cleaning agent in spot removers during shoe polishing. Trichloroethane can be absorbed by inhalation and ingestion. It is an irritant to the eyes and nose and can result in damage of the central nervous system, liver and kidneys if ingested. Methylene chloride, known also as methylene dichloride and dichloromethane, irritates skin that comes in contact. Memory loss, liver and kidney damage are reported with chronic exposure. This is a known animal carcinogen and a suspected human carcinogen. The use of products containing methylene chloride by people with heart conditions may result in fatal heart attacks [8]. Nitrobenzene**,** is also a highly toxic substance, found in some shoe polish, furniture polish and floor polish. In addition to this, the coloring pigments used in the health products are mostly industrial and plastic based pigments. These pigments can create allergic reactions, scarring, phototoxic reactions and other adverse effects. These are notoriously toxic and radioactive.

This paper presents a detailed analysis of the impact of various synthetic additives added in health products. A series of 'healthy' health products that are prepared from natural materials which are beneficial to health and do not harm the environment are also presented.

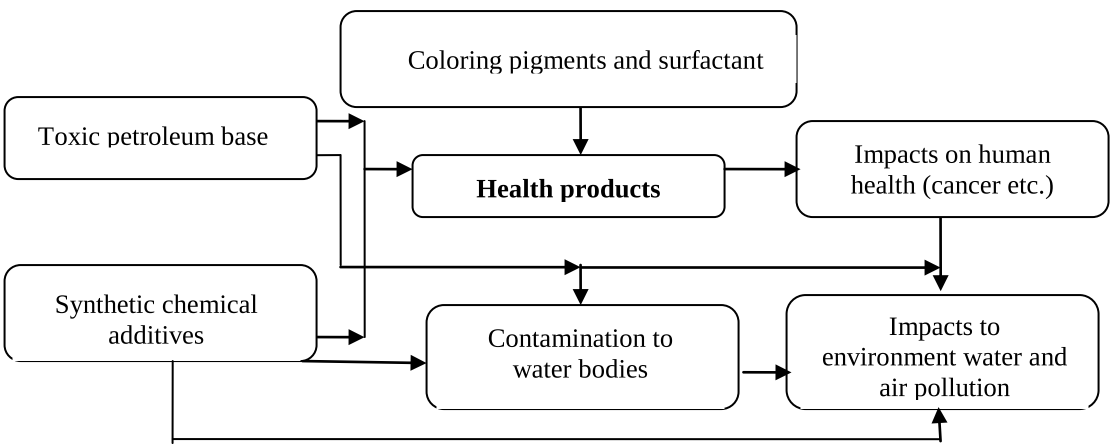

Figure 1. Schematic of pathway of production of health products.

2. Materials and Method

In this research, we studied the pathways of various chemicals used to produce different types of health products. Their impacts based on the pathways were analyzed. Based on this analysis, a series of 'healthy' health products were developed. The details on the use of materials and the process to make 'healthy' health products are discussed in the following section.

2.1 Natural soap

Ancient soap making was a completely natural process. The purpose of the bathing was to stay clean and treat skin diseases. All of the ingredients used came from the natural surroundings. The use of synthetic chemicals began in the late 19th century and expanded and proliferated as a result of military research during the First and Second World

Wars. Since then, the use of synthetic chemicals has become standard in all commodities particularly in personal care products [9]. For example, the synthetic chemicals such as NaOH or KOH as alkaline agents are very toxic and corrosive compounds. Haynes (1976) [10] reported that a dose of 1.95 grams of sodium hydroxide can cause death. The most serious effects of sodium hydroxide at 50% by weight of active ingredient are corrosion of body tissues. Eye and skin contact can cause very serious burns. It has been reported that concentration of sodium hydroxide of 10 g/l cause nervousness, sore eyes, diarrhea and retarded growth in rats [10]. Even the vegetable oils that are produced using chemical fertilizers or are refined will have some toxic effects. Similarly, animal fats from animals injected with synthetic hormones also alter the natural course of the animal fat. Figure 2 is the schematic for the manufacturing of natural soap.

Olive oil

Olive oil is a triacylglyceride with three fatty acids attached to a glycerol molecule. It is a complex compound of fatty acids, vitamins, volatile compounds, water soluble compounds and some other micro compounds. The primary fatty acids available in olive oil are Oleic acid and linoleic acid with a small amount of linolenic acid. Oleic acid is monounsaturated (55-85%), linoleic acid is polyunsaturated (9%) and linolenic acid is also polyunsaturated with (0-1.5%) [11]. Olive oil has several other constituents such as tocopherols, chlorophyll and pheophytin, sterols, squalene, aroma and flavour compounds which exhibit a significant impact on human health. It is a highly monounsaturated oil and is therefore resistant to oxidation. The presence of phenols, tocopherols and other natural antioxidants prevent lipid oxidation within the body eliminating the formation of free radicals which may cause cell destruction. Use of olive oil in soap making is characterized by many of its advantages. Thus olive oil soap is very good from health point of view. In this research, olive oil was used as one of the major ingredients of natural soap.

