

INDIGENOUS KNOWLEDGE SYSTEMS AND WESTERN SCIENCE: THE CONUNDRUM OF VALIDATION

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ABSTRACT

This article focuses on the conundrum regarding the need for validation of indigenous knowledge. Researchers hold diverse opinions, with some researchers stating that indigenous knowledge should not be measured or validated using Western scientific knowledge or criteria as the gold standard. Such a practice would further strengthen the perceived superiority of Western science and might be disempowering and disrespectful in terms of local communities (holders of indigenous knowledge). On the other hand, some researchers show that there are good examples of mutualistic relationships between indigenous knowledge holders and Western scientists working together on projects. Often, the indigenous knowledge holders perceive the validation of their indigenous knowledge by Western scientists in such projects as empowering, and that it creates respect for the rigour of indigenous knowledge in the broader society. A specific focus of this article is the possible contribution of the Rationality Index of Plant Use (RIPU) heuristic, which could provide Western sceptics with knowledge and appreciation of the merit often associated with the metaphysical aspects of indigenous knowledge, as a holistic knowledge system.

Keywords: Validation, indigenous knowledge, ethnobotany, Rationality Index of Plant Use.

INTRODUCTION: SHOULD INDIGENOUS KNOWLEDGE BE VALIDATED?

There are two schools of thought regarding the relationship between indigenous knowledge and so-called 'Western science'. Sadly, authors such as Widdowson and Howard (2008: 242) described indigenous knowledge as "junk science". It is this scepticism that probably leads to the urge among Western scientists to utilise the heuristics of Western science to validate indigenous knowledge claims. These authors are of the opinion that "ideas derived from indigenous expression, require scientific testing before they are accepted as knowledge" (Matsui, 2015: 11). Gratani *et al.* (2011: 2) eloquently painted an alternative point of view: "That the validity of one knowledge system must be confirmed by another raises issues over the equity of such an approach. The risk is that the superiority currently held by scientific knowledge is perpetuated if validation of indigenous ecological knowledge (IEK) is achieved by either adopting scientific knowledge as the standard against which IEK must be measured, or by accepting only scientific evidence to support IEK". Advocates of the latter view refer to the fact that such validation might be disempowering and disrespectful for local communities (Gratani *et al.*, 2011). Clearly, this is an important issue that should be debated.

The authors of this article conducted extensive ethnobotanical research among Khoisan descendants in the Northern Cape Province of South Africa, the original home of the San people. In this article we shed light on the conundrum of validation and argued that validation could serve to create appreciation and respect for indigenous knowledge among Western scientists, and boost the morale of indigenous knowledge holders, who could then feel that Western science acknowledges their contributions and insights. However, the authors are of the firm opinion that we cannot just depend on the empirical aspects of indigenous knowledge when assessing knowledge claims but must embrace the specific worldviews underpinning the indigenous knowledge systems.

RESEARCH METHODOLOGY

The ethnobotanical surveys were conducted in five towns in southern Bushmanland, namely Swartkop, Van Wyksvlei, Carnarvon, Williston and Brandvlei (Figure 1), in the Northern Cape Province of South Africa. Esler *et al.* (2006) described this area as Bushmanland. The authors utilised the matrix method (De Beer and Van Wyk, 2011) to record the ethnobotanical knowledge of the participants.

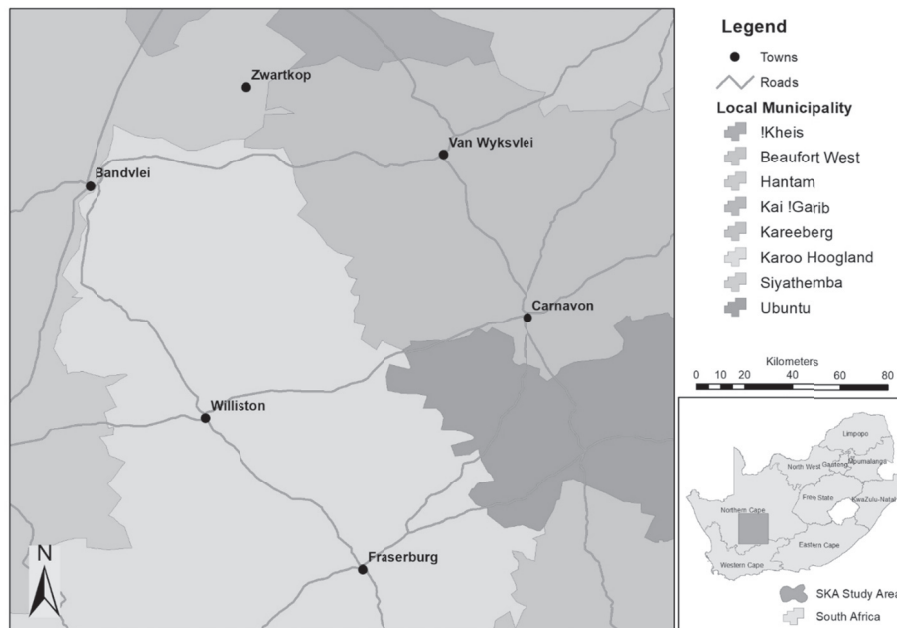


Figure 1: A map of the study area, in relation to the rest of South Africa.

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The focus of this article is on the conundrum whether or not indigenous knowledge should be validated. We provide a few interesting examples from our data.

