



Original paper

THE RELEVANCE OF TOPICAL PLANT USAGE IN TRADITIONAL HERBAL MEDICINE: AN INVESTIGATION INTO WEST AFRICAN TRADITIONAL MEDICINAL PLANTS WITH COSMECEUTICAL POTENTIAL IN SOUTHERN GHANA.

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Abstract

Introduction: Cosmetopea, a relatively novel and under-reported field in ethnobotany, is concerned with documenting medicinal plants' cosmetic/skin-related uses across countries and cultures.

Aim: To identify Western African plants and plant preparations traditionally used for skin conditions and other skin applications and to determine the activity of a selected medicinal plant.

Method: A quantitative ethnobotanical survey was conducted within Southern Ghana to investigate knowledge of medicinal plant species and preparations used topically for various skin conditions amongst local and rural communities.

Results: Plant use was cited as highest amongst men (76%) and herbal practitioners (60%). In total, the survey revealed 25 medicinal plants distributed amongst 20 plant families with 6 species being most frequently cited overall, which included *Senna alata*, *Ageratum conyzoides*, *Momordica charantia*, *Phyllanthus amarus*, *Alstonia boonei* and *Ricinis communis*. Major skin applications of most plant species reported were for the treatment of skin diseases whilst lesser applications were recorded for cosmetic use. In terms of skin conditions, pimples/rashes was recorded with a high frequency of citations (34.87%). Mixtures were cited as the most common (62%) preparation type whilst raw application was recorded with the lowest usage (3%). A total of 28 medicinal plant recipes were recorded with the leaf plant part being reported with the highest frequency of usage (64%) in preparations. Mechanical extraction techniques including grinding or crushing were frequently cited (46%) whilst solvent extraction namely by water was reported with the lowest use (3%).

Conclusion: It was determined that the uses of such plants are relevant amongst local and rural communities and in the traditional herbal industry in Ghana.

List of Abbreviations

CPMR Centre for Plant Medicine Research

FDA Food and Drugs Authority

FDB Food and Drugs Board

GHAFTRAM Ghana Federation of Traditional Medicine Practitioners Association

GSB Ghana Standards Board

NIMNR Noguchi Memorial Institute for Medical Research

THMP Traditional Herbal Medicinal Practitioner

TMP Traditional Medicine Practitioner

INTRODUCTION

From observing the statistics concerning the global use of herbal medicine, one could assert that a large majority of the world's population is reliant upon its use. Reportedly, about "80% of the continent's population depends on herbal medicine for their primary health care" (WHO, 2002). However, the ubiquitous use of this statistic, cited amongst numerous ethnobotanical and ethnopharmacological studies within the African continent, is primarily outdated (Moyo, Aremu, & Van Staden, 2015). This reporting is consequently alarming given the frequency of researchers and policymakers that continue to rely on outdated statistics (Pouliot, 2011) revealing the stark reality that up-to-date estimations on the global use of herbal medicine is unavailable (Moyo et al., 2015).

Within the last 20 years, there has been increased research into medicinal plant use in Africa. However, it has previously been reported that not up to a third of medicinal plant species have been studied on the continent (Sofowora, 1993). Despite this, investigations into the traditional uses of African medicinal plants have unearthed significant findings. Notably, research into the *Pelargonium sidoides* species led to the development of a treatment for tuberculosis in Europe around the early 20th century and it is one of the most widely researched and marketed species in Europe hailing from the African continent (Moyo and Van Staden, 2014; Moyo et al., 2015). The research of John Smyth in 1695, Henry Tedlie from 1792–1818 and Peter Thonning from 1799–1803 in the West African nation of Ghana represent early examples of ethnobotanical studies and herbarium specimen collection (Soelberg et al., 2015; Moyo et al., 2015). More recent ethnopharmacological research has investigated a biodiversity hotspot in the Guinean Forests of West Africa for the screening of neuroprotective compounds for Alzheimer's disease after deriving knowledge from local communities in São Tomé and Príncipe (Currais et al., 2014). Alongside this, the traditional use of medicinal plants has continued to be the mainstay of primary healthcare and trade within Africa since time immemorial. The introduction of the first African herbal pharmacopoeia by the Organisation for African Unity/Scientific, Technical and Research Commission (OAU/STRC) in 1985 was developed in recognition of this and made possible by pharmacognostical research reporting recommendations for quality control (Odukoya et al., 1988 as cited in Sofowora, 1993).

Research into validating the traditional use of African medicinal plants has continued to evolve since the post-colonial era where there has been a boom in phytochemical, bioassay-guided isolation, biological, pharmacological and toxicological studies by African researchers (Sofowora, 1993; Moyo et al., 2015). The rich biodiversity encountered in the African medicinal flora has drawn interest from international scientific researchers and sponsors. Outside of the OAU/STRC, international organisations have largely aided developments in medicinal plant research. This has involved collaborations between international research laboratories and African scientists. Alongside this, funding was given by international organisations including but not limited to Commonwealth Science Council, International Foundation for Science, Japan Foundation for Science, DAAD, DANIDA, EEC, UNESCO, ORSTOM (Sofowora, 1993).

Medicinal plants continue to form a part of Africa's rich cultural history, with their value being immeasurable for African livelihoods and industries. Neuwinger (2000) reports that an estimated 9% of the 60,000 described plant taxa in Africa possess over 16,300 therapeutic uses. Threatening this rich cultural legacy is the major loss of plant biodiversity that continues to occur. Data from the IUCN (2014) reports a number of African countries including Cameroon (54%), Democratic Republic of Congo (33%), Gabon (36%), Ivory

Coast (33%), Kenya (29%) Madagascar (51%), Nigeria (36%) and Tanzania (46%) as currently having plant species that are either critically endangered, endangered or vulnerable. Factors involved in this loss of biodiversity are many and include overexploitation of plants for traditional uses, habitat destruction, population growth, and pollution to name a few (Sofowora, 1993; Affolter and Pengelly, 2007 as cited in Moyo et al., 2015). Parallel to this, is the general loss of traditional medicinal knowledge owing to factors such as poor documentation and unsustainable harvesting practices of medicinal plants from their natural habitats. Ahrends *et al* (2011) reports the need for reliable data on the distribution of wild plant species to effectively manage their conservation. One area of research tackling this is the quantitative medicinal market survey. This type of survey serves to examine the level of species distribution, commonly traded plants and degree of harvesting from which inferences can be made about the status of wild plant populations in countries (T. R. van Andel et al., 2015). Ultimately, the quantitative medicinal market survey can identify the overexploitation factor of high-risk species and identify conservation priorities although currently these markets are under-represented in many African countries (Quiroz et al., 2014).