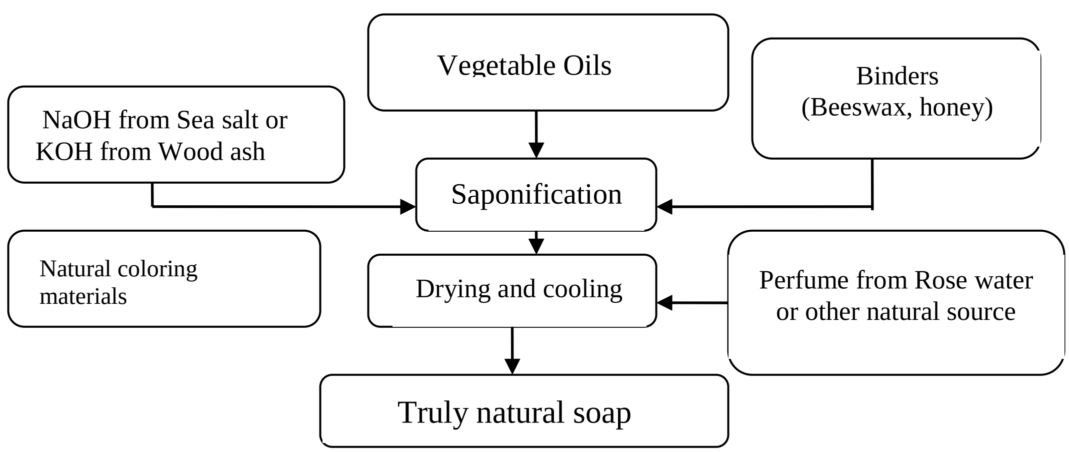

Figure 2. Flow process for natural soap making

Palm oil

Palm oil is semi solid at room temperature and is popular for manufacturing solid fat products. Palm oil has been in use for various edible and non edible products. It is also used in chemical, cosmetic and pharmaceutical application. Palm oil olein and stearin are used worldwide in making margarine, confectioneries, and in frying snack foods. The high content of natural antioxidants and its stability at high temperatures make palm oil excellent as a deep frying medium in the food industry. It also gives fried products a longer shelf life, while its bland taste brings out the natural flavors of food. Palm oil is a base material for manufacturing of soap, detergents and surfactants. In addition to this, this is a good raw material to make fatty acids, fatty alcohols, glycerol and other derivatives for the manufacture of cosmetics, pharmaceuticals, household as well as industrial products. Palm oil was also used to make natural soap in this research.

Beeswax and honey

Beeswax is a product secreted by honey bees. This is a natural product used for several purposes such as medicine, paint, material for shoe polish, candles, sealing materials, natural glue and others. This is a very complex material which contains hundreds of compounds. Honey has inhibitory effects on bacteria, fungi, yeast and viruses [12]. Honey application eradicates bacterial infections and accelerates wound healing. Honey is used even for dermatitis and dandruff treatment. Because beeswax and olive oils have similar antibacterial properties, a combination of beeswax, honey and olive oil which contain flavonoids, antioxidants and antibacterial ingredients useful for treatment in skin diseases was used in this study. The study showed that the mixture with honey, olive oil and beeswax (1:1:1) was successful in treating 75%, 71% and 62% of skin disease patients with pityriasis versicolor, (PV), tinea cruris and tinea corporis respectively. Honey mixtures appear to be useful in the management of dermatitis and psoriasis vulgaris. Considering these all benefits to the human health, beeswax and honey were used as ingredients in the soap prepared in this research.

2.2 Coloring and Fragrance Materials

The coloring and addition of fragrance of soap have become a tradition over time. However, the colors and fragrance used conventionally are from synthetic pigments or artificial musks. However, in this research, all natural colors and fragrance were used to give the desired colors to the finished products.