WHEN INDIGENOUS KNOWLEDGE HOLDERS AND WESTERN SCIENTISTS WORK HAND-IN-HAND: AN AUSTRALIAN EXAMPLE

An interesting case of the integration of Western science and indigenous knowledge is described by Gratani *et al.* (2011). Holders of indigenous knowledge (Aboriginal IK holders in the Wet Tropics of Queensland, Australia) teamed up with scientists to test traditional fishing poisons for the control of the invader fish, tilapia. The research indicated that the fishing poisons were effective at immobilising the fish. Surprisingly, the indigenous knowledge holders reported that they did not find the validation process disrespectful, but “instead empowering and necessary for their indigenous knowledge to be understood and appreciated by scientists” (Gratani *et al.*, 2011: 1).

SOUTH AFRICAN EXAMPLES OF INDIGENOUS KNOWLEDGE HOLDERS AND WESTERN SCIENTISTS WORKING TOGETHER

In the South African context, it should be realised that the research in assessing African plants is essential to determining the safety of these extracts. Poisoning due to traditional medicines is not uncommon in South Africa and mortalities vary from 8,000 to 20,000 per annum (Fennell *et al.*, 2004). A study by Ramchundar and Nlooto (2017) showed that 79.5% of traditional healers in KwaZulu-Natal who were involved in the study expressed a strong willingness to cooperate with ‘Western’ researchers in analysing the medicinal plants that they use. The authors of this article also have a long-standing relationship with indigenous knowledge holders in the Northern Cape Province, and indigenous knowledge holders often express their appreciation and pride at being involved in such participatory research. In all research outputs the indigenous knowledge holders are acknowledged, and these publications give some permanency to the rich indigenous knowledge and ensure that this knowledge is preserved for future generations.

There was a strong focus on the use of plants for ‘magic’ in this study, therefore since many researchers (Widdowson and Howard, 2008) debunk indigenous knowledge because of such metaphysical aspects, this research study focused on the rationality of such plant use. Due to the inclusion of incantation and magic, traditional medicine worldwide, including in this case Khoisan medicinal practices, is often perceived as irrational and not grounded in scientific epistemologies or methods (Sobiecki, 2014). In fact, Sobiecki states that the Western world often fails to interpret or appreciate African traditional medicine as *materia medica* in terms of its holistic nature. The same is also true of the San, who have the oldest indigenous knowledge system in the world. The metaphysical (magic) component of healing is inherent in these knowledge systems.

The authors of this article therefore developed the RPU instrument with the rationale that it could be a heuristic to enhance acknowledgement and appreciation of indigenous knowledge among scientists. The point of departure was that there are often scientifically plausible reasons for what seems at first to be ‘magic’ or irrationality.

WHAT WOULD CONSTITUTE THE RATIONAL USE OF TRADITIONAL MEDICINE?

A large number of phytopharmacological studies have been conducted on South African plants (Sobiecki, 2014) in order to screen and isolate phytochemicals. Van Wyk *et al.* (1997) found that natural products and their derivatives are present in more than 50% of all clinical drugs in the world. A few such phytomedicines are quinine (*Cinchona* spp.), atropine (*Atropa belladonna*) and opium (*Papaver somniferum*) (Van Wyk *et al.*, 1997). The same research validation has not been undertaken for plants used for spiritual healing (Sobiecki, 2014). This is not surprising as it is more difficult to test the psychological effects from the administration of psychoactive plants in humans. Sobiecki (2014) also argues that a reason for this lack of validation of 'magic' plants is the culturally ingrained prejudice against traditional medicine.

The RIPU is limited to plant uses that have a biological and pharmacological basis. Symbolic and ritual uses (e.g. *Myrothamnus flabellifolius*, which can be described as having a spiritual use) are excluded. However, these uses often make rational sense but there is no chemical basis on which to assess the use of the plant. The use of *Myrothamnus flabellifolius* ('*uvukwabafile*' or 'opstandingsplant') is an interesting example of African psychology (Van Wyk, 2015). This plant has an interesting characteristic: its leaves become brown and curl up in the dry winter months, giving it an almost dead appearance. If placed in water, it miraculously turns green within a few hours. According to the well-known Zulu sanusi and healer, the late Tr. Dr. Credo Mutwa (pers. com. to B-E Van Wyk), this plant is used to treat people suffering from the trauma of the death of a beloved or depression. The traditional healer/African psychologist would give a twig of this plant to the patient, with the instruction to put it in a glass filled with water on a windowsill. Within a few hours, the patient experiences the 'miracle' of the plant 'becoming alive'. This serves to show the patient that there is always hope, and that there is life after death. This serves to illustrate the holistic nature of African medicine, as a form of indigenous knowledge system (De Beer and Mentz, 2019). Given the context of the plant use, it thus makes rational sense. Such cases, however, cannot be investigated with the RIPU heuristic.

MOTIVATION FOR THE RIPU

Ellis *et al.* (2010: 3) listed a number of criteria for rational beliefs:

Rational beliefs refer to beliefs that are logical, and/or have empirical support, and/or are pragmatic... a belief does not have to fit all three criteria to be rational. (researchers' emphasis)

The use of *Myrothamnus flabellifolius*, discussed above, should be seen as pragmatic. Ellis *et al.* (2010: 5) explain that most complex human responses (e.g. feelings) are cognitively penetrable... a change in cognition will induce a change in the expressed response.

Thus, the use of *Myrothamnus flabellifolius* should be seen as a pragmatic treatment for depression: the embodied cognition of witnessing that the plant's leaves become green overnight (after a twig has been put in water) could result in an improved emotional state.