Ethnomedicine in West Africa

The African continent serves as the historical bedrock of plant diversity amongst the world. Therefore, it is no surprise that within this bedrock lays the area that began as “the centre of domestication for economic plants”, West Africa (Grace et al., 2017). The richness and rarity of plant species within the region have been studied by various authors (Taplin and Lovett, 2003; Bongers et al., 2004; Linder, 2014; Marshall et al., 2016; Sosef et al., 2017). These studies indicate that species-richness is concentrated predominantly around the coast of West Africa. Further to this, Sosef *et al* (2017) reports that the nations of Benin, Cameroon, Ivory Coast and Liberia are, from a botanical perspective, the “best-explored” although none have been optimally explored. As described by the United Nations, West Africa is geopolitically formed of the countries of Benin, Burkina Faso, Cape Verde, Ivory Coast, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo (Fig. 1). The region occupies a landmass in excess of 6,140,000 km, accounting for approximately one-fifth of Africa’s landmass and has a total population of over 300 million (United Nations, 2017).

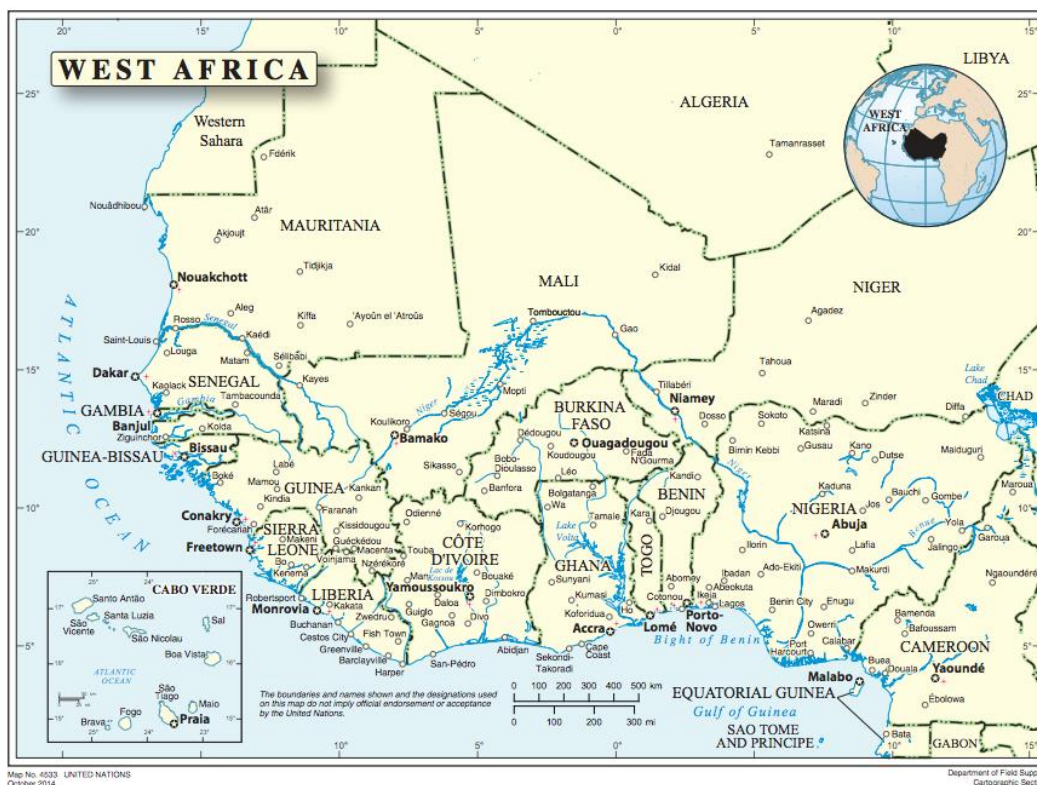


Figure. 1 Map of West Africa. Source: United Nations, 2014

Specifically, the use of medicinal plants in W. Africa is widespread and it comprises a major proponent of African traditional medicine. The term traditional medicine itself refers to many different branches of non-conventional healthcare practices. The World Health Organisation defines it as “the sum total of the combination of knowledge and practice, whether explicable or inexplicable, used in diagnosing, preventing, or eliminating physical, mental, or social diseases, that may rely exclusively on past experience or observations handed down from generation to generation, verbally or in writing” (World Health Organisation, 2000). African traditional medicine in particular is seen to be distinct from alternative and complementary therapies as it is denoted as the “indigenous system of health care and therefore cannot be seen as an alternative” (Kofi-Tsekpo, 2004). African traditional medicine practiced in W. Africa share common disease concepts in the treatment and management of disease. These concepts are centred upon physical, spiritual, moral, social and/or cultural aspects. Thus, it is the belief that if one finds balance within these aspects then good health will follow and conversely if any of these aspects are imbalanced then sickness will follow (Ozioma & Chinwe, 2019). As such treatment of disease in African traditional systems takes on a holistic approach and is concerned with treating not just the physical symptoms but also the other aforementioned aspects.

Herbal industries in West Africa

Traditional herbal medicine (THM) dominates the African traditional medicine scene across many countries. The World Health Organisation defines its use as “herbs, herbal materials, herbal preparations, and finished herbal products that contain whole plants, parts of plants, or other plant materials, including leaves, bark, berries, flowers, and roots, and/or their extracts as active ingredients intended for human therapeutic use or for other benefits in humans and sometimes animals” (World Health Organisation, 2001). Although the use of medicinal plants is common practice across W. Africa their uses differ from country to country varying by the manner of use and type of plants used to treat the same conditions and therefore treatment modalities lack a standardised form across these countries (Ozioma & Chinwe, 2019).

The traditional use of these medicinal plants is governed by empiricism and after being used over thousands of years their efficacy has been established. These plants are used as crude drugs and may also be referred to as organised drugs if they are obtained from plant parts containing cells such as the bark, leaves and roots or referred to as unorganised drugs if obtained from secondary products produced from the plant, which do not contain cells such as balsams, exudate, gels, gums and oils (Ozioma & Chinwe, 2019). THM's most common plant parts/products include the bark, bulbs, flowers, fruits, leaves, rhizomes, roots, seeds, stems and tubers, gum and exudate. These part plants are sold in fresh or dry markets and form a major industry in many W. African and other African countries (World Health Organisation, 2001). In addition to traditional medicine, medicinal plants are widely used in several other African industries as diverse as cosmetics, essential oil manufacture, extraction-formulation industries, health foods, medicine and pharmaceuticals amongst others (Fig.2; Dzoyem et al., 2013). The pharmaceutical industry is the largest user of medicinal plants comprising therapeutic and preventative uses. Mainly products including dried plants, extracts and isolated active ingredients are used to manufacture medicines. Specifically, pharmaceutical companies produce highly standardised advanced extracts and isolate single purified drugs although these mostly tend to comprise admixtures with other ingredients in the final product. Also the para-pharmaceutical and cosmetics industries are large users of vegetable derivatives and plant oils including essential oils, and waxes to manufacture personal care products including bath gels, deodorants, elixirs, mouthwashes and toothpastes to name a few. Further to this, the aromatherapy industry is driving an emerging demand that has spurred on the production of higher quality essential oils in comparison to those used in traditional medicine (Dzoyem et al., 2013). A major problem currently facing the production of herbal medicines in African countries today is the lack of testing in terms of the efficacy, quality, safety, and standardisation. Although regulations are in place and many registered enterprises adhere to them there are many enterprises that do not adhere to these regulations or registration processes. These are termed cottage-level enterprises that manufacture herbal medicine according to African traditional systems only (Dzoyem et al., 2013).