Turmeric, Neem leaf, Cinnamon powder

Turmeric is a perennial plant with roots or tubers oblong, palmate, and deep orange inside. Turmeric has a peculiar fragrance and bitter, slightly acidic taste exciting warmth in the mouth and colouring the saliva yellow. This is a mild aromatic stimulant and used for coloring. Turmeric tincture is used as a colouring agent. It dyes a rich yellow coating. Turmeric paper is prepared by soaking unglazed white paper in the tincture and drying. This is a completely natural colorant which also has some medicinal value. Coloring the soap with turmeric is beneficial for health. In this research, turmeric powder was used to color the soap and seems aesthetically pleasing. Neem leaf ground in powder form was used to add the natural color in soap. Neem is a tree that can thrive on various climates from 0^0C to 49^0C. It grows in almost all types of soil including clayey, saline and alkaline. The Neem tree thrives on dry, stony, shallow soils, and shallow depth. Neem leaf is used as anti bacterial medicine. To make the gentle green color of soap, Neem leaf was ground into power form to use as colorant. Cinnamon is the inner bark of a tropical evergreen tree. Cinnamon has been is use as spice, medicine and many other products. The lighter color of cinnamon bark has sweet properties gives soap making some flavor. Cinnamon bark was used medicinally and as a flavoring for beverages in ancient Egypt. Cinnamon powder was also used as coloring agent to make the soap.

Natural fragrance

A natural extract from rose water was used to give the fragrance for the finished soap product. No synthetic chemicals were used in the process.

Production of Natural Soap

Soap was prepared by using all natural ingredients (Figure 3 and 4). 34.0g with clean water at room temperature, 12.5g of sodium hydroxide (derived by the electrolysis of sea salt), 45.4g olive oil, 10.0g of beeswax , 15.0g of honey, 28.4g coconut oil, 17.0g palm oil, 5g of essential oil (tea oil) were used. In addition to this, cinnamon powder, turmeric powder, neem leaf powder were used as coloring agent. Natural fragrance could be added at a later stage not to heat. First a salt water solution was heated to 200^0F and cooled. Beeswax was melted and mixed with the oil ingredients and stirred. The mixture of olive oil, palm oil, coconut oil and bees wax was stirred. Both mixtures were heated and when both oils and salt water were near similar temperatures around 130^{o}F, then all ingredients were mixed. The honey and essential oils were added and stirred with a glass rod and transfer the mixture into mould. It normally takes 24-48 hours to get the desired hardness of the soap.

Figure 3. Natural soap with natural color

Figure 4. Natural soap

2.2 Non Toxic Shoe Polish

Commercial shoe polish contains various toxic substances. Generally, shoe polish is made from ingredients including naptha, lanolin, wax, bicarbonates of potassium and various types of coloring pigments. It also contains carbonates and bicarbonates of sodium and potassium. The burning of shoe polish will result in the yielding of carbon dioxide and/or carbon monoxide and traces of oxides of nitrogen and various toxic materials depending upon the chemicals, and solvents used to make the shoe polish.

To make a good and non-toxic shoe polish, olive oil, beeswax, and carbon soot collected by burning olive oil were used. Beeswax is a tough wax formed from a mixture of several compounds including hydrocarbons (14 %), monoesters (35 %), diesters (14%), trimesters (3%), hydroxy monoesters (4%), hydroxy polyesters (8%), acid esters (1%), acid polyesters (2%), free acids (12%), free alcohols (1%) and some unidentified materials [13].

A good black shoe polish was prepared by collecting carbon from burnt olive oil and mixing with olive oil and beeswax (Figure 5). The beeswax was melted by heating the pan with hot water. The direct heating of wax results in breaking and color change. The ratio 1:3:3 of beeswax, olive oil and carbon particles will make a good viscous shoe polish. The beeswax, olive oil, carbon mixing ratio depends on the how viscous the polish is to be made. In countries where biomass cookstoves are used, carbon can also be collected from the chimneys of cookstoves by making a water oil trap. Various colors can be extracted from flowers, vegetations and Ocher, the naturally occurring colored earth that yield different colors. Beeswax forms a protective layer over the surface of the shoe and becomes a barrier against water, preventing its absorption by the leather. This beeswax mixed shoe polish is highly effective for use in wet or muddy conditions. This shoe polish has no toxicity and no harmful ingredients. Such shoe polish can be made easily at home.

Figure 5. Non toxic shoe polish made from beeswax, olive oil and carbon soots.

2.3 Sunscreen

The commercially available sunscreen is mostly made from synthetic materials which have several impacts on human health and the environment. The model of natural products manufacturing such as natural soap and non toxic shoe polish can be extended to make natural sunscreen. A mixture of beeswax, honey and olive oil can become an excellent sunscreen material. Beeswax has a high resistance to the passage of heat. This works as a good moisture retainer in the body. Honey, a substance contained in the beeswax is a natural hummectant, which means it draws and holds moisture, and is therefore soothing to dry and damaged skin. As a natural wax, beeswax protects the skin and leaves it feeling healthy and soft. Beeswax reduces inflammation, softens skin, and has antioxidant properties. After processing, beeswax remains a biologically active product retaining anti-bacterial properties. It also contains vitamin A, which is essential for human cell development. Throughout time, people have used it as an antiseptic and for healing wounds. Olive oil has antioxidant properties and absorbs certain ultraviolet rays. The polish material which is made out of beeswax, olive oil and carbon particles can be used as an excellent sunscreen or skin protector.