Our hypothesis is that there are often very good explanations for what seems to be 'magic' in indigenous knowledge systems. Where plants are used to expel 'evil spirits', as in the case of *Adenia gummifera* ('*impinda*'), these plants often have anti-microbial qualities and disease-causing bacteria or fungi can be killed by using such plants. Others have powerful symbolic uses employed in psychological treatments that form part of a holistic approach that is typical of African traditional medicine, as in the use of *Myrothamnus flabellifolius* to treat depression.

THE QUESTIONNAIRE AND RATIONALITY INDEX OF PLANT USE (RIPU)

The authors wanted to develop an index that is easy to use (such as the ethnobotanical knowledge index (EKI) and species popularity index (SPI) (De Beer and Van Wyk, 2011). Five questions with a number of possible answers comprise the instrument.

1. Number of original anecdotes recorded on the plant and its use(s)
 - 1.1 How many original anecdotes have been published?
 - None = 0
 - One or two only = 1
 - Three to ten = 2
 - Eleven to twenty = 3
 - More than twenty = 4
 - 1.2 Were these anecdotes published in accredited, peer-reviewed publications?
 - No, it was published in grey/low-impact journals = 1
 - Yes, it was published in respected peer-reviewed publications = 2
 - 1.3 How many unpublished anecdotes have been recorded?
 - One to ten = 1
 - Eleven to twenty = 2
 - More than twenty = 3
2. Is there a workable (plausible) hypothesis for the plant's use(s)?
 - No = 0
 - It is possible to speculate on the merit of the plant use = 1
 - The hypothesis is unpublished (or published in grey literature) = 2
 - The hypothesis is published in low-impact journals = 3
 - The hypothesis is published in high-quality journals, but there are still unanswered questions = 4
 - Confirmed hypothesis, published in high-quality journals = 5

3. Chemical evidence
 - The chemistry is unknown = 0
 - Little is known about its chemistry = 1
 - The chemistry is known, but irrelevant to its use = 1
 - The chemistry is known, and is related to its use = 3
 - The chemistry is very well recorded, and clearly linked to its specific use; there is no doubt about its effectiveness = 5
4. *In vitro* evidence for the plant use (pre-clinical tests)
 - No *in vitro* tests have been conducted = 0
 - Little or doubtful *in vitro* testing was conducted = 1
 - Some *in vitro* testing supports the specific plant use = 2
 - Extensive *in vitro* testing has been conducted, with varied results, or results indicating limited effectiveness = 3
 - There is good evidence of rigorous *in vitro* testing that supports the plant use = 5
5. *In vivo* evidence for the plant use
 - No *in vivo* testing has been conducted = 0
 - Some evidence of *in vivo* testing in animals = 1
 - Good evidence of *in vivo* testing in animals = 2
 - Some evidence of *in vivo* testing in humans = 3
 - Sufficient evidence of *in vivo* testing in humans, with either mixed results, or indicating limited effectiveness = 4
 - Very good evidence of *in vivo* testing in humans, indicating the efficacy of the plant use = 6.

A specific plant use could have a maximum score of 30, which would result in a Rationality Index of Plant Use of 1.0 (a maximum score of 30, divided by 30). To illustrate the use value of the RPU, we discuss two plants that were subjected to the above questionnaire, following a comprehensive literature review. The first plant, *Sutherlandia (Lessertia) frutescens*, is used extensively as a medicinal plant by various cultural groups, including the Khoisan. The second plant, *Cissampelos capensis*, has both medicinal and magic uses, both of which are discussed. In Table 1, the results of a Google Scholar search, a Scopus search (Elsevier's largest citation database of peer-reviewed literature) and a SciFinder search (completed on 27 April 2020), for the two plants are shown. SciFinder is produced by the Chemical Abstracts Service and is the most comprehensive database for chemical literature. In the search, synonyms were also used, e.g. *Sutherlandia frutescens* and *Lessertia frutescens*. Determining the Rationality Index of Plant Use of *Lessertia (Sutherlandia) frutescens* is illustrated in Table 2.

Table 1: Results of a Google Scholar search, with specific keywords, for the two plant species. (as at 27 April 2020)

Species	Overall Hits Species Name (Only)			Species + Medicina L Use			Species + Magic Use			Species + <i>In vitro</i>			Species + <i>In vitro</i>		
	GS	Sc	SF	GS	Sc	SF	GS	Sc	SF	GS	Sc	SF	GS	Sc	SF
Sutherlandia frutescens	2030*	158	186	1400	127	36	152	0	0	1320	39	14	931	16	18
Cissampelos capensis	824	18	17	409	2	3	63	0	0	207	5	3	207	2	3

Key: GS = Google Scholar; Sc = Scopus citation database; SF = SciFinder database.

Table 2: Determining the Rationality Index of Plant Use of Lessertia (*Sutherlandia*) frutescens.

