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Review Article

Review on How Herbal Medicines/Preparations are being Contaminated Using Local Methods

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Abstract

This review documents currently known pathogenic microorganisms that are associated with herbal remedies as well as their health impacts on consumers and discusses the need for consistent regulatory practices as a form of quality assurance of herbal remedies. Phytomedical practices are used since ancient time but remain crude despite a growing number of users around the world. Importantly, there is a potential public health emergency as some herbal remedies contain microbial contaminants and heavy metals as a legacy of crude production techniques. Therefore, there is a need to put mechanisms in place to ensure that herbal remedies are safe for human use. Herbal remedies typically contain phytochemicals that exhibit antimicrobial activities, but issues linked to the toxicity of the crude extracts, method of extraction and purification, the dosage of administration, and microbial contaminants have negative implications on the practice, the general public, and users. Some microorganisms associated with herbal medicines have been known to cause serious harm, especially to children, the elderly, and immune-compromised people. Some microbes that have been isolated from herbal remedies include Escherichia, Salmonella, Pseudomonas, Streptococcus, Staphylococcus, *Klebsiella*, *Bacillus*, *Enterococcus*, *Proteus*, *Citrobacter, Moraxella, Serratia, Citrobacter, Enterobacter, Shigella Candida, Aspergillus, Cladosporium, Rhizopus, Mucor,* and *Alterneria*. Also, some harmful materials like heavy metals, dust, pesticidal residues, microbial contamination, and toxins have been isolated from adulterated herbal remedies. There is an urgent need to adopt more strategic quality control practices to reduce the density and diversity of microbes and other contaminants found in formulated and ready-to-use herbal medicines. Some important strategies would be knowledge sharing, formulating policies, and pharmacovigilance, which are capable of ensuring the quality, safety, and effectiveness of traditional and complementary medicine in the national health systems.

Keywords: *Contaminants; Herbal Remedies; Microorganisms; Microbial Contaminants; Public Health; Policy Frame Work; Quality Control; Safety; Toxicity*

Introduction

Herbal medicines, also called botanical medicines or phytomedicines, refer to herbs, herbal materials, herbal preparations, and finished herbal products that contain parts of plants or plant materials as active ingredients. The plant materials include seeds, berries, roots, leaves, bark or flowers (Abdel-Tawab, 2018) Herbal medication is a clinical framework in view of the utilization of plants or plant extract for treatment (Adhikari & Paul, 2018; Zhang *et al.*, 2012). The Customary Chinese medication, Japanese

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Kampo, Indian Ayurveda and Arabic Unani are a portion of the famous reciprocal and elective drugs (CAM) frameworks with worldwide acceptance (Zhang *et al*., 2012).

Traditional herbalists in Nigeria use various herbal preparations to treat various types of ailments, including diarrhea, cough, 'neonatal fistula', convulsions, skin dis-eases, etc.

1. Most of these preparations are used in the form of concoctions (soup or drink made usually from ingredients after boiling) or infusions (soaking the plant material and allowing it to stand for varying lengths of time).
2. Medicinal plant materials normally carry a large number of microbes originating from the soil. Microorganisms of various kinds are normally adhered to leaves, stem, flowers, seeds, and roots. Additional contaminants may also be introduced during harvesting, handling, and production of various herbal remedies since no conscious efforts are made to decontaminate the herbs other than by washing them.

History of Herbal Medicine

The history of herbal medicine presumably started with our most old progenitor tracker finders, who might have discovered that eating specific spices brought about a palliative impact (Inoue, Hayashi & Craker, 2019). Probably this started with a marshmallow plant which quiets stomach disturbs. The present natural medication is continually developing science and integrates data we have over the course of the hundreds of years from herbal medicine specialists all over the world (Hassan *et al*., 2021). The historical backdrop of natural medication started with earliest man who was first put down in the herbal record account which was 2800 BC which was the Pent'sao by Shennong (likewise known a heavenly rancher) (Hassan, 2019).