3. Results and Discussions

In this paper, the use of various chemicals in commercially available health products, focusing on cleansing products, general cosmetics (e.g. lip balm, lipstick, mascara, perfumes) and coloring agents (hair dye, show polish, bleaching agents) and their harmful effects on health were studied.

Saxena et al (2001) [14] reported that eye cosmetics are a common cause of eye lid dermatitis. These products contain coloring pigments, fragrances, resins and preservatives. Eye mascara may cause eye irritant, or allergic contact dermatitis of the eyelids. Black iron oxide used in mascara causes severe reaction to the eyelid. Iron oxide come in several forms and is used in pigment products. Black iron oxide is also known as magnitite ($Fe_3\ O_4$), yellow or brown limonite ($2Fe_2\ O_3\ 3H_2O$) contains 60% Iron, Red hematite (Fe_2O_3) contains 70% iron. Iron oxides are used as pigments in many cosmetics, including mascara, eyeliner, eyeshadows, and lipsticks. However, these pigments are toxic to human health (Saxena et al, 2001).

Nikkie (2002) [15] reported that that mascara tubes made by Benson, Lecco (Italy), contains thin film, amorphous polyamide marked Selar PA by DuPont. Polyamide is a thermoplastic polycondensate, a nyclon resin compound and is very much hygroscopic in nature. It spears that this causes severe health problems because the plastic molecules enter the human body through the skin. Various chemicals used in health products include artificial musks, used to add scent to perfumes and perfumed products, and perfluorinated compounds, used in water-repellent coatings and to prepare non-stick surfaces such as teflon. It was also reported that flame-retardants suspected of causing learning and behavioural problems in animals, and the antibacterial agent triclosan, were used in antibacterial soap [16].

3.1 Chemicals used in health products

Alkali is one of the heavy chemicals used by industries such as petroleum refining industry, pulp and paper mills, battery industry, cosmetic industry, soap and detergent manufacturing, leather processing, metal processing, water treatment plants and biofuel processing industries such as biodiesel and ethanol. Synthetic chlorine and sodium hydroxide are among the top ten chemicals produced in the world and are used in the manufacturing of a wide variety of products including deodorants, detergents, disinfectants, herbicides, pesticides, and plastics. These are also major chemicals used in various health products. It was reported that the worldwide demand of sodium hydroxide was 44 million tones expressed as NaOH 100% in the year 1999 [17]. The total global demand of alkalis in 2005 was 62 million tones (Figure 6). The growth of alkali demand was approximately 3.1% per year.

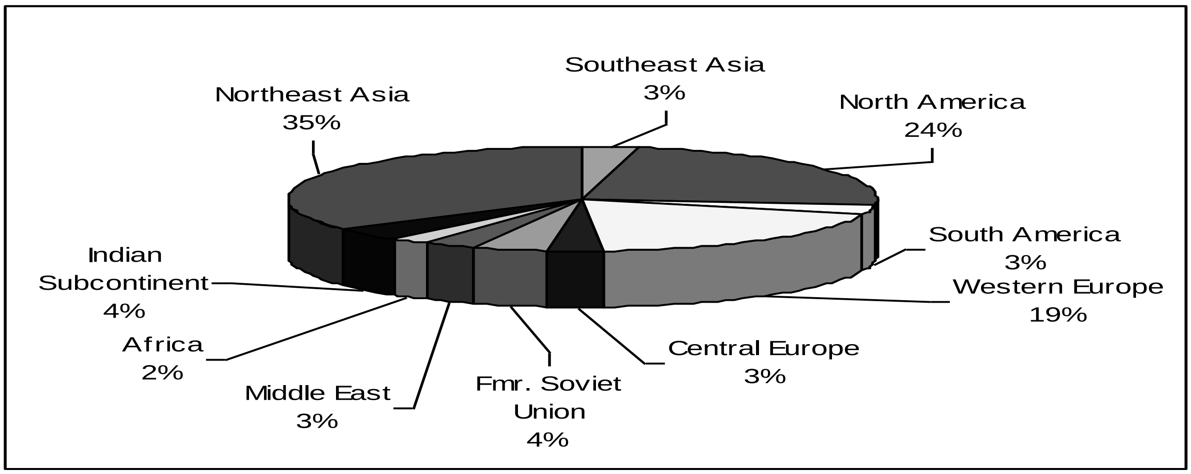

Figure 6. Global Chlor-Alkali Production (CMAI, 2005)