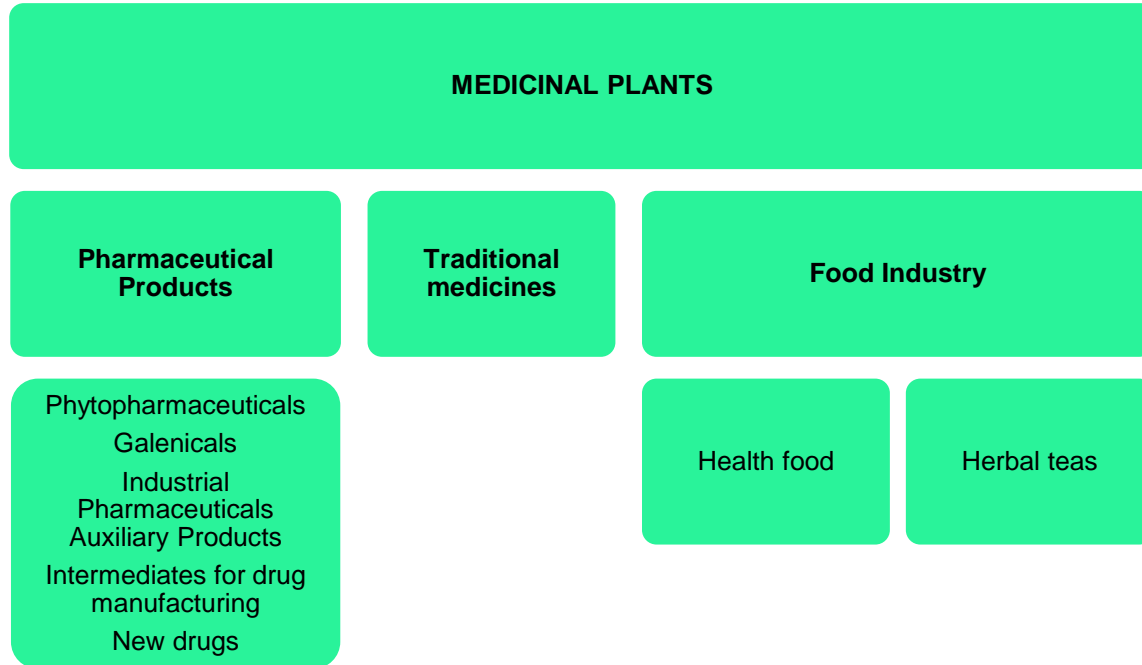


Figure. 2 Uses of Medicinal Plants in African Industries. Adapted from: Dzoyem *et al* (2013).

Plant-based remedies have long been established for skin care and treatment of skin conditions and disorders. Their use over many centuries can be observed in treating conditions such as atopic dermatitis (Fig. 3), alopecia areata, photo-toxicity, psoriasis, wound healing and many other dermatological and inflammatory conditions. Despite their empirical standing, their scientific standing is seen as questionable, particularly amongst dermatologists (Ariffin & Hasham, 2016). Cosmetopea, a relatively novel and under-reported field in ethnobotany, is concerned with documenting the cosmetic/skin-related uses of medicinal plants across countries and cultures. As such it is an area of study that requires further research despite medicinal plants being reported on a global scale with known uses in skincare applications (Fongnzossie *et al.*, 2017).

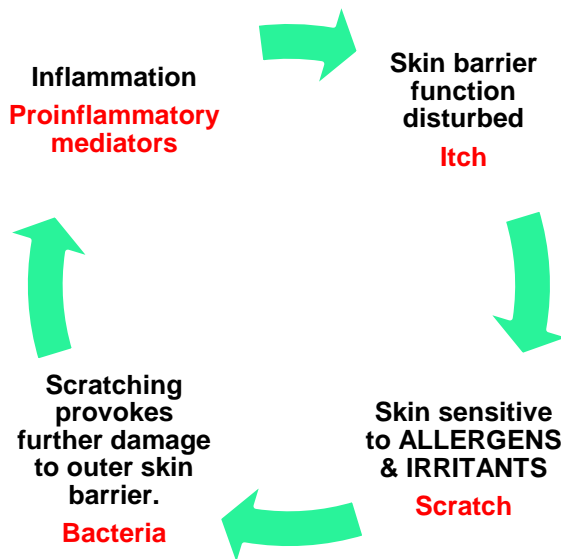


Figure. 3 The disease cycle of atopic dermatitis. Adapted from: Ariffin and Hasham (2016).

The integumentary system contains the largest organ system of the body consisting of the skin, hair, nails and exocrine glands. Within this system, it is the skin that serves the function of the primary defence barrier against external agents of the environment including bacteria, microbes, viruses, UV radiation and other harmful pathogens and substances. Furthermore, the skin also serves as the primary thermoregulatory system of body temperature (Lee, Jeong, & Ahn, 2006).

In terms of its anatomy, the skin is composed of two distinctive layers, namely the epidermis, a stratified squamous epithelium region and the dermis, a layer formed of dense irregular connective tissue comprising blood and lymph vessels, nerves, hair follicles and sweat glands (McGrath and Uitto, 2010; Betts et al., 2019). A further closely associated layer, the hypodermis exists beneath the dermis and is comprised of loose connective and fatty tissues (Betts et al., 2019). The epidermis is “typically 0.05–0.1 mm in thickness” and is housed within the upper layer of skin being further subdivided from superficial to deep into the stratum corneum, stratum lucidum, stratum granulosum or granular layer, stratum spinosum or spinous layer and the stratum basale or basal layer. The latter is also referred to as the stratum germinativum. Of note, however, is that the four layers excluding the stratum lucidum comprise most of the skin on the body and is termed “thin skin”. In contrast, the stratum lucidum is found only on the palms of the hands and soles of the feet and is termed “thick skin”. Antimicrobial peptides are key agents involved in the skin’s defence process and act by directly inhibiting the growth of bacteria, viruses, and fungi or indirectly by activating the cellular and acquired immunity (Twilley & Lall, 2014).

ETHNOBOTANICAL INVESTIGATION OF GHANAIAN MEDICINAL PLANTS USED FOR SKIN APPLICATIONS

Traditional herbal production of cosmeceuticals in Ghana

Cosmeceutical production in Ghana has a long history with medicated skin balms (Fig. 7 and 8) being one of the first mass produced goods in the country during the period of independence from colonial rule in 1957 (Droney, 2016). van Andel *et al* (2012) reports that an estimated 951 tons of crude herbal medicine were sold at Ghana’s herbal markets in 2010 and this was with a total value of around US\$ 7.8 million. Manufacturing of dosage forms, packaging, and marketing of herbal products has continued to innovate since this post-colonial era and there has been a surge in the production of pills, tablets, capsules, creams in tubes, medicated soaps and mixtures bottled for longer shelf life similar to allopathic drugs. Further to this, a range of health food products exist that include beverages and tea bags. Alongside this processing techniques are also seeing the adoption of innovative approaches, which include the use of modern equipment leading to increases in production and quality (Essegbey et al., 2014).