Moreover, in 40 B.C, Hippocrates put down the primary natural medication account in Greek in 100 B.C the principal delineated home grown record was created in Greece in 50 B.C; the Roman Domain started spreading data about natural cures all through the realm as well as the plant utilized for different cures (Issa & Basheti, 2017). In 200 A.D. Galen, a herbal specialist fostered a grouping framework for cures and disease. (Asiminicesei *et al*., 2020). In 800 A.D, Priests helped spread information about natural medication through their clinics at every cloister (Inoue, Hayashi & Craker, 2019) During the 1100s Avicema a doctor and Parisian researcher, composed the ordinance of medication in the 1800's. (Awodele *et al.,* 2014) The public relationship of restorative cultivator was established to help advance and shield the act of natural medication. In 1941, the pharmacies and medication act were passed, stripping home grown professionals of the option to administer restorative spices. In 1968, the medication act was passed and reestablishes specialist's more right than wrong to administer restorative spices. The English natural medication affiliation was

Herbal Medicine, Uses and Applications in Nigeria

Therapeutic plants in Nigeria are plants utilized for making home cures and customary prescriptions or what we as a whole know as natural medication. Any piece of the plant could be utilized (Idu, Erhabor & Idele, 2011). In certain plants, pretty much every part can be utilized in some home cure. While specifically establishes just a few sections are utilized. Natural medication in Nigeria is earning more respect, and this is found in how much requests individuals make concerning home cures and conventional medication (Awodele *et al*., 2012). Some of the commonly plant utilized for herbal mixture are discussed below

Moringa Plant (Moringa oleifera)

Moringa tree is also known as the ‘miracle tree’ and there is a good reason why. The leaves, fruit, sap, oil, roots, bark, seeds, pod and flowers of the tree have medicinal properties. The products from the tree have many uses. It is also known as the ‘drumstick tree’. It is found mostly in Asia, Africa, and South America.

Moringa leaves are rich in vitamins A, C, B1 (thiamin), B2 (riboflavin), B3 (niacin), B6 and Folate. They are also rich in magnesium, iron, calcium, phosphorus, and zinc.

Moringa leaves are rich in amino acids, the building blocks of proteins. 18 types of amino acids are found in them and each of them makes an important contribution to our wellbeing.

Bitter Leaf (Vernonia Amygdalina)

Bitter leaf is a plant that is found in Africa and many part of the world. It is known as Ewuro in Yoruba, Onugbu in Igbo, and Shuwaka in Hausa. As the name implies the leaves of this plants are bitter, and to that end a many individuals can't endure it. Bitter leaf has a ton of detoxification properties that make is strong in assisting the body with battling against numerous infection and diseases (Awodele *et al*., 2012). It additionally has antipyretic properties. Be that as it may, if you think it wise to take it new, these are a portion of the restorative purposes of the unpleasant leaf. Utilizes one of the notable purposes of the unpleasant leaf is that it is a solution for stomach ache. Additionally, you can hammer the leaves and press out the juice from the leaves. Leaf is utilized for treating malaria, typhoid fever, and diarrhea. It is likewise good for the blood and lymphatic framework (Youkparigha & Izah, 2019). It has solid restorative properties that assistance to get the blood and lymphatic framework free from impurities. This is accomplished by drinking the juice pressed from new severe leaf sometimes. It is additionally useful in individuals with hypertension in keeping their blood pressure low. It is useful in the administration of diabetes. It tends to be powerful in bringing down blood glucose level. It is utilized as traditional medication for the cure of numerous infection and disease for example sexual transmitted infection, pneumonia, skin exanthemas like eczema, ringworm, and so on. One more well-known restorative utilization of unpleasant leaf that you can find anyplace is that it is extremely useful for individuals with prostate disease (Amadi & Orisakwe, 2018). It assists with easing side effects related with this disease such as difficult and painful urination known as dysuria. By taking a glass cup of juice from bitter leaf crushed in water four times in a day. It assists in increasing the flow of urine reduce pain and slow down the spread of the neoplastic cells. It is likewise a demonstrated solution for treating a sleeping disorder. A few investigations show bitter leaf likewise assists with supporting possibilities getting pregnant, i.e. it enhances fertility pregnant, i.e., it enhances fertility (Areo *et al.,* 2020).

Aloe Vera (Aloe Barbadensis Miller)

Aloe Vera is a common medicinal plant which can be grown in the backyard. It is more famous for its cosmetic uses, especially for hair and scalp moisturization and treatment (Izah & Aigberua, 2017). It is an important ingredient a lot of natural hair and healthy skin items. It is used topically on the skin to soothe skin irritations and rashes. It is used in the treatment of skin conditions such dermatitis and psoriasis (Izah, Aseibai & Orutugu, 2015). It is also used to treat oral mucositis, mouth ulcers, and canker sores. This is by application of the gel or a patch of the Aloe Vera leaf on the area of the sore or ulcer. It is also used to make mouth rinse to reduce dental plaque. Aloe Vera gel is used as a home remedy for accelerating the healing of burn injuries. Aloe Vera is commonly used to treat constipation. But in this case, it the latex found just under the skin of the Aloe Vera plant that is used to make the traditional medicine (Pharmacopoeia, 2019). The latex has a very strong laxative effect. Aloe Vera is also used sometimes as traditional medicine in diabetes management. Some studies show that it may be useful in the management of blood sugar level (Pharmacopoeia, 2019).