Alkalis are raw commercial products and need further processing before application. Huge amounts of these chemicals may leak during the transfer from one place to another directly or indirectly polluting the environment. It also has significant effect on human health. Inhalation of dust, mist, or aerosol of sodium hydroxide and other alkalis may cause irritation of the mucous membranes of the nose, throat, and respiratory tract. Exposure to the alkalis solid or in solution can cause skin and eye irritation. Direct contact with the solid or with concentrated solutions causes thermal and chemical burns leading to deep-tissue injuries and permanent damage to any tissue [18].

3.2 Surfactants used in health products

Personal cleansing products are potential sources of skin drying, a common problem among the dermatologic patients [19]. The major reason behind this is due to the use of synthetic detergents. The problem can further be aggravated by the use of synthetic personal care products including body mist, and body lotion. Various surfactants are added to the cleansing products that adhere to skin surface and decrease the amount of friction required to remove unwanted materials. Surfactants are the chemical substances incorporated into cleaning agents, due to the widely held belief that the dirt is not effectively removed by water alone even with vigorous washing [20]. Anionic surfactants used in commercial cleaning products are synthetic surfactants including sodium lauryl sulfate (SLS), triethanolamine lauryl sulfate, ammonium lauryl sulfate, and sodium stearate. Surfactants such as SLS are also found in ointments and creams as well as in cleansers.

Walker et al (2005) [21] studied the acute and short-term toxicity in rats that have been made on the surfactants sodium lauryl sulphate, sodium lauryl (3EO) ethoxysulphate and their matches C_{12}–C_{15} alcohol sodium sulphate and C_{12}–C_{15} alcohol sodium (3EO) ethoxysulphate. The acute oral LD_{50}s of the four materials were found to range from 1 to 2 g/kg. This clearly indicates the toxicity level of sodium lauryl sulfate (SLS). SLS is reported to be a strong oxidizing agent and is a highly toxic compound. This causes respiratory, eye and skin irritation. Carcinogenic nitrates can form in the manufacturing of SLS or by its inter reaction with other nitrogen bearing ingredients which show permanent eye damage in young animals from skin contact in non eye areas. The studies indicated that SLS enters and maintains the residual levels in the heart, the liver, the lungs and the brain from skin contact. This poses a serious health threat by its use in shampoos, cleansers, and tooth pastes. SLS is used in almost all health products including soaps, shampoos, bubble baths, tooth paste, washing up liquid, Laundry detergent, children soaps and shampoos stain remover, carpet cleaner, fabric glue, body wash, shaving cream, mascara, mouth wash, skin cleanser, moisturizing lotion and sun screen.

Table 1

Common surfactant ingredients used in health products

Product	Ingredient	Common uses
Anionic-natural	Natural soap, Potassium cocoate	Skin cleansing
Anionic-synthetic	Sodium Lauryl sulfate Tryethanolamine lauryl sulfate Ammonium lauryl sulfate	Ointments, creams Skin cleansing Tooth paste
Cationic	Cetrimide Bemzalkonium chloride	Disinfectants Antimicrobial preservative
Amphoteric	Cocamidopropylbetaine	Baby shampoos, Foam boosters
Nonionic	Polysorbate 20, Polysorbate 60	Cosmetic, Food products, Pharmaceuticals
Alcohols	Isopropyl, Benzyl alcohol Cetyl or stearyl alcohol	Antimicrobial, preservatives, Emollients, thickeners in moisturizers and lubricants

Source: [22]

3.3 Humectants and Moisturizers

Various types of humectants such as glycerin, methyl glucose esters, lactates, lanolin derivates and mineral oils are added to the skin cleansing products because of their moisturizing properties. These synthetic chemicals are also harmful to the human health and hence the health products.

Most of the chemicals used in the health products (Table 1) are from petroleum derivates. The petroleum products are highly toxic chemicals as their refining process involves using heavy metals and highly toxic chemicals and high temperature [19;1]. For instance, oil refining uses hydrochloric acid and hydrofluoric acid. Similarly, gas processing involves use of glycol, amines and various other chemicals. These are all toxic chemicals and the petroleum derivates are contaminated with these chemicals. The use of these petroleum derivatives which are contaminated with toxic chemicals will have severe health impacts when used in health products manufacturing. These health products are inherently unsustainable as the manufacturing process follow the anti-natural path (1; 23]. Moreover, to consider a technology truly sustainable, it should fulfill the economic, social, environmental and time criteria [24]. Thus the conventional methods used to manufacture health products today are neither sustainable nor beneficial to the human and environment.