Regulatory aspects of traditional medicine and the role of Ghana’s herbal knowledge banks.

The Food and Drugs Authority (FDA) in Ghana currently serves as the major authority for the licensing of herbal medicines for sale in the country and key activities of the FDA include:

- The registration of herbal medicines.
- Monitoring of advertisements promoting the sale of traditional medicines.
- Conducting Good Manufacturing Practice (GMP) inspections.
- Issuance of manufacturing and export licences for herbal medicine.

At the time of 2010, FDA Ghana had issued marketing authorisations for over a 1000 traditional medicines (Moshi & Mhame, 2013). The National Pharmacovigilance Centre is an arm of the FDA Ghana that monitors the pharmacovigilance activities and conducts safety monitoring of all medicines including herbal medicine (Wambebe, 2009). The centre is part of an international network of more than 150 countries that operate institutions, which monitor pharmacovigilance activities within the respective country. The network began through the efforts of the World Health Organisation (WHO) Programme for International Drug Monitoring, which was originally set-up in 1968 and subsequently through the addition of the WHO Uppsala Monitoring Centre following in 1978. These organisations were established with the aim of building a global repository of pharmacovigilance information concerning the reporting of adverse drug effects and to ensure the safer use of medicines following the thalidomide drug scandal (WHO-UMC, 2019).

A number of other key governmental bodies and non-governmental organisations (NGOs) exist to regulate the activities of traditional medicine in Ghana. The Ghana Food and Drugs Authority (FDA Ghana), formerly

the Food and Drugs Board (FDB), is one such governmental body that was set up in 1997 to improve regulations on the trade in consumable products of which herbal medicines were included (Osseo-Asare, 2005). The introduction of the body brought with it a divergence from the existing models, which were in effect at the time and only tested herbal products as and when needed. The FDA Ghana sought to instead make the licensing of locally manufactured products universal and ensured that manufacturers conformed to Good Manufacturing Practices (GMP; Osseo-Asare, 2005). The Traditional Medicine Practice Act 595 of 2000 is the main legislation central to the regulatory framework of traditional medicine in Ghana. This was enacted by the Traditional and Alternative Medicine Directorate (TAMD) of the Ministry of Health who serve as the legislative body that determine “policy, institutional and regulatory” functions concerning traditional medicine in the country (Wambebe, 2009; Moshi and Mhame, 2013).

The Ghana Standards Board (GSB) is another governmental body in operation with its main role being to determine standards for locally produced goods, which include herbal medicines (Moshi & Mhame, 2013). The GSB along with the Ghana Pharmacy Board (GPB) were previously major regulators of the trade in herbal medicines before the introduction of the FDA Ghana (Osseo-Asare, 2005).

The Centre for Plant Medicine Research (CPMR) formerly known as the Centre for Scientific Research into Plant Medicine (CSRPM), is an NGO that performs quality control testing ensuring the safety, quality and efficacy of herbal medicines in Ghana (Wambebe, 2009). The centre began its work in 1975 where it was set-up by the late Dr Oku Ampofo to conduct research into the screening of the Ghanaian flora for drug development. The centre houses a research and manufacturing facility alongside a patient clinic. The Noguchi Memorial Institute of Medical Research (NMIMR) is another NGO that conducts quality control assessments of herbal medicines in Ghana. The research institute was established within the University of Ghana in 1979 as a semi-autonomous research function, which was funded by the government of Japan. The institute hosts collaborative work between researchers from Ghana and Japan and is named after the researcher Hideyo Noguchi, who passed away in 1928 from yellow fever (Droney, 2016). The research centre houses a research facility that performs full-scale animal toxicity studies in line with Good Laboratory Practice (GLP) standards (Moshi & Mhame, 2013). The Ghana Federation of Traditional Medicine Associations (GHAFTRAM) was set-up to organise and co-ordinate all practitioners of traditional medicine (Moshi & Mhame, 2013).

Ghana is heavily involved in propelling its development of traditional medicine. This is exemplified with it being one of a handful of African countries that have taken steps to promote and protect the curation of traditional medicinal knowledge. The country has developed a National Herbal Pharmacopoeia and has created databases on traditional medicine practitioners and traditional medicinal knowledge. Further to this, guidelines have been developed for the protection of traditional medicinal knowledge and intellectual property rights within the country (WHO, 2011 as cited in Moshi and Mhame, 2013).

Independent companies include SGS Ghana, which is involved in the inspection, verification, testing and certification of cosmetics and personal care products. The company began its operations in France and has had a branch in operation within Ghana since 1960. Their testing services meet international standards for regulatory requirements and product safety (SGS Ghana, 2019).

AIMS

This study was conducted to record the plant-based traditional knowledge of communities within Southern Ghana in order to provide insight into how medicinal plant species are currently used for cosmeceutical or cosmetic applications. In addition, a select plant species will be subjected to further investigation to determine relevant phytochemical, pharmacological and biological activities.

The main objectives are as follows:

- To investigate and identify herbs applied topically as medicines or used as cosmetics within southern Ghana.
- To identify patterns of traditional usage amongst medicinal plants for common skin conditions.
- To identify preparation forms traditionally used in treating skin conditions/ailments in parts of southern Ghana.
- To determine from the literature the degree to which selected medicinal plants found in Ghana coincide with topical plant uses from other West African countries.

- To determine regulatory aspects of herbal products in Ghana.

MATERIALS AND METHODS

Ethnobotanical survey

Data collection consisted of ethnopharmacological fieldwork and a literature review of the most frequently cited medicinal plant species identified from the ethnopharmacological survey.

The ethnobotanical survey took place over the course of one month from the 1st of June to the 1st of July 2019. Primary data was obtained from identified respondents, which included, traditional medicine practitioners, herbalists, farmers, herbal shop owners, market traders, local people and a lab technician. Respondents consisted of both men and women. The age ranges for respondents were grouped and ranged from 18 – 65 years and over. Two sets of validated questionnaires (Appendix 1) were designed, with the first set being administered to Awukugwa village respondents, which was later modified and administered to the remaining respondents. Semi-structured questionnaires and semi-informal interviews were conducted. The questionnaires were written in English and consisted of three main sections pertaining to:

- The respondents' backgrounds,
- Medicinal plant knowledge/knowledge of skin conditions/plant preparations
- Conservation issues surrounding the named plants.

Assistance was sought from the Centre for Plant Medicine Research (CPMR) to aid in data collection. This was enacted by firstly organising a visit to the Awukugwa village community through a key informant that worked for the centre. The interviews were carried out in either the local dialect, Akuapem-Twi or in Asante-Twi. Approximately 15-20 villagers gathered on arrival and data was gathered from the 6 respondents that were willing to be interviewed. Another set of interviews were carried out with the assistance of CPMR with members of the Ghana Federation of Traditional Medicine Practitioners Association (GHAFTRAM) during one of their regular training sessions at the centre. These interviews were conducted in either English or Asante-Twi. Both the Awukugwa and GHAFTRAM respondents were made aware of the purpose of the survey and informed consent was given. Cash was given during both visits to encourage respondents to give information and as a gesture of gratitude for participation within the study. Local names of plants were translated into English with the assistance of researchers from CPMR and through the use of previously published work.