Basil or Scent Leaf (Ocimum Gratissimum)

The African basil also is known as scent leaf and is a popular medicinal plant in Nigeria. It is called Efirin in Yoruba, Daddoya in Hausa, and Nchanwu in Igbo. This plant is typically traditional medicine and easy to come by. So it is a famous therapeutic plant for making home remedies. These are some of its uses. Uses one of its most common use is as a home remedy for diarrhea, dysentery, stomach ache, and vomiting (Tulunay *et el*., 2015). It is also used to make a home remedy for relieving colon pains and earache. Scent leaf likewise utilized for preventing and treating cold and catarrh, cough, fever, and malaria (Wal *et el*., 2011). Another use of scent leaf is for aiding digestion and relief bloating. Squeezed scent leaf can also be applied to the skin to treat ringworm and some other skin diseases (WHO, 2004). Scent leaf is also used to make traditional medicine for treatment of oral infections. Also, for treating fungal infections. Some people also chew the stick of scent leaf for cleaning of the mouth

and teeth (local chewing stick.) Scent leaf or African Basil is also used for cooking because of its aromatic taste (WHO, 2013).

Girdle Pod (Mitracarpus Scaber)

This plant is known as Irawo Ile among the Yoruba's in Southwestern Nigeria. It is called Gudugal in Hausa and Obuobwa or Ogwungwo in Igbo. Uses include: The treatment of skin infections such as scabies, dermatoses, and ringworm (Izah & Aigberua, 2020). The home remedy for the treatment of body aches, headaches, toothaches, and arthritic pains. Likewise utilized in making traditional medicine for treating amenorrhea, hepatitis, and some sexually transmitted infections. This plant is a famous medicinal plant in the tropics is called Ogalu in Igbo and Asunrun Oyinbo in Yoruba. This plant has antibacterial, antifungal, anti-inflammatory, anti-tumor, analgesic, diuretics, and laxative properties (Izah *et al*., 2022). Uses it is widely known for its antifungal properties which makes it efficient for treating a couple of fungal infections of the skin, ringworm and scabies included. It is also used to treat parasitic skin infections and eczema. The plant has laxative properties. It is also used in making traditional medicine for treating constipation, diarrhea, intestinal parasites, uterus problems, and also expulsion of filarial worms. The decoction made from the leaves can be used to treat biliousness and hypertension (Izah, Kigigha & Anene, 2016).

Common Disease in Nigeria treated with Herbal Mixture

- ***Malaria Treatment*****:** Malaria is an endemic prevalent disease in Nigeria, and herbal medicines are often used for its prevention and treatment. Plants such as Artemisia annua (Sweet Wormwood) and *Azadirachta Indica* (Neem) have been traditionally used for their anti-malarial properties (Kigigha, Apreala & Izah, 2016).
- ***Digestive Disorders*****:** Many Nigerians turn to herbal medicine for the management of digestive disorders, such as indigestion, diarrhea, and stomach ulcers. Plants like *Zingiber officinale* (Ginger), *Ocimum gratissimum* (Scent leaf), and Aloe vera are commonly used for their digestive benefits (Izah & Ohimain, 2016).
- ***Immune Boosting*****:** Herbal remedies are often used to strengthen the immune system and promote overall health. Plants like *Echinacea purpurea*, *Allium sativum* (Garlic), and *Morinda lucida* (Brimstone tree) are believed to have immune-boosting properties and are used in traditional Nigerian medicine (Seiyaboh, Odubo & Izah, 2020).
- ***Pain Relief:*** Herbal medicine is frequently used for pain management, including headaches, body aches, and arthritis. Plants such as *Curcuma longa* (Turmeric), *Cymbopogon citratus* (Lemongrass), and *Capsicum annuum* (Chili pepper) are known for their analgesic properties (Kigigha, Igoya & Izah, 2016).
- ***Women's Health:*** Herbal medicine has a long history of use in women's health, including menstrual disorders, fertility issues, and postpartum care. Plants like *Vitex agnus-castus* (Chasteberry), *Asparagus racemosus* (Shatavari), and *Trigonella foenum-graecum* (Fenugreek) are commonly used for women's health conditions in Nigeria (Izah & Odubo, 2023).
- ***Respiratory Conditions*****:** Herbal remedies are frequently used to alleviate symptoms of respiratory conditions, including coughs, colds, and asthma. Plants such as *Adhatoda vasica* (Malabar nut), *Justicia adhatoda* (Adhatoda), and *Ocimum sanctum* (Holy basil) are traditionally used for their respiratory benefits (Shaban, Abdou & Hassan, 2016).