Item in the Ripu Questionnaire	Discussion: Measuring the Plant Use Against the Criterion	Score
1.1. How many original anecdotes have been published? <ul style="list-style-type: none"> • None = 0 • One or two only = 1 • Three to ten = 2 • Eleven to twenty = 3 • More than twenty = 4 	Extensive anecdotes published on the plant's use for stomach problems and internal cancers (Van Wyk <i>et al.</i> , 1997; Dykman, 1891; Watt and Breyer-Brandwijk, 1962; Van Wyk and Albrecht, 2008); wounds and ailments of the eye (Pappe, 1847; Van Wyk <i>et al.</i> , 1997); colds, influenza, diabetes, varicose veins, piles, inflammation, liver problems, backache and rheumatis (Van Wyk <i>et al.</i> , 1997; Dykman, 1891; Watt and Breyer-Brandwijk, 1962; Van Wyk and Albrecht, 2008); blood purifier (Smith, 1895); high blood pressure (De Beer and Van Wyk, 2011); kidneys (Thring and Weitz, 2006; Van Wyk and Albrecht, 2008); carbuncles (Kling, 1923); chickenpox (Shearing and Van Heerden, 1994; Van Wyk and Albrecht, 2008); asthma, heartburn and tuberculosis (Van Wyk and Wink, 2015). De Beer and Van Wyk (2011) also reported its use to treat toothache. Anecdotes also highlight its use to treat stress-related ailments such as shock, trauma, fits and depression (Moteetee and Van Wyk, 2007), as well as anxiety (Masondo <i>et al.</i> , 2019).	4

continued

Item in the Ripu Questionnaire	Discussion: Measuring the Plant Use Against the Criterion	Score
<p>1.2. Were these anecdotes published in accredited, peer-reviewed publications?</p> <ul style="list-style-type: none"> • No, it was published in grey/low impact journals = 1 • Yes, it was published in respected peer-reviewed publications = 2 	<p>Anecdotes were published in, among others, a scientific book (Van Wyk, Van Oudtshoorn and Gericke, Medicinal Plants of South Africa), in peer-reviewed journals (such as the South African Journal of Botany and the Journal of Ethnopharmacology), and reported in several examined post-graduate theses (e.g. De Beer, 2012; Nortje, 2011).</p>	2
<p>1.3. How many unpublished anecdotes have been recorded?</p> <ul style="list-style-type: none"> • One to ten = 1 • Eleven to twenty = 2 • More than twenty = 3 	<p>In all probability, many. De Beer and Van Wyk, for example, recorded anecdotes during their 2009-2011 ethnobotanical survey of the Agter-Hantam, in Middelpos, that has not yet been published.</p>	3
<p>2. Is there a workable (plausible) hypothesis for the plant's use(s)?</p> <ul style="list-style-type: none"> • No = 0 • It is possible to speculate on the merit of the plant use = 1 • The hypothesis is unpublished (or published in grey literature) = 2 • The hypothesis is published in low-impact journals = 3 • The hypothesis is published in high-quality journals, but there are still unanswered questions = 4 • Confirmed hypothesis, published in high-quality journals = 5 	<p>The active ingredients are known, among others the neurotransmitter GABA (Van Wyk and Albrecht, 2008; Van Wyk <i>et al.</i>, 1997, which could support claims that it treats anxiety and stress. <i>Sutherlandia</i> (<i>Lessertia</i>) leaves contain high levels of canavanine (Van Wyk and Albrecht, 2008), which has been documented to be an effective anti-cancer treatment (Crooks and Rosenthal, 1994). Lin <i>et al.</i> (2016) hypothesise that <i>S. frutescens</i> extracts could suppress prostate cancer growth by inhibiting the Gli/hedgehog signalling pathway. The hypothesis that the plant can be effective in the fight against cancer therefore is plausible. Van Wyk and Albrecht (2008) reported on the presence of ino-inicytol (commonly known as pinitol), which is a well-known anti-diabetic agent (Ostlund and Sherman, 1996). The hypothesis that the plant could assist in the treatment of diabetes therefore also seems plausible. Van Wyk and Albrecht (2008) also hypothesized that, since canavanine is an inhibitor of nitric oxide synthase, it holds potential to treat septic shock (see also Anfossi <i>et al.</i>, 1999). Furthermore, the triterpenoids have amarum activity, stimulating appetite, and may contribute to immune-boosting effects</p>	5

continued

Item in the Ripu Questionnaire	Discussion: Measuring the Plant Use Against the Criterion	Score
	(Van Wyk <i>et al.</i> , 1997. Camille and Dealtry (2018) showed that the plant has the ability to regulate macrophage differentiation, thus impacting on metabolic immune diseases.	
<p>3. Chemical evidence</p> <ul style="list-style-type: none"> • The chemistry is unknown = 0 • Little is known about its chemistry = 1 • The chemistry is known, but irrelevant to its use = 1 • The chemistry is known, and is related to its use = 3 • The chemistry is very well recorded and clearly linked to its specific use; there is no doubt about its effectiveness = 5 	<p>The plant has active ingredients such as canavanine, amino acids (including the neurotransmitter GABA), pinitol, flavonoids, triterpenoids and polysaccharides (Van Wyk <i>et al.</i>, 1997). They also stated that SU1 (sutherlandioside B), a triterpenoid saponin, is a main compound in commercial medicines produced from <i>Sutherlandia</i>. Van Wyk and Wink (2015: 193) explained the pharmacology as follows: “The triterpenoids have bitter tonic, anticancer and corticomimetic effects. Canavanine has anticancer and antiviral activity. Pinitol is an antidiabetic and is potentially useful to treat wasting in cancer and AIDS”. Bessong <i>et al.</i> (2006) screened fractions of methanol extracts of the plant for activity against HIV-1 reverse transcriptase. Laila <i>et al.</i> (2019) showed that the phytoconstituents of the plant have the potential to interrupt the life cycle of HIV as well as to act as immunomodulators to strengthen the immune system. Research also showed that the plant, apart from its antidiabetic properties, also exhibits central nervous system effects.</p>	5
<p>4. In vitro evidence for the plant use (pre-clinical tests)</p> <ul style="list-style-type: none"> • No in vitro tests have been conducted = 0 • Little or doubtful in vitro testing was conducted = 1 • Some <i>in vitro</i> testing supports the specific plant use = 2 • Extensive in vitro testing has been conducted, with varied results, or results indicating limited effectiveness = 3 	<p>Van Wyk <i>et al.</i> (1997) stated that, although <i>in vitro</i> studies showing anticancer activity are attributed to canavanine, it should also be linked to the triterpenoids that have proven cancer chemopreventive activity. Chen (2007) tested <i>Sutherlandia</i> (<i>Lessertia frutescens</i>) extracts for growth inhibition effects against PC-3 and LNCaP human prostate tumor cell lines, and the study also showed anti-carcinogenic activity. Van der Walt <i>et al.</i> (2016) showed that <i>L. frutescens</i> extracts are effective in inducing apoptosis in malignant melanoma cells. Mquco <i>et al.</i> (2014) studied the cellular interaction of the plant extracts with breast adenocarcinoma epithelial cell line (MCF-7) and a non-tumorigenic breast cell line (MCF-12A). In vitro work on the effect of <i>Lessertia</i> extracts on HIV target enzymes (among others, HIV reverse transcriptase) showed that there are inhibitory</p>	5