Study areas

The ethnobotanical study collected cross-sectional data in three areas located in the Eastern region and Greater Accra region of southern Ghana. The study targeted a village, an association of herbal practitioners (interviewed in a research centre) and a business district. The study areas are shown in Figures 12 and 13. Awukugwa village is a small farming community located within the latitude and longitude of 6.06851, - 0.17244. The village falls under the Local Government Area of Asifaw South in the Akwapem North district of the Eastern region (Fig 4). Awukugwa village has a population of approximately 300 inhabitants from the Akan sub-ethnic group of Akwapem with inhabitants speaking the Akwapem dialect of Twi. The village was visited at the beginning of June during the rainy season. The Centre for Plant Medicine Research is located in Mampong-Akuapem, Eastern region. 15 members of the GHAFTRAM association were interviewed at the premises of the Centre for Plant Medicine Research. Sakunomo is a business district located in the Tema West district of the Greater Accra region. A market survey was conducted in herbal shops and a herbal clinic to obtain information regarding traditional herbal products on the consumer market.

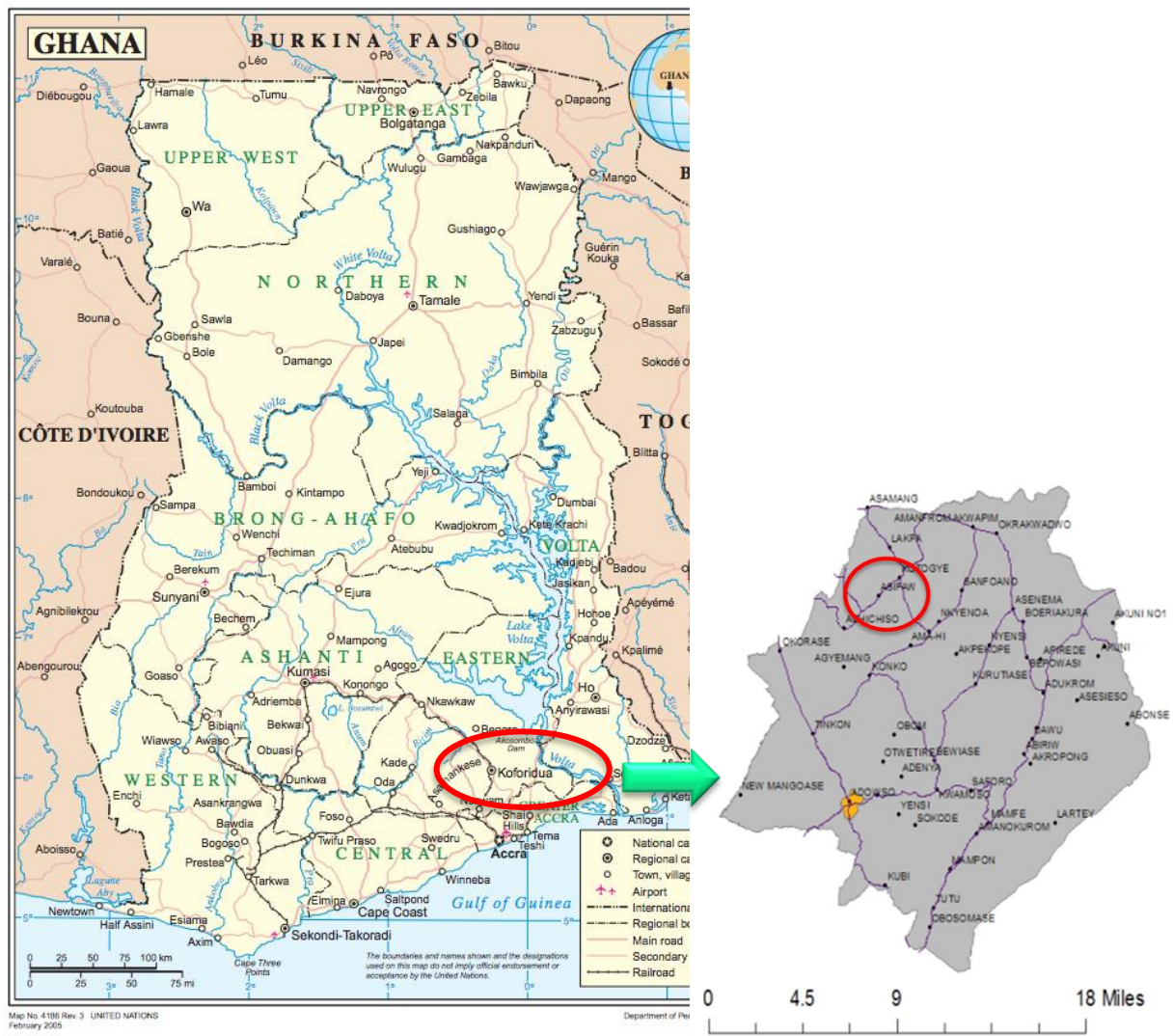


Figure 4. Map of Ghana showing study areas. Sources UN, 2005; Adamba *et al* (2016).

Literature searches and Data Analysis

To perform the literature search a targeted survey of the literature was carried out on the most commonly cited species identified from the ethnobotanical survey. Boolean search operators alongside key search terms and phrases were applied through a combination of different search types including:

- Searches by historical texts and recent literature.
- Searches by specific West African country.
- Searches by species.
- Searches by ethnomedicinal use.
- Searches by formulations.
- Searches by skin conditions/ailments.
- Searches by pharmacognostic studies.
- Searches by pharmacological activity.
- Searches by biological activity.
- Searches by extraction techniques.
- Searches by toxicological studies.

- Key search terms and phrases included but were not limited to: “ethnobotanical”, “ethnopharmacological”, “ethnobotanical survey”, “ethnobotanical study”, “ethnopharmacological study”, “ethnopharmacological survey”, “West African”, “Ghana”, “herbal”, “fibroblasts”, “human fibroblasts”, “melanoblasts”, “in vitro activity”, “cytotoxicity”, “skin conditions”, “skin inflammation”, “wounds”, “anti-ageing”, “herbal skin formulations”, “phytocosmetics”, “plant cosmeceuticals”, “solvent extraction”.
- Data sources included ethnobotanical books and peer-reviewed research papers. Numerous databases were consulted for research including but not limited to: JSTOR, UCL Explore, Google Scholar, PubMed, EMBASE, NAPRALERT, Semantic Scholar, CSIR Ghana, Elsevier Journal of Ethnopharmacology, International Journal of Pharmacognosy, International Journal of Dermatology Treatment, Journal of Asian Natural Products Research, Taylor and Francis Online, Proquest and DOAJ. Data was also communicated verbally from consulted contacts.