WHO Approval of Herbal Medicine

The world health organization (WHO) noticed that inappropriate utilization of conventional prescriptions or practice can have negative of hazardous impacts and prompted that further research is expected to find out the viability and security of a few medicinal plants and practice utilized in traditional medication framework. To meet the developing necessities and moves which have emerged because of inescapable utilization of conventional medication, world organization has developed some strategies to tackle them, these strategies are:

1. Increasing availability and affordability of traditional medicine.
2. Incorporating pertinent traditional medicine with national health care system by developing and implementing national medicine policies and programs.
3. Promoting the safety, efficacy in the event that customary medication treatment as giving guidance, regulating and quality assurance standard.
4. Advancing sound of traditional medicine by suppliers and buyers.
5. Documentation of traditional medicine and remedies Sources of microbial contamination of herbal medicine

Microbial contamination of herbal medicine can occur at different phases during production, processing, packaging, and storage of the products. Common sources of microbial contamination include.

- ***Raw Materials***: The herbs or plant materials utilized in herbal medicine can be a source of microbial contamination. If the raw materials are contaminated with bacteria, fungi, or other microorganisms, they can introduce these contaminants into the final product (Arroyo-Manzanares, García-Campaña & Gámiz-Gracia, 2013).
- ***Soil and Water*****:** Herbs are often grown in natural environments, and the soil and water used for irrigation can contain microorganisms. Contaminated soil or water can lead to the presence of pathogens or spoilage microorganisms in herbal medicine (Enaregha, Izah & Okiriya*,* 2021).
- ***Processing Facilities*****:** The processing facilities where herbal medicine is manufactured can harbor microorganisms if proper hygiene and sanitation practices are not followed. Contaminated equipment, utensils, or surfaces can introduce microbes into the products (Enaregha, Izah & Okiriya*,* 2021).
- ***Cross-Contamination:*** Cross-contamination can occur when there is improper handling of herbal medicine during processing or packaging. For example, if equipment or utensils are not properly cleaned between batches or if there is contact between contaminated and non-contaminated products, microbial transfer can occur (Enaregha, Izah & Okiriya*,* 2021).
- ***Airborne Contaminants*****:** Microorganisms present in the air can settle on herbal medicine during processing or packaging, leading to contamination. This can cause problematic if the processing facility is not equipped with adequate air filtration systems (Seiyaboh, Odubo & Izah, 2020).
- ***Improper Storage:*** If herbal medicine is not stored properly, it can become susceptible to microbial contamination. Factors such as high humidity temperature fluctuations, or exposure to light can create conditions that promote microbial growth (Izah, Aseibai & Orutugu, 2015).
- ***Packaging Materials:*** In some cases, the packaging materials utilized for herbal medicine may be a source of contamination. If the packaging is not sterile or if it becomes contaminated during handling or storage, it can introduce microorganisms into the product (Izah, Orutugu & Kigigha, 2015).

To prevent microbial contamination in herbal medicine, good manufacturing practices (GMP) should be followed, including strict quality control measures, proper sanitation and hygiene protocols, regular testing for microbial contaminants, and appropriate storage condition (Seiyaboh, Seiyaboh & Izah, 2020).

Types of bacteria and fungi commonly found in herbal medicine

Organism	Source
Bacillus spp	These spore-forming bacteria are commonly found in soil and can contaminate herbal products during cultivation or processing.
Escherichia coli	This bacterium is a common indicator of fecal contamination and can be present if hygiene practices during cultivation or processing are inadequate
Salmonella spp	Another group of bacteria associated with fecal contamination, salmonella can pose a significant health risk if present in herbal products.
Staphylococcus aureus	This bacterium can be found on the skin and in the nasal passages of humans and animals and can contaminate herbal products if proper hygiene practices are not followed
Pseudomonas spp	These bacteria are widely distributed in nature and can be found in soil, water, and plants. They can contaminate herbal medicine during processing or storage.