4. Conclusions

Commercial health products are the source of various diseases. This paper presents a series of 'healthy' health products which were produced by using all natural ingredients and non toxic chemicals. A natural soap was prepared by using sodium hydroxides obtained from natural sea salt and cold pressed vegetable oils such as olive oil, palm oil and coconut oil. Beeswax and honey were used as binding agents. Natural colouring agents such as cinnamon, turmeric and neem leaf were used. Similarly, a non toxic shoe polish was prepared from beeswax, olive oil and carbon soot collected by burning cotton thread soaked in olive oil. Coloring materials can be extracted from flowers and perfumes can also be produced by the fermentation of flowers. This model for producing health products such as natural soap, non toxic shoe polish and sunscreen can be extended to all 'healthy' health products which are being commercially produced in the market.

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Spirostachys Africana – The Latex Content

NM Munkombwe[1], ZJ. Duri[2], NA. Hughes[3], T. Maswabi[1], MB Leketo[1] and OD. Dijogadifele[1]

[1]Chemistry Department, University of Botswana, Private Bag 00704, Gaborone, Botswana; [2]Chemistry Department, University of Zimbabwe, MP 167, Harare, Zimbabwe; [3]University of Newcastle Upon Tyne, NE1 7RU, UK

Key words
Spirostachys africana: Euphorbiaceae; uses and diterpene content of the latex

Abstract
Spirostachys africana is an endemic species of East and Southern Africa and is variously known in vernacular languages [7, 9]. The wood preserves very well and has many commercial uses. Its latex has several medicinal uses [3] which, as expected, depend on location. The latex is also reported to be toxic. Biological activity studies have shown that the latex has genotoxic effects [8]. We have been interested in the phytochemical studies of the latex since 1991. In our studies, we have found that the latex only contain diterpenes with the beyerane skeleton. The compounds are closely related to each other and only differ in the oxidation pattern, especially in ring A. Positions 2, 3 and 4 are commonly oxidized to obtain diols, diketones and hydroxyketones. Demethylation at position 4 of the diketones leads to diosphenols. Cleavage between positions 2 and 3 leads to secobeyeranes which gives acids [5], lactones and lactols. It was a challenge to separate these compounds. They were separated using chromatographic techniques, wet chemistry, acetylation and methylation. Spectroscopic methods were used to identify the isolates and derivatives.

Introduction
Spirostachys africana is a well known tree in Southern Africa. It spreads from Tanzania to South Africa. The trees are huge in rainy areas but small in poorly watered soils. Thus, east of the sub continent has large trees whereas the west, especially south of Botswana and north west of South Africa, has mainly small trees except in river basins. It has many uses because its huge heartwood. The heartwood makes 80 % of the trunk which is dark in colour. In dried trees, the heartwood is hardly affected by weather and feed ants. It is very durable. It has a characteristic smell which persists for many years- a piece of heartwood hundreds of years old will give a strong scent if scraped. It is the structural wood of the Great Zimbabwe Ruins [9].

It is very good for furniture and because of this it is a protected species in South Africa [7]. Many other artifacts are made from the heartwood such as necklaces, gunstocks and walking sticks. Fencing poles and rafters are often made from this tree. Its sawdust or powder or chopped pieces are used as anti-feedants or insect repellants. The leaves give milky latex while that from the heartwood is brown and viscous. The latex when mixed in porridge is a purgative or an emetic [3]. It is taken orally to quench stomach aches. It is smeared on boils to retard infection. Inhaled smoke is a reported method of driving away bad spirits. It is a malaria drug in Mozambique and Tanzania [4].

The latex is also a renowned poison. It does stupefy fish when mixed with water and often used as an arrow poison. Meat smoked with or roasted on *Spirostachys Africana* wood causes diarrhea. Ox-yokes made from the tree induce uncontrollable bruising when continuously used. The plant extract from the twigs and bark is genotoxic to micronuclei [8].

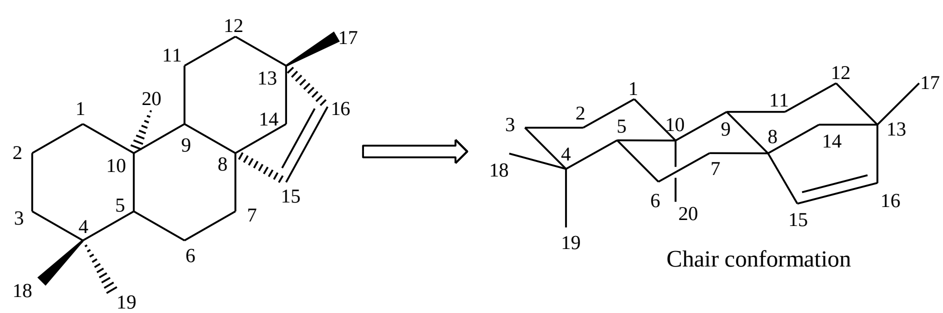
It was the anti-feedant property which prompted us to start the phytochemical study on *Spirostachys africana*. When we started, there were three compounds known from resin of the heartwood [1].