Analysis of medicinal plant species was performed by determining the frequency of citation (FC) of plant species with given uses overall, calculated as Equation 1.

Equation 1. frequency of citation (FC):

$$FC = (\text{number of times a particular species was mentioned} / \text{total number of times that all species were mentioned}) \times 100.$$

Ethical Considerations

Assistance was sought from the Centre for Plant Medicine Research (Ghana) to aid in data collection. Previous agreement with Informed consent was obtained from local people, and permission was granted to disseminate their traditional knowledge.

Safety

All precautions were taken to ensure safety, including receiving a vaccination for yellow fever, wearing appropriate footwear for fieldwork, and adhering to display screen equipment safety.

RESULTS**Field Study/Ethnobotanical Survey**

A total of 26 respondents were interviewed, which included both males and females in the age range of 30 – 84 years. The results demonstrated that there were a higher number of male respondents compared to female respondents. Male respondents were mostly concentrated in the age categories of 35 -49 years (47%), and over. Most female respondents were middle aged (50-64 years). The majority of respondents had attained a minimum of junior high school education (35%) whilst 8% reported having no formal education, 12% had attended primary school, 27% had attended senior high school and 8% were found to have studied tertiary level courses whilst 12% had a university degree.

Respondents were predominantly of the Akan ethnic group (76%) and the Akuapem sub-ethnic group comprised the largest number of these respondents followed by the Akyem sub-ethnic group (Table 1). The Ewe ethnic group followed representing 12% of respondents. Common occupational backgrounds were farming 24%, trading 12%, and traditional herbalists 32% while 12% were involved in allied health professions, namely a physiotherapist/medical herbalist and a health practitioner and herbal practitioners made up the largest group of key informants. Religious backgrounds were majority Christian (84%) followed by Muslim (8%) and traditional African religion or other (4%).

A total of 25 plant species distributed into 20 families were identified from the ethnobotanical survey, which can be found in Table 2. Plant families recorded with the highest number of cited species included Euphorbiaceae, recorded with 3 species followed by Apocynaceae, Fabaceae, Melinaceae, Malvaceae, which were all recorded with 2 species each. Plant species were present in a number of botanical forms with trees (44%) being the most abundant life form recorded followed by herbs (36%), shrubs (16%) and climbing herbs (4%).

Modes of use and Methods of Preparation

Overall, the most frequently used plant parts in preparations included the leaves (64%) followed by the sap/exudate (12%) with the stem bark, tree bark, seeds, oil and pod being reported at 4%. These plant parts/products were recorded in 28 recipes with preparation types that consisted of mixtures (62%); ashed powder (10%); soap (7%); combination of preformulated soap/raw material (7%); combination of preformulated cream/raw material (4%); poultice (4%); mask (4%); and 3% were used raw without any preparation, which included *Jatropha curcas* and *Ocimum basilicum*. Preparations were largely obtained by mechanical extraction involving grinding/crushing (46%), followed heating by fire or frying (28%), drying (23%) and water extraction (3%).

Medicinal Applications of Plants

The major categories of skin applications of plant species can be found in Table 3). Results showed that skin diseases were the main application of plants with cosmetic use being less cited. Of all major skin conditions cited, pimples/rashes had the highest number of species cited (12) followed by wounds (7 species), boils (6 species), ringworm (5 species) eczema (4 species) hives and cosmetic uses (3 species each) shingles and insect bites/stings (2 species each; Fig.). Plants with the most cited overall use included *Senna alata*, *Ageratum conyzoides*, *Momordica charantia*, *Phyllanthus amarus*, *Alstonia boonei* and *Ricinus communis*. *Senna alata*, which was recorded with the highest frequency of usage overall, was cited with multiple uses that included boils, hives, eczema, rashes and ringworm. *Ageratum conyzoides* was reported with the second highest number of citations and had multiple uses that included insect bites, boils, hives, rashes and wounds. *Momordica charantia* and *Phyllanthus amarus* made up the third highest group of plant species cited with frequency of usage. *Momordica charantia* was cited in the treatment of measles, wounds, rashes, ringworm, boils and hives. *Phyllanthus amarus* was cited in the treatment of measles, wounds and rashes. *Alstonia boonei* and *Ricinus communis* were recorded with the fourth highest number of citations. *Alstonia boonei* was recorded for use in the treatment of heat rash and measles whilst *Ricinus communis* was recorded for use in the treatment of boils, eczema and ringworm. *Momordica charantia* was subjected to further investigation in the literature review and assessed by comparison of its uses in other parts of West Africa.

Market Survey

From the market survey it was revealed that medicated ointments and soaps were the most prevalent preparation type in the herbal market. (Fig.5) Common uses included for the treatment of wounds, itchy skin, eczema and ringworm. Formulation of products were either done on the premises (as in the case of herbal clinics with on-site production facilities) or bought straight from the supplier.



Figure 5. Market survey in Ghana: (A) Typical selling point of cosmetics (B) Common medicated skin balms/ointments and (C) (B) soaps found in Ghana. Source: Author's own pictures.

Table 1. Demographic profile of respondents interviewed in southern Ghana

Variable	Category	n
Gender	Male	20
	Female	6
Age	18-34	2
	35-49	11
	50-64	10
	65 \geq	4
Informant Category	Herbal practitioners/	15
	Other health practitioner	1
	Non-herbal practitioners	10
Ethnic Background	Akan	
	Akan not specified	3
	Akuapem	6
	Akyem	4
	Asante	1
	Brong-Ahafo	2
	Fante	2
	Fante-Nzema	1
	Nzema	1
	Wassa	1
	Bono	1
	Ewe	3
	Fra Fra	1
	Ga	1
Religious Background	Christian	22
	Muslim	2
	Traditional	1
	Other	1

Table 2. Ethnobotanical data of medicinal plants with topical application for use in the treatment of skin conditions/ailments and as cosmetics

Plant family, Scientific name, and Local name	Skin condition ailment	Plant part(s) used	Citations	Preparation, Application and Dosage Form
AMARANTHACEAE <i>Pupalia lappacea</i> (L.) A Juss. Aposompo (TWI)	Boils.	Leaf.	1	First apply a mixture of clay, activated charcoal and lemon to bring boil to a head. Apply minimal heat to leaf until soft and do not allow to burn. Add <i>Vitellaria paradoxa</i> (shea butter) to front of leaf then apply to affected area to draw fluid out. Repeat as needed until boil bursts.
ANNONACEAE				
<i>Annona reticulata</i> (L.) Custard apple plant (ENGLISH)	Common skin diseases (Unspecified).	Leaf and seed.	1	Dry and grind leaves to form a powder. Fry the seeds with oil and add the powdered leaves to form a cream. Wash the affected area with an antiseptic and apply mixture to the area twice daily, morning and evening.
APOCYNACEAE				
<i>Alstonia boonei</i> De Wild. Nyame dua/Onyame dua (ASANTE-TWI)	Measles, heat rash.	Stem bark.	4	Grind bark then add <i>Piper guineensis</i> (black pepper) and lemon juice then smear onto skin and leave to dry. Apply as and when needed.
<i>Rauvolfia vomitoria</i> Afzel. Kakapempem (ASANTE-TWI)	Rashes	Leaf	2	Dry leaves and grind into powder and mix with <i>odiaba</i> , <i>snappy aba</i> and <i>Abom egu wakyi</i> (<i>Phyllanthus amarus</i>). Can also be mixed with kerosene. Applied as a cream or can be used with a soap.
ARACEAE				
<i>Colocasia esculenta</i> (L.) Schott. Mankane/Kooko (ASANTE-TWI)	Snake bite.	Leaf.	1	Cut leaf and crush/squeeze leaf to the extract fresh juice and apply to affected area. Normally used as a temporary measure until further treatment can be sought.