Aspergillus spp	This group of fungi is commonly found in the environment, including soil and decaying vegetation. Some species can produce mycotoxins that can be harmful if consumed.
Penicillium spp	These fungi are commonly found in soil, decaying organic matter, and indoor environments. Some species can produce mycotoxins and may contaminate herbal medicine.
Alternaria spp	This genus of fungi is widespread and can be found on various plants and in soil. Some species can produce mycotoxins and may contaminate herbal products.
Fusarium spp	These fungi are often found in soil and on plants. Some species produce mycotoxins that can pose health risks if consumed.

Factors contributing to microbial growth in herbal mixtures.

- ***Moisture:*** microorganism require moisture to grow and multiply. If herbal medicine is stored in a humid environment or comes into contact with water, it can create a favorable environment for bacterial and fungal growth. Moisture can also be introduced through improper drying or inadequate storage conditions (WHO, 2015).
- ***Contamination during harvesting and processing*****:** Herbal medicines can become contaminated with during harvesting, processing, or packaging. If proper hygiene practices are not followed, bacteria and fungi from the environment, soil, or handling equipment can contaminate the herbal material (Izah, Kigigha & Anene, 2016).
- ***Storage conditions*****:** The storage conditions of herbal medicine play a crucial role in preventing microbial growth. If herbal products are stored in warm and humid conditions, such as a bathroom or a poorly ventilated area, it can promote bacterial and fungal growth. Additionally, exposure to sunlight can also impact the stability of herbal medicine and create conditions suitable for microbial growth (Izah, *et al*. 2016).
- ***Presence of organic matter:*** Herbal medicines may contain organic matter such as plant residues, seeds, or parts of insects, which can provide a nutrient source for bacteria. These organic materials can support bacterial growth if not properly removed during processing or quality control (Izah & Odubo, 2023).
- ***Packaging and container hygiene*****:** If herbal medicines are stored in unclean containers or packaging materials, it can introduce microorganism into the product. Contaminated containers or packaging can be a potential source of bacterial growth and should be avoided (Izah & Odubo, 2023).
- ***Cross-contamination*****:** If herbal medicine comes into contact with contaminated surfaces, equipment, or utensils during preparation, dispensing, or storage, it can lead to microbial contamination and subsequent growth. Proper cleaning and sanitation practices should be followed to prevent cross contamination (Izah & Ohimain, 2013).
- ***Inadequate Preservatives or Antimicrobial Agents***: Some herbal medicines may contain preservatives or antimicrobial agents to inhibit microbial growth. If the concentrations of these agents are insufficient or if they degrade over time, it can allow bacterial and fungal growth to occur (Izah & Ohimain, 2013).

Mycotoxin and their Implications

Regarding mycotoxins, herbal medicine can be contaminated by many toxigenic fungi during harvesting, handling, storage, and distribution. The risk of contamination by mycotoxigenic fungi and subsequently hence with mycotoxins, increase with poor agricultural and harvesting practices or inadequate conditions of storage, distribution, or transportation (Ashiq, Hussain & Ahmad, 2014). Low qualities of unrefined substance can likewise affect the final product. Mycotoxins are consequence of fungal growth; thus, its presence indicates sterile deficiency during production and storage (Ałtyn & Twaru˙zek, 2020). In general, medicinal herbs are produced through the customary open, small workshop, and scattered planting business models. The lack of a uniform standard or efficient monitoring method may damage them during processing, storage, and transportation steps. The

intrinsic factors join to external environmental conditions lead to serious spoilage and decay along with mycotoxigenic fungi contamination (Chen *et al*. 2020).

Recommendation

Herbal medicine practitioners should be educated to produce a good quality and sterile herbal product, by reducing and eliminating all sources of contamination that can lead to serious health risk to the consumers.

- The regulatory agency, NAFDAC, should carry out more detailed and monitoring regular analysis on these herbal preparations to prevent the uninformed consumers from buying what may worsen their ailment.
- Validation of equipment cleaning procedures should be practiced in herbal products industries to prevent cross contamination of drug products
- At every stage of processing, production, packaging, storage, handling

Conclusion

Herbal medicine sold in the market can habour several Microorganisms which find their way in during processing, handling and transport. Absent of Microorganism indicates the monitoring and Aseptic technique in all step of preparation to the final consumer. It may be necessary to evaluate the safety, efficacy and quality of herbal medicines and their products through randomized clinical trial studies. Public enlightenment programme about safe use of herbal medicines may be necessary as a means of minimizing the potential adverse effects.

Conflict of Interest

The authors declare that they have no competing interests.

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