continued

Item in the Ripu Questionnaire	Discussion: Measuring the Plant Use Against the Criterion	Score
<ul style="list-style-type: none"> • There is good evidence of rigorous <i>in vitro</i> testing that supports the plant use = 5 	<p>effects (Harnett <i>et al.</i>, 2005). Williams <i>et al.</i> (2013) also reported the plant's anti-diabetic properties displayed in animal models. Gonyela <i>et al.</i> (2019) researched the influence of sutherlandioside A, B and D on the immune system.</p>	5
<p>5. <i>In vivo</i> evidence for the plant use</p> <ul style="list-style-type: none"> • No <i>in vivo</i> testing has been conducted = 0 • Some evidence of <i>in vivo</i> testing in animals = 1 • Good evidence of <i>in vivo</i> testing in animals = 2 • Some evidence of <i>in vivo</i> testing in humans = 3 • Sufficient evidence of <i>in vivo</i> testing in humans, with either mixed results, or indicating limited effectiveness = 4 • Very good evidence of <i>in vivo</i> testing in humans, indicating the efficacy of the plant use = 6 	<p>Bates <i>et al.</i> (2000) engaged in <i>in vivo</i> work with diabetic mice and the research showed that pinitol had an insulin-like effect and reduced the blood sugar levels in the mice. Work conducted by Ojewole (2004) reported a hypoglycemic effect on diabetic rats (Afolayan and Sunmonu, 2010). Lei <i>et al.</i> (2016) investigated the immunomodulatory activities of sutherlandia (<i>Lessertia frutescens</i>) in healthy mice. However, <i>in vivo</i> work has also been conducted on human subjects. An NIH NCAM sponsored clinical study has been conducted to investigate the possible effects of the plant on cachexia (seen in people suffering from cancer, tuberculosis and HIV/AIDS). Kumar <i>et al.</i> (2005) conducted <i>in vivo</i> work on mice, to determine the plant's anti-inflammatory activity and effect on cyclooxygenase. The study showed that sutherlandia does not cause significant side effects and that it is well tolerated by the human body. Mills <i>et al.</i> (2005) showed that very light side effects might accompany the use of sutherlandia, such as a dry mouth, light diarrhoea or slight dizziness. A clinical study in which 25 healthy adults in Cape Town participated (Johnson <i>et al.</i> 2007) showed a statistically significant increase in appetite, as well as higher platelet count and albumin levels. Van der Walt <i>et al.</i> (2016) researched whether <i>L. frutescens</i> could induce apoptosis in the A375 melanoma cell line.</p>	6
Total score	A full score of 30, thus the RIPU is 1.0	30

Based on plausible hypotheses that were tested *in vitro* and *in vivo*, the use of *Lessertia frutescens* for medicinal reasons is completely rational. This scientific *in vitro* and *in vivo* validation shows that the plant use by traditional healers or holders of indigenous knowledge is completely rational.



Figure 2: *Lessertia frutescens*.

Cissampelos capensis is an interesting case, as it has a number of both medicinal and magical uses. The magical plant use as a good luck charm/to keep evil away and clearing the mind is supported anecdotally (De Beer, 2020). To illustrate (Table 3) the versatility of the RIPU, the plant will be assessed in both categories, namely medicinal use (M) and magical use (P – stands for ‘paljas’ meaning spell in Afrikaans).

Table 3: Determining the Rationality Index of Plant Use of *Cissampelos capensis*.

