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Invited Review

Toxicology of some important medicinal plants in southern Africa

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ABSTRACT

Africa is home to two major floral kingdoms: the Paleotropical kingdom of central Africa and the Capensis kingdom of the Western Cape province of South Africa, the latter of which consists of approximately 10,000 species, representing about 20% of Africa's floral 'gold mine', better known as the Cape herbal medicine. Needless to say, such rich flora comes with numerous plants with a potential to cause poisoning to humans. This review document reports important toxic medicinal plants and their toxic ingredients for plant species resident in the southern African region. These include important medicinal uses and pharmacological properties ranging from antimicrobial, antiviral, anticancer, anti-inflammatory as well as those that are used as aphrodisiacs and for maternal health care.

Contents

1. Introduction

Southern Africa has a rich flora that includes several biodiversity hotspots (Botha and Penrith, 2008). Most of the populations in rural and urban southern African communities rely on the rich flora as herbal medicines for their health care needs and food security (Fennell et al., 2004). Needless to say, such a rich flora comes with numerous plants with the potential to cause poisoning to humans. This is because all plants produce a plethora of compounds as defense against invasion by microorganisms and viruses as well as herbivores (Wink and Van Wyk, 2008). The complex substances include several groups of compounds, some of which are deadly to humans even when consumed in smaller quantities. There are approximately 750 known poisonous substances occurring out of a pool of 150,000 plant secondary metabolites that exists in about 1000 plant species (Wink and Van Wyk, 2008).

Poisonous plants can cause superficial irritation or discomfort through contact with the skin or serious poisoning when ingested

Abbreviations: CNS, central nervous system; DNA, deoxyribonucleic acid; GAP, Good Agricultural Practice; GABA, gamma-aminobutyric acid; GI, gastrointestinal; HIV, human immune deficiency virus; HIV 1 RDDP, HIV-1 RNA-dependent DNA polymerase; ISO/TC249, International Organization for Standardization of Traditional Medicine; LD, lethal dose; RNA, ribonucleic acid; SABS, South African Bureau of Standards; WHO, World Health Organization.

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(Van Wyk et al., 2002). Toxic substances from plants can affect the entire spectrum of vital human organs while some may affect key functional body systems like the central nervous system (CNS) thereby interfering with the coordination of nerve functions of the body. The most dominant toxins are neurotoxins that affect the brain and CNS, followed by cytotoxins and metabolic toxins that affect organs such as kidneys, the liver, heart and lungs. The severity of a toxic effect may depend on the route of administration, growth stage or part of the plant, the amount consumed, the species and susceptibility of the victim (Botha and Penrith, 2008). Other factors that may influence the severity of toxins include the solubility of the toxin in body fluids, frequency of intoxication as well as the age of the victim.

The toxicity of plants has been known for a long time, and humans learnt how to cope with them for their benefit. Humans developed skills to use poisonous plants for hunting, war, rituals, murder, executions, suicide, abortions and euthanasia. Toxic plants that act on the CNS, inducing paralysis when injected were used by hunters as arrow poisons for hunting and warfare. Examples are *Taxus* alkaloids, atropine and toxiferine together with various cardiac glycosides. In southern Africa, the San hunters used fast-acting cardiac glycosides from genera such as *Acokanthera*, *Boophone*, *Strophanthus* and *Adenium* (Wink and Van Wyk, 2008). Most substances that act as poisonous defense chemicals tend to have medicinal properties at lower concentrations. Some of the groups of such compounds include alkaloids, cardiac glycosides, phorbol esters, lectins and cyanogenic glycosides which are classified as extremely toxic. In early civilizations, plants rich in alkaloids and other toxins such as *Conium maculatum* were used for murder, abortions, executions and suicide. These included the infamous coniine, aconitine, atropine, strychnine, colchicine and several cardiac glycosides. Extracts from *Bryonia dioica*, *Helleborus viridis* and *Petroselium crispum* are rich in cytotoxic alkaloids, sesqui- and triterpenes (cucurbitacins) used as abortifacides (Van Wyk et al., 2002).

Unfortunately, very few of the African toxic plants from these early times have been recorded. In southern Africa, the scales of the poisonous *Boophane* bulbs were used to preserve the bodies of the Khoisan. *Boophane* bulbs were also associated with the traditional trance dance which forms part of ancient healing and divination traditions (Wink and Van Wyk, 2008). This review documents some important toxic medicinal plants that are either introduced or indigenous to southern Africa and used for different therapeutic purposes.