Experimental

The wet heartwood of plant was harvested from Rusape, Zimbabwe while dry heartwood was collected from Borotsi, Botswana. In all cases the dried heartwood was chopped into small pieces and ground to a powder.

A known amount of powder was extracted with CH_2Cl_2/MeOH mixture for twenty four hours. After evaporation, the syrup was made into slurry on silica gel. In general, chromatographic procedures were used to separate into fractions. The fractions were further resolved using liquid-liquid partition, recrystallisation, acetylation and methylation. The liquid-liquid partition employed sodium carbonate solution and chloroform to separate acids from non acid material. Neutralisation of the carbonate layer with dilute hydrochloric acid and subsequent extraction with chloroform yielded the acid material. These were further resolved by chromatography. Many a time, crystals were collected at this stage. Acetylation largely employed acetic anhydride and pyridine. Methylation was achieved using diazomethane. The compounds were identified using spectroscopic techniques. The principle skeleton of compounds isolated from the latex is the beyerene or stachene type which is a diterpene and this is shown below

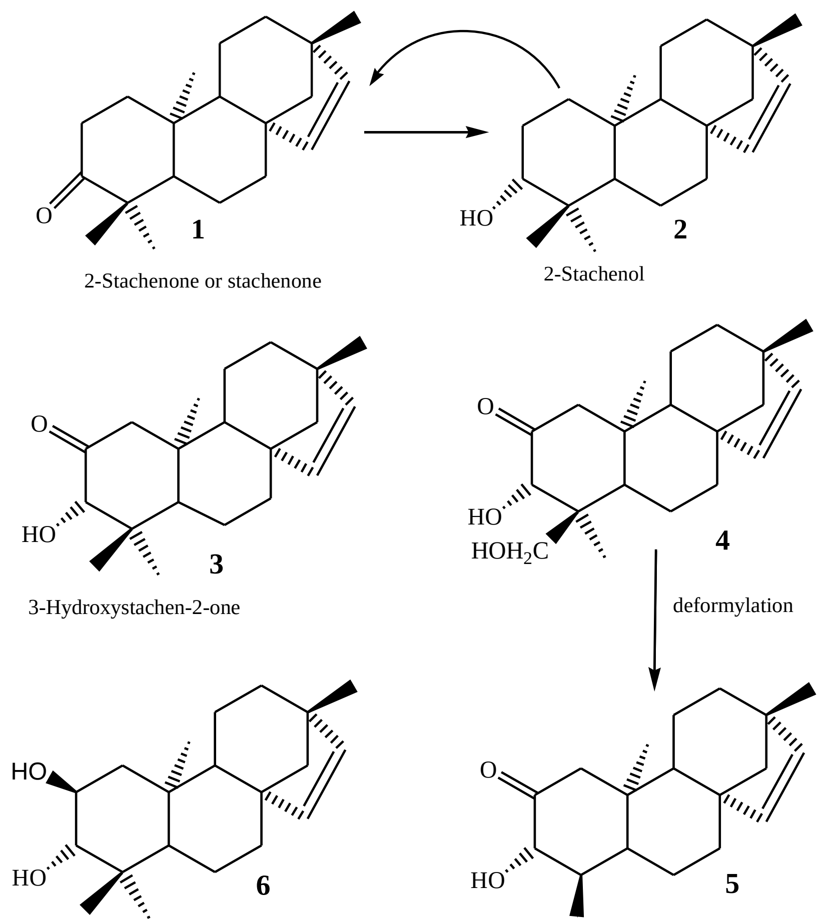
Beyerene or stachene skeleton



Results and Discussion

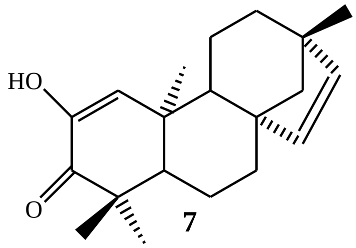
Compounds of the non acid material

These were observed as nice colored spots (red to brown) on TLC when sprayed with 1 % vanillin and 5 % sulphuric acid in MeOH. The majority of these were 2-hydroxyketones [2]. 2-Stachenone has been known since 1962 and was reduced to stachenol [1]. We established that stachenol is present in the plant, as natural product and it is also readily oxidized to stachenone [6]. Like **1**, compounds **3** and **4** are present in large quantities. Compound **5** has only nineteen carbons and it may be as a result of deformylation of **4**. Compound **7** was only isolated recently.