Item in the Ripu Questionnaire	Discussion: Measuring the Plant Use Against the Criterion	Score M=Medicinal; P=Paljas (Magic)
1.1 How many original anecdotes have been published? <ul style="list-style-type: none"> • None = 0 • One or two only = 1 • Three to ten = 2 • Eleven to twenty = 3 • More than twenty = 4 	M: The Dawidjiewortel, <i>Cissampelos capensis</i> , is used to treat pain, diarrhoea, colic, diabetes, tuberculosis, stomach ailments and skin cancers (Van Wyk <i>et al.</i> , 1997; Van Wyk and Gericke, 2018), as well as asthma, coughs, fever, arthritis, obesity, snakebite, jaundice, and heart and blood pressure related conditions (Semwal <i>et al.</i> , 2014; Afolayan and Mbaebie, 2010). Van Wyk and Gorelik (2017) also referred to its use for treating syphilis. Other authors who confirmed these uses include Watt and Breyer-Brandwijk (1962), De Wet and Van Wyk (2008), Mendes and Carlini (2007) and Giorgetti <i>et al.</i> (2011). Shalaweh <i>et al.</i> (2014) indicated that it has traditionally been used to treat male fertility problems. Ayers <i>et al.</i> (2007) commented on the anthelmintic activity of aporphine alkaloids in <i>Cissampelos capensis</i> .	M: 4

continued

Item in the Ripu Questionnaire	Discussion: Measuring the Plant Use Against the Criterion	Score M=Medicinal; P=Paljas (Magic)
	<p>P: Magical ('paljas') uses include carrying the underground stem as a good luck charm or chewing it to clear the mind and improve mental alertness. The rhizomes may also be burnt in a house to protect it from unwanted influences. There are fewer anecdotes referring to magical plant use (compared to medicinal use). Reference to its use as a good luck charm, or magical plant use, is found in De Wet and Van Wyk (2008); Hulley and Van Wyk (2017); and De Beer and Mentz (2019). Mabogo (1990) has an interesting VhaVenda magical use, where the stem and leaves of the plant are soaked in water, and sprinkled on the hands and feet of the relatives of the deceased after they have visited the deceased's house after the funeral. Nathen (2016) referred to the Xhosa use of the plant (mayesaki) as a medicine to be used for good luck in court cases. Sobiecki (2014) referred to its sedative action.</p>	P: 3
<p>1.2. Were these anecdotes published in accredited, peer-reviewed publications?</p> <ul style="list-style-type: none"> • No, it was published in grey/low-impact journals = 1 • Yes, it was published in respected peer-reviewed publications = 2 	<p>M: The plant's uses and chemistry are described in high-quality publications, e.g. Van Wyk <i>et al.</i> (1997) Medicinal Plants of South Africa, and in accredited journals, such as the South African Journal of Botany and the Journal of Ethnopharmacology.</p> <p>P: The magical plant uses are published in journals such as the South African Journal of Botany, in a peer-reviewed AOSIS scientific book and recorded in post-graduate dissertations from reputable universities.</p>	<p>M: 2</p> <p>P: 2</p>
<p>1.3. How many unpublished anecdotes have been recorded?</p> <ul style="list-style-type: none"> • One to ten = 1 • Eleven to twenty = 2 • More than twenty = 3 	<p>M/P: In all probability, many. De Beer and Van Wyk, for example, have recorded anecdotes during their 2009 – 2011 ethnobotanical survey of the Agter-Hantam in Middelpos that has not yet been published. Also, during this study, several anecdotes were recorded in the survey of 67 participants in the SKA area.</p>	<p>M: 3</p> <p>P: 3</p>

continued

Item in the Ripu Questionnaire	Discussion: Measuring the Plant Use Against the Criterion	Score M=Medicinal; P=Paljas (Magic)
<p>2. Is there a workable (plausible) hypothesis for the plant's use(s)?</p> <ul style="list-style-type: none"> • No = 0 • It is possible to speculate on the merit of the plant use = 1 • The hypothesis is unpublished (or published in grey literature) = 2 • The hypothesis is published in low-impact journals = 3 • The hypothesis is published in high-quality journals, but there are still unanswered questions = 4 • Confirmed hypothesis, published in high-quality journals = 5 	<p>M: Ramasubramaniraja and Babu (2010) investigated the hypothesis that the plant extracts, due to two anthelmintic aporphine alkaloids, namely (S)-dicentrine and (S)-neolitsine, could treat internal worm infestation. Another hypothesis, namely that the alkaloid fraction of <i>C. capensis</i> is active against a range of microorganisms, has also been tested by various researchers (Semwal <i>et al.</i>, 2014; Babajide <i>et al.</i>, 2015). Babajide <i>et al.</i> (2015) showed that the tertiary alkaloid fraction showed high activity against <i>Bacillus subtilis</i>. Another hypothesis, namely that <i>C. capensis</i>, due to its alkaloids, would show cytotoxicity against breast, melanoma and renal cancer cell lines has also been tested (Semwal <i>et al.</i>, 2014). The plant showed activity against breast, melanoma and renal cancer cell lines (De Wet <i>et al.</i>, 2009). Deuschländer <i>et al.</i> (2009) hypothesized that the plant's sedative, antiplasmodic and antitumor properties can be ascribed to Menispermaceae alkaloids. The hypothesis that <i>C. capensis</i> extracts could be effective in treating prostate cancer, has been disproved by Pearce (2014).</p> <p>P: The feelings of safety and wellness associated with the magical uses may be linked to the high levels of bisbenzyltetrahydroisoquinoline alkaloids, which have a sedative effect (Van Wyk <i>et al.</i>, 1997; De Beer and Van Wyk, 2016). This hypothesis is also presented by Deuschländer <i>et al.</i> (2009). Farzaei <i>et al.</i> (2016) showed that phytochemicals like alkaloids, flavonoids, phenolic acids, cinnamates, terpenes and saponins have anxiolytic effects in animal models of anxiety. The relevant mechanisms include interaction with γ-aminobutyric acid (GABA) receptors at benzodiazepine (BZD) and non-BZD sites and dopaminergic systems. Phytochemicals can also modulate the hypothalamo-pituitary-adrenal (HPA) axis. Waşık and Antkiewicz-Michaluk (2012) indicated that the alkaloids have an influence on dopaminergic neurons. Wink and Van Wyk (2008) also showed that it is a muscle relaxant. The biochemical and pharmacological research provides some evidence that there are plausible reasons for the plant's magical use.</p>	<p>M: 5</p> <p>P: 4</p>