2. Important toxic plants of southern Africa with ethnopharmacological uses

2.1. Toxic plants used against bacterial and fungal infections

Poisoning in humans from plants usually arises either from the misidentification and unintentional use of toxic plants for medicinal purposes (Van Wyk et al., 2002). This type of poisoning is higher in societies where plant-based traditional medicines are common practices (Botha and Penrith, 2008). A study by Joubert and Mathibe (1989) revealed that traditional medicine poisoning is the second most common cause of acute poisoning representing 12.1% in South Africa. Previously, Joubert and Sebata (1982) had reported 277 cases of acute poisoning cases of patients admitted to Ga-Rankuwa hospital (Gauteng Province, South Africa) between 1981 and 1982, of which 18% were due to ingestion of toxic traditional medicines, 26% of these resulted in death. Six years later, Venter and Joubert (1988) reported an increase in these incidents amounting to 1306 cases at the same hospital, this time with 15.8% cases of poisoning from traditional medicines of which 15.3% resulted in death (Popat et al., 2001).

Table 1 represents toxic plants that are used ethnobotanically for the treatment of bacterial and fungal infections in humans. Most of the active principles in the plants are highly poisonous e.g. cardiac glycosides. Plants containing cardiac glycosides have been used traditionally since ancient times as arrow poisons and as heart tonic agents (Botha and Penrith, 2008). To date cardiac glycosides such as digoxin from the genus *Digitalis* are still prescribed by western doctors for the treatment of congestive heart failure (Botha and Penrith, 2008).

Most of the poisonous plants highlighted in Table 1 induce diarrhoea when consumed, however, the mode of action for most toxins differ considerately. Active principles that are mostly reported to affect the gastrointestinal tracts are the lectins. Lectins cause necrosis of the cell linings of the gastrointestinal tracts (Gonzalo, 2011). Examples of medicinal plants reported to contain lectins affecting humans are *Abrus precatorus* and *Jatropha curcas*. However, these plants continue to be used in traditional medicine as treatment for bacterial and fungal infections. It is, however, speculated that the antibacterial and antifungal activity of these species could not be from the lectins. Yadava and Reddy (2002) reported flavonol glycoside 7,3',5'-trimethoxy-4'-hydroxy flavone-3-*O*-β-D-galactosyl-(1→4)-α-L-xyloside to be the biologically active compound from *A. precatorius*. It is also interesting to note that some of the plant species such as *Catharanthus roseus* are reported to be used as antibacterial medicines yet they contain cardiac glycosides. It is thus important to regulate the dosages to be administered to a patient in order to prevent lethal side effects. In some cases, plants used for treating wounds also contain skin irritants. Skin irritation by some compounds can cause mechanical damage resulting in skin problems and sometimes allergic dermatitis, pruritic in sensitive individuals as well as blindness (Botha and Penrith, 2008). Such plants include *C. roseus* and *Solanum incanum* (Table 1).

The plants presented in Table 1 are regarded as 'important medicinal plants of southern Africa' and are highly utilised by at least 80% of the southern African population on a yearly basis. One of these highly utilised plants is *Callilepis laureola* which is a highly reported toxic plant commonly used by the Zulu people to treat stomach problems, tape worm infections, impotence, cough and to induce fertility. The plant is administered to pregnant women to ensure the health of the mother and child as well as to facilitate birth labour (Popat et al., 2001). The value of this plant among people is great (Steenkamp et al., 1999; Bye and Dutton, 1991) yet approximately 1500 deaths per annum have been reported to be caused by *C. laureola* in KwaZulu-Natal province of South Africa alone (Obatomi and Bach, 1998). Despite its highly reported toxicity, *C. loureola* continues to be used due to its traditional value among South African populations.

2.2. Important toxic plants used for viral treatments in southern Africa

Unlike bacterial and fungal cells, which exist as living entities, viruses are parasitic entities containing little more than wads of genetic material in either ribonucleic acid (RNA) or deoxyribonucleic acid (DNA) form. Viral infections thus present a challenge to both human and animal health due to the difficulty associated with their treatment. With the ever increasing incidents in human immune deficiency virus (HIV) infection rates and other associated viral infections in the world, most societies in Africa continue to seek treatment options from the indigenous flora. As a result, several medicinal plants have been found to be useful as drug agents targeted on the different stages of the viral life cycle. To date, varying degrees of efficacies have been recorded in each case. Time and