Plant family, Scientific name, and Local name	Skin condition ailment	Plant part(s) used	Citations	Preparation, Application and Dosage Form
Cocoyam (ENGLISH)				
ARECACEAE				
<i>Elaeis guineensis</i> Jacq. Abɛ dom (ASANTE-TWI) Adwe ngo (Palm Kernel Oil) Palm tree (ENGLISH)	Shingles <i>Ananse</i> (ASANTE-TWI).	Leaves specifically taken from the middle section of the plant and palm kernel oil.	1	Leaves are heated until they become ash then palm kernel oil is added to form a mixture and smeared on as an ointment to the affected area.
ASPHODELACEAE				
<i>Aloe vera</i> (L.) Burm. f.	Burns, skin inflammation, cosmetics.	Sap or gel.	2	Gel is applied topically in combination with other plants used to treat skin conditions. Apply as and when needed. Also combined with cocoa pod ash to form soap cosmetic.
ASTERACEAE				
<i>Ageratum conyzoides</i> (L.) Yaa kankan (ASANTE-TWI) Guekuro/Guaukro (AKUAPEM- TWI) Ahaban kankan (FANTE-TWI)	Insect bites, boils, hives, rashes and wounds.	Leaf and seeds.	8	Leaves are dried and then pounded to powder, petroleum jelly is added then mixture is heated to produce an ointment. Seeds can also be added to mixture but must be heated first before grinding. Apply to affected area by smearing on skin as an ointment morning and evening after bathing.
BORAGINACEAE				
<i>Symphytum officinale</i> (L.) Comfrey (ENGLISH)	Psoriasis, pimples and blood spots.	Leaf and root.	3	Dry root then grind with lemon alternatively grind fresh leaf and apply to affected area as and when needed.
CARIACACEAE				
<i>Carica papaya</i> (L.) Bofere (ASANTE-TWI) Akpakpa (GA)	Rashes, eczema, ringworm.	Leaf.	3	Used as soap for bathing.

Plant family, Scientific name, and Local name	Skin condition ailment	Plant part(s) used	Citations	Preparation, Application and Dosage Form
Papaya (ENGLISH)				
CUCURBITACEAE				
<i>Momordica charantia</i> (L.) Nyinya/Nyanya (ASANTE-TWI)	Rashes, wounds, measles.	Leaf from male plant known as <i>atooto</i> .	6	Wash and pound fresh leaves and mix with hyire (kaolin clay) and smear on to skin.
EUPHORBIACEAE				
<i>Jatropha curcas</i> (L.) Nkanyadua/Nkrangyedua ^{[1][SEP]}	Keloid scars.	Latex/exudate from stem.	1	Rub exudate on to scar.
<i>Phyllanthus amarus</i> Schumach & Thonn. Abom egu wakyi (ASANTE- TWI) Boma gu akyire (FANTE-TWI)	Measles, rashes and wounds.	Leaf	6	Dry leaves then grind and roast in oven. Melt petroleum jelly or shea butter and mix with powdered leaves whilst heating. Apply as an ointment twice a day to body morning and evening.
<i>Ricinus communis</i> (L.) Adedenkuruma/Adedenkuma (ASANTE-TWI)	Boils and guinea- worm sores.	Leaf	3	Boils: Grind with black pepper. Has an immediate action. Guinea-worm sores: add salt instead of black pepper.
FABACEAE				
<i>Tamarindus indica</i> (L.) Borofo (ASANTE-TWI)	Rashes and wounds.	Leaf.	1	Dry leaves then grind and roast in oven. Melt petroleum jelly or shea butter and mix with powdered leaves whilst heating. Apply as an ointment twice a day to body morning and evening.
<i>Senna alata</i> (L.) Sempe/Osempe/Nsempii (ASANTE-TWI)	Boils, hives, eczema, rashes and ringworm.	Leaf	12	Leaves are dried and then pounded to a powder, petroleum jelly is added then mixture is heated to produce an ointment. Apply to affected area by smearing on skin as an ointment morning and evening after bathing.

Plant family, Scientific name, and Local name	Skin condition ailment	Plant part(s) used	Citations	Preparation, Application and Dosage Form
				Ground leaves can also be added to pre-formulated creams.
LAMIACEAE/LABIATAE				
<i>Ocimum basilicum</i> (L.) Akoko mesa (ASANTE-TWI)	Bee stings	Leaf	1	Crush and rub on skin and leave to dry. Smear on skin and leave to dry as and when needed.
MALVACEAE				
<i>Cola nitida</i> (Vent.) Schott & Endl. Besè (ASANTE-TWI) Kola nut (ENGLISH)	Boils.	Stem bark.	2	Combine black pepper and maize leaves for application.
<i>Theobroma cacao</i> (L.) Kooko (ASANTE-TWI)	Rashes, eczema and pimples.	Cocoa pod ash	1	Cocoa pod ash combined with <i>Aloe vera</i> is used to make soap products.
MELIACEAE				
<i>Khaya senegalensis</i> A. Juss. Kuntunkiri/Odupong (ASANTE-TWI) Mahogany (ENGLISH)	Benign skin growths.	Bark	1	Dry then grind into powder; add ginger then leave to dry. Apply 2-3 times daily.
<i>Azadirachta indica</i> A. Juss. Neem (ENGLISH)	Whitlow (Fungi).	Sap of the leaves	1	Crush fresh leaves in mortar with a small amount of distilled water to extract sap from leaves. Apply 2-3 drops on fingernails 3-4 times daily.
MORINGACEAE				
<i>Moringa oleifera</i> Lam. Moringa (ENGLISH)	Minor rashes, ringworm and eczema.	Seed.	3	Dry seeds by frying for easy powdering for preparation as an ointment to be used once a day.
PLANTAGINACEAE				

Plant family, Scientific name, and Local name	Skin condition ailment	Plant part(s) used	Citations	Preparation, Application and Dosage Form
<i>Plantago major</i> (L.) Plantain leaf (ENGLISH)	Ring worm and <i>Kakawere</i> .	Leaf.	2	Mash leaves together and add to soap product.
RANUNCULACEAE				
<i>Actaea racemosa</i> (L.) Black cohosh (ENGLISH)	Boils, hives and wounds.	Leaf and root.	3	Used as a lotion applied twice daily morning and evening.
VERBENACEAE				
<i>Lantana camara</i> (L.) Ananse dokono (ASANTE- TWI)	Toning and brightening of the skin, rashes.	Leaf.	2	Combine with chickweed (<i>Stellaria media</i>) and nunun (<i>Ocimum gratissimum</i>) and grind then add black pepper, turmeric, ginger may also be added. Apply fresh on skin and leave to dry, apply twice a day morning and evening.