continued

Item in the Ripu Questionnaire	Discussion: Measuring the Plant Use Against the Criterion	Score M=Medicinal; P=Paljas (Magic)
<p>3. Chemical evidence</p> <ul style="list-style-type: none"> • The chemistry is unknown = 0 • Little is known about its chemistry = 1 • The chemistry is known, but irrelevant to its use = 1 • The chemistry is known, and is related to its use = 3 • The chemistry is very well recorded and clearly linked to its specific use; there is no doubt about its effectiveness = 5 	<p>M: Van Wyk <i>et al.</i> (1997) stated that the Menispermaceae family is known for the diversity of biologically active alkaloids of the bisbenzyl-tetrahydroisoquinoline type. The rhizome contains insularine (Van Wyk, 2002), and the leaves glaziovine. Semwal <i>et al.</i> (2014) listed other alkaloids such as warifteine, methylwarifteine, berberine and hayatin. Some of these alkaloids are known to have sedative, antispasmodic and antitumour properties (Van Wyk <i>et al.</i>, 1997). Semwal <i>et al.</i> (2014: 1011) listed the following pharmacological properties of the plant: anti-bacterial, anti-oxidant, antispasmodic, diuretic, hypotensive, muscle-relaxant, antiseptic, aphrodisiac, analgesic, anti-haemorrhagic and cardio-tonic. Ayers <i>et al.</i> (2007) showed that aporphine alkaloids in the plant led to a 90% loss of larval motility, showing potential to treat parasitic worms.</p> <p>P: The feeling of safety and happiness is ascribed to bisbenzyltetrahydroisoquinoline alkaloids (Van Wyk <i>et al.</i>, 1997; Deuschländer <i>et al.</i>, 2009). The glaziovine in the plant is known to be an antidepressant (Van Wyk and Wink, 2015).</p>	<p>M: 5</p> <p>P: 3</p>
<p>4. In vitro evidence for the plant use (pre-clinical tests)</p> <ul style="list-style-type: none"> • No in vitro tests have been conducted = 0 • Little or doubtful in vitro testing was conducted = 1 • Some in vitro testing supports the specific plant use = 2 • Extensive in vitro testing has been conducted, with varied results, or results indicating limited effectiveness = 3 • There is good evidence of rigorous in vitro testing that supports the plant use = 5 	<p>M: Extensive in vitro work has been conducted. Alkaloid extracts of <i>Cissampelos capensis</i> have shown cytotoxicity against the MCF7 (breast), UACC62 (melanoma) and TK10 (renal) cancer cell lines (Semwal <i>et al.</i>, 2014). The total tertiary alkaloid fraction of the plant was furthermore found to be active in in vitro work against a range of microorganisms (including <i>Bacillus subtilis</i>, <i>Pseudomonas aeruginosa</i>, <i>Proteus vulgaris</i>, <i>Escherichia coli</i>, <i>Staphylococcus aureus</i>) and fungi, such as <i>Candida albicans</i> and <i>Aspergillus niger</i> (Semwal <i>et al.</i>, 2014). Shalaweh <i>et al.</i> (2014) have showed that extracts of <i>C. capensis</i> triggered human sperm intrinsic superoxide production, leading to sperm capacitation.</p> <p>P: Ayaz <i>et al.</i> (2013) showed that extracts of the plant improve cognitive abilities, and that it has neuroprotective functions. These authors indicated that it might be linked to the inhibition of cholinesterases. However, unlike the richness of in vitro work on its medicinal uses, little research has been conducted on the plant's magical uses.</p>	<p>M: 5</p> <p>P: 2</p>

continued

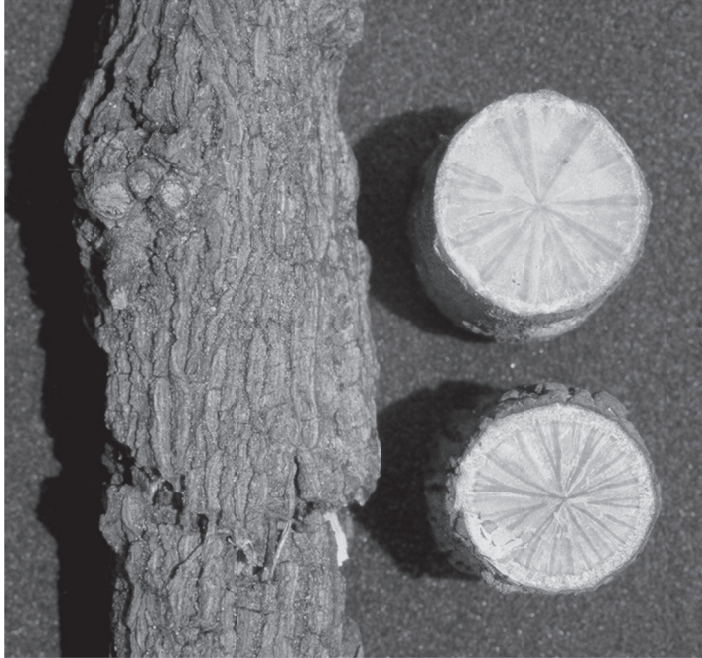


Figure 3: *Cissampelos capensis*.