A number of enolised 1,2-diketones (diosphenols)were isolated from the non acid material. These compounds do not readily burn on TLC. They appear as light brown spots at first before getting dark and they are also visible under UV [6]. Their other unique characteristic was the presence of chelated hydrogen between the hydroxyl and carbonyl groups in their ^{1}H-NMR.

It has remained very difficult to confirm the presence of diosphenol **7**. However all the other three diosphenols may be postulated or predicted from **7**. The postulate is that demethylation of **7** followed by oxidation leads to other diosphenols. Deformylation may even be easier if **7** is hydroxylated at C-18 first.



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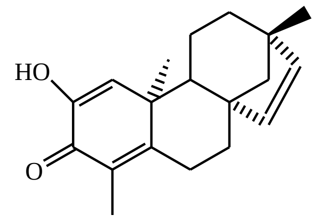
3-Hydroxystach-1, 15-dien-2-one
or diosphenol

Isolated by Baarschers et al



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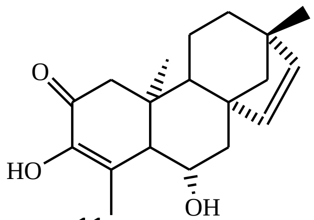

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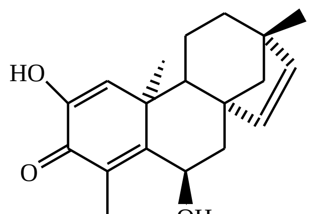

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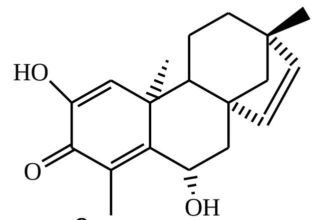

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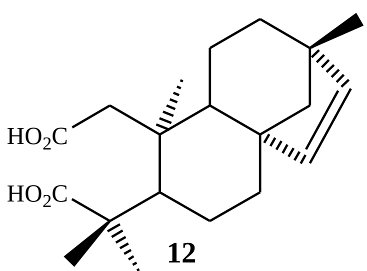
Diosphenols

Acids

Four have been charaterised this far. The diacid **1**2 is most abundant. In fact it spreads in many fractions. A number of its derivatives have been prepared in order to ascertain its characterization [5]. It appears that atmospheric oxidation of the diosphenol **7** cleaves it to give **12**, while oxidative induced rearrangement of **7** should give **15**. Compound **13** was observed as one of the products when **11** was kept in solution in air for a number of days.



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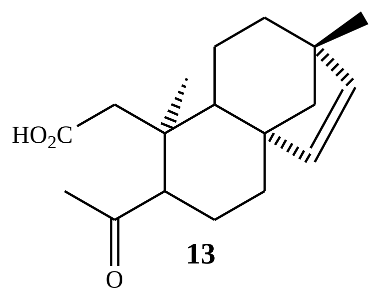

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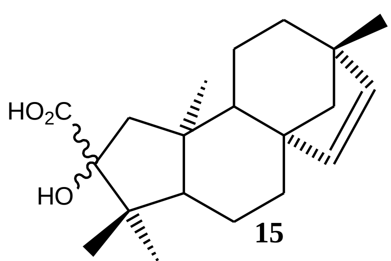

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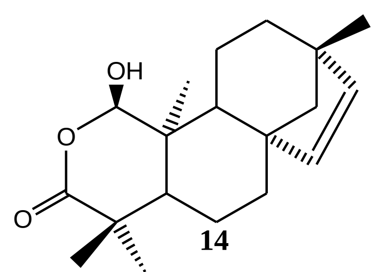

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Only compounds with the beyerene moiety have been isolated from this plant. Thus the biological activity reported for this plant is as a result of the action of these compounds. This is yet to be proved as very little biological assays have been carried out with the compounds.

Conclusions

The heartwood of *Spirostachys africana* is a rich source of beyerenes. Oxidation in ring A readily occurs at positions 2 and 3 to obtain diols and hydroxyketones. Further oxidation of diols (and hydroxyketones) leads to demethylation or deformylation giving C-19 and C-18 derivatives. Rearrangements have also been observed. The most abundant compounds are the hydroxyketones, diosphenols **9** and **10** and acid **1**2.

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