Table 3. Frequency of citation of plants used in skin conditions/application

Type of skin application	Number of plant species used per condition	Frequency
Pimples/Rashes	24	33%
Wounds, Ringworm	7	10% each
Boils	6	8%
Measles, Eczema	5	7% each
Hives, Cosmetic use	3	4 % each
Insect bites, Shingles	2	3% each
Burns, Benign skin growths, Blood spots, Guinea worm, Keloid scars, Psoriasis, Snake bites, Whitlow, Non-specific use.	1	1.36% each

DISCUSSION

Discussion of Present Study

Medicinal plants continue to be a valuable resource for humankind with many being identified to treat a wealth of conditions and diseases. A repository of medicinal plant knowledge has subsisted inter-generationally through oral tradition and even in spite of it. However, the dissemination of knowledge remains an issue in African indigenous systems of medicines, where the use of whole plants, plant parts and their extracts are not extensively documented. The field of ethnobotany is one research avenue that seeks to counteract this phenomenon through the detailed collection of knowledge about the uses of medicinal plants amongst local and indigenous communities.

The presented research involved the collection of such data from around 26 people that were interviewed in this study. As reported, the majority of respondents were men whilst women formed the minority. This trend was not entirely surprising due to the nature of gender-roles within Ghanaian society. Further to this, it has been previously reported that women are less knowledgeable about traditional medicine compared to men who tend to dominate the practice (Togola, Diallo, Dembélé, Barsett, & Paulsen, 2005). Moreover, the authors also report that men tend to treat a wider demographic of patients that include both adults and children whereas women are observed treating more child cases. However, due to the small sample size used this cannot be ruled out as an impacting factor. Also not surprising was the lack of young adults and teenagers reported although the sample size again is likely to have had a significant impact on this trend. Another factor likely to have affected results was the unwillingness to give information that was observed in some cases. One example of this was seen with some of the individuals that were met at the Awukugua village community of which some felt they would need to consult with spiritual entities before divulging in information. Others too were less inhibited and were further encouraged by cash incentives. Further instances involved individuals located in the city areas that stated they would return to give information at a later date but due to time-constraints were unfortunately unable to honour this commitment.

Preparation forms and routes of administration of traditional herbal skin applications

The present study set out to collect and analyse data on the relevancy of medicinal plant usage in skin applications through traditional herbal medicine and traditional herbal products. As reported, the use of medicinal plants for the treatment of skin diseases were a common feature of this investigation. Their uses are widely cited for this skin application in traditional medicine and more prevalent than their use for strictly cosmetic purposes although these do tend to overlap. The majority of the traditional herbal products were prepared from multiple sources that were either of plant or non-plant origin as with the case of clay and this seemed to represent excipient properties. Herbaceous plants tended to be the most widely used in preparations and this is likely to be due to their ease of harvest and ease of preparation. Preparations almost always contained leaf parts and this trend coincides with the leaf tending to be the most abundant plant part that is encountered by practitioners followed by the bark (Egharevba & Ikhatua, 2008).

Preparations also tend to involve grinding and combining with other plant parts or products to enhance their effectiveness. This is the case with lemon juice, aloe vera, ginger and black pepper, which are all commonly cited in the preparations described within the presented survey. The latter three are reported as bioavailability enhancers (Kesarwani & Gupta, 2013). Pharmacologically speaking, these herbal "bioenhancers" contain compounds that are noted to enhance the activity of drug molecules through several mechanisms that serve to increase the bioavailability and of drugs across membranes without exerting their own pharmacological function and thus increasing the bioefficacy of the drug (Kesarwani & Gupta, 2013). Another common observation was the mixing of plants with either pre-formulated cosmetic soaps (4%) or creams (4%). This was reported as a means to boost the action of the cosmetic and/or used as an alternative to conventional medications. One use reported strictly in the cosmetic sense was as a facial mask. The preparations recorded with the highest frequency of use however included mixtures and ointments (both at 35%) which surpassed the use of raw applications (4%) coinciding with the reports by Essegbey *et al* (2014) that there has been an adoption of innovative manufacturing and processing techniques in the delivery of traditional herbal products to consumers of this industry within Ghana.

Informants versus non-informants

Informants provided the majority of the citations for the skin rashes category of disease whereas non-informants provided the majority of the citations for the measles skin category.

Limitations

Some difficulty was encountered with aspects of the data collection process and these included not being able to confirm plant species through local names of Ewe and Twi. Moreover, there was disagreement on the ethnobotanical studies regarding botanical identification of species. Due to this some of the informant data collected from the GHAFTRAM association was rendered unusable. Further to this, as there was a small population size no random data sampling took place and no voucher specimen collection was undertaken.

Observations on Plant Use and Phytochemistry of *Momordica charantia*

The use of THMs for skin conditions is widely reported. Borokini *et al* 2013 surmises that topical application is the main route of administration for the treatment of conditions and this supports traditional knowledge about exoparasites, namely fungi and their aetiopathology in skin infections. *M. charantia* extracts possess antioxidant effects and in particular flesh extracts of the fruit have a higher antioxidant activity and a higher phenolic and flavonoid content in comparison to fruit pulp extracts. Therefore, it is suggested that the free radical scavenging activities associated with *M. charantia* extracts is attributed to polyphenolic compounds present in the plant.

CONCLUSIONS AND FUTURE WORK

The collection of medicinal plants studied in this research indicated to have putative cosmeceutical use from Ghana and across other parts of Western Africa demonstrates a vast wealth of untapped traditional plant knowledge, which warrants further investigation by pharmacological screening to aid in the development of traditional herbal medicine. Thus, elucidating the link between the pharmacological activities behind the traditional uses of these plants and their extracts can serve to strengthen and support their wider use amongst communities. This study shows that the communities within the southern regions of Ghana have various topical uses for plants in terms of skin health. Thus it is imperative to promote the sustainable use of plants/plant products within these regions. Furthermore, the conservation of species is a critical area of focus and requires a concerted effort amongst all Ghanaian authorities and West African nations in order to fully protect the conservation of these plants and their local development within communities.

Traditional herbal medicine dominates the healthcare system of many West African countries and continues to be the mainstay of access to healthcare for the urban and rural poor. Currently, traditional herbal medicine is impeded by a lack of safety through limited knowledge on cytotoxicity and it is imperative that stronger alliances are formed between the traditional and conventional operators of healthcare within these regions. The impact of this research was to provide a means to elucidate the work into the cosmetopea and issues surrounding its development hence more investigations are needed in this field of study to fully establish it within the realm of ethnobotanical research.

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