The use of *Cissampelos capensis* for medicinal reasons is completely rational, based on plausible hypotheses that were tested *in vitro* and *in vivo*. However, with a RIPU of 0.6 for magical use, further investigation is needed into its chemistry, and more *in vitro* and *in vivo* work is needed. However, the value of 0.6 shows that such reported magical uses cannot be dismissed, as there is nascent scientific evidence for such uses.

Another interesting case is the use of *Galium tomentosum* for magical use. We also subjected this plant to the RIPU and, with a RIPU of 0.33, its use should be further explored. In other words, the chemistry of the plant should be studied, and *in vitro* and *in vivo* work conducted. There is emerging research that gives possible credibility to the plant's common name 'rooivergeet' (freely translated from Afrikaans, "red forget"). Research by Gräff *et al.* (2014), published in the journal *Cell*, showed that by using an HDAC2-targeting inhibitor (HDACi) remote memories could be reduced. It can be hypothesised that *G. tomentosum* contains extracts that affect the physiology of the hippocampus, that regulates memory, in a similar way to HDACi. Although the plant's magical use does not seem very rational currently, future research might provide a very plausible explanation. It is possible that *G. tomentosum* could assist a person in forgetting unpleasant experiences.

To conclude, the RIPU is based on measurable criteria, such as published anecdotes, and chemical and pharmacological research, that could support hypotheses for a particular plant use. It should be acknowledged that plant use could also have a placebo effect, which was not taken into consideration. From

the two examples provided above, the medicinal uses of *Lessertia frutescens* (with a RIPU of 1.0) and *Cissampelos capensis* (value of 1.0) are completely rational. The use of *Cissampelos capensis* for magical reasons (RIPU 0.6) indicates that there might be plausible hypotheses for its magical use, but that further research into its chemistry and pharmacological working is needed.

WHEN INDIGENOUS KNOWLEDGE AND WESTERN SCIENCE MEET

In our data collected in southern Bushmanland, we have recorded many anecdotes that descendants of the San and Khoi chew the plant medicines. Van Wyk and Gorelick (2017) observed that the drinking of herbal teas or infusions was not part of the indigenous San or Khoi traditions. One of the San cultural keystone species is *Mesembryanthemum tortuosum*, commonly known as kanna or kougoed. The Swedish botanist Thunberg, during his travels between 1772 - 1775, recorded the following:

(they) came far and near to fetch this shrub with the root, stalk and leaves which they stamp together, and afterwards twist them up like pig-tail tobacco; after which they let the mass ferment, and keep it by them for chewing, especially when they are thirsty. If it is chewed immediately after fermentation, it intoxicates (Gericke, 2018: 127).

Our data show that many plants are still chewed by the Khoisan participants, e.g. *Artemisia afra*, *Dicoma capensis*, *Eriocephalus ericoides*, *Eucalyptus camaldulensis*, *Jamesbrittenia atropurpurea*, *Malva parviflora*, *Mesembryanthemum tortuosum*, *Pentzia incana*, *Rhigozum trichotomum* and *Schinus molle*. The significance of this is illustrated by nascent research. Bennick (2002) has shown that more than 20 proline-rich proteins (PrPs) are present in human saliva. These PrPs interact with polyphenols in food. Flavonoids are polyphenols that have beneficial effects on humans, e.g. they have anti-oxidant properties (Bennick, 2002). On the other hand, tannins are polyphenols that may be harmful to humans as they could interfere with normal growth and metabolism. Bennick's (2002) research shows that salivary proteins serve as screening factors that allow for the absorption of flavonoids, but also neutralise the less desirable effects of tannins. There is therefore great merit in chewing plant medicines, rather than making a tea/infusion from it – wisdom demonstrated by the (Khoisan) holders of indigenous knowledge.

Another example of traditional wisdom is the use of the plant *Malva parviflora* by Khoisan people in the study area. We recorded the use of the leaves of the *Malva parviflora* plant that are chewed and then applied as a poultice to assist with sore and wound healing. The wisdom of this practice is demonstrated by the research of Oudhoff *et al.* (2008). Human saliva contains histatins, substances that contain antimicrobial properties and have been demonstrated to assist in wound healing. The application of a poultice consisting of a mixture of *Malva parviflora* leaves (shown to have antibacterial, antifungal and anti-inflammatory properties) and saliva (containing histatins shown to have wound-closure stimulating potential) will ensure faster wound healing. This is a practical demonstration

of how 'Western' science research could validate indigenous knowledge and promote respect for indigenous knowledge.

CONCLUSION

As Mazzocchi (2006) pointed out, indigenous knowledge holders have gained knowledge by conceptualising empirical observations to better understand nature – just as Western scientists do. However, indigenous knowledge systems are characterised by their holistic nature, and often indigenous knowledge does not make distinctions between the empirical and the spiritual/sacred (Nakashima and Roue, 2002). Attempts to analyse and validate indigenous knowledge carry the risk of distorting such knowledge (Mazzocchi, 2006). A focus on the empirical only, would ignore an essential dimension of indigenous knowledge. The RIPU heuristic is only applicable to indigenous knowledge contexts where it is possible to focus on the chemistry and pharmacology of plant use. The authors acknowledge that plant use for symbolic reasons may also be completely rational. Furthermore, the focus of the RIPU is not to try to validate indigenous knowledge utilising the processes of science, but rather to enhance appreciation and respect for the richness of indigenous knowledge and its merit.

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