Ethnoveterinary Survey on Medicinal Plants Used by Indigenous People of Limpopo for Treatment of Covid-19 Symptons on Pets and Animal

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ABSTRACT

Animals infected with SARS-CoV-2 have been documented around the world. Most of these animals became infected after contact with people with COVID-19, including owners, caretakers, or others who were in close contact. Animals in zoos and sanctuaries, including several types of big cats (e.g., lions, tigers, snow leopards), otters, non-human primates, a binturong, a coatimundi, a fishing cat, hyenas, hippopotamuses, and manatees. There is no specific antiviral drugs or vaccines available for the treatment of this lethal disease. The prevention measures as pronounced by World Health Organization (WHO), are less effective but can only delay the spread of the virus. Medicinal plants used to treat viral infections are assumed to be safe due to their long usage in traditional medicine. In this study, an ethnobotanical survey was conducted to document the indigenous knowledge of medicinal plants used to treat Covid-19. Using semi-structured interviews and questionnaires, ethnobotanical data were collected from 5 farmers and 30 traditional healers in Sekhukhune region. The results showed that 34 plant species were used to manage respiratory livestock diseases. Plant leaves, roots were commonly used, being crushed in water, and administered orally or smoking. During the survey, it was noted that these thirty-four plants were traditionally used by indigenous people to treat various human and veterinary diseases such as basic first aid for pneumonia, respiratory, flu, bronchitis, tonsillitis, influenza, TB and chronic conditions like anthrax or chronic obstructive pulmonary disease.

Keywords: Covid-19, Pandemic, Perception, Stress, Transmission, COVID-19, Infectious disease

INTRODUCTION

The COVID-19 pandemic has been termed as the most consequential global crisis since the World Wars. The first line of defences against the COVID-19 spread are the non-pharmaceutical measures like social distancing and personal hygiene which only reduce the spread. Corona virus disease 2019 (COVID-19) is a pandemic disease that spreads primarily through droplets of saliva or discharge from the nose. There is no specific antiviral drugs or vaccines available for the treatment of this lethal disease. The prevention measures as pronounced by World Health Organization (WHO), are less effective but can only delay the spread of the virus. This calls for scientific research to be carried out to develop novel drugs and vaccines that may be used to combat and minimize the spread of the corona virus.

A several animal species are prominent to be vulnerable to experiment infection of SARS-CoV or SARSCoV-2, including ferrets, Syrian hamsters, deer mice, white-tailed deer, cynomolgus macaques, rhesus macaques, crab-eating macaques, African green monkeys, baboons, raccoon dogs and many others (Halfmann, et al 2020, Shi et al 2020).Amid April and November 2020, 69 out of 127 mink farms in the Netherlands were infected with SARS-CoV-2, triggering large-scale culling to prevent further spread of the virus (van Aart et al. 2021).

The uninterrupted and quick spread of SARS-CoV-2 in the mink population also contributed to the emergence of a mink-associated SARSCoV-2 variant that was later identified in human beings confirming mink-to-human spread (Sharun et al. 2021b). Considering that cats and dogs can be infected with SARS-CoV-2 and that both

may increase symptoms in a similar way that humans do (Sit et al 2020, Medkour et al 2021), it would be reasonable to think about the possibility of these domestic animals transmitting the virus back to humans and hence, being a risk factor for human infection. The increasing reports of SARS-CoV-2 in animal species indicate the need to understand and evaluate the susceptibility of animals as it is of utmost importance to public health and the economy.

This circumstance plays away since of the short feature of healthcare management system and lack of possessions to combat the incidences (Raimi et al 2021, Maema et al 2019). Herbal medicines are prepared using plant parts such as the root, stems, barks, leaves, flowers, fruits or the seeds, harvested from the wild ,garden or conservation parks. Africa's wealth in cultural and floral variety provides the indispensable recipe for development of new drugs either customarily or by modern medicine (Raimi ,2021). Conventionally, about 90% of the African population particularly the rural dwellers are still dependent on traditional medicine (Semenya et al 2013) and Southern Africa is known to have a abundance of native and valuable medicinal plants, which have been used as unconventional medicine for many decades (Van Wyk,2015). World Health Organization (WHO) shows a livid aspiration and encourages the records of medicinal plants used in treating diseases by indigenous from different parts of the world (Raimi ,2021).

Medicinal plants used to treat viral infections are assumed to be safe due to their long usage in traditional medicine**.** Natural product research continues to provide a tremendous variety of lead structures, which are used as templates for the development of new drugs by the pharmaceutical industry (Van Wyk,2015, Raimi ,2021). The field of ethnobotanical research has expanded greatly in recent years as the value of this type of research has come to be more widely recognised. The traditional use of medicinal plants and the pharmacological activity of extracts previously investigated shows that a viable approach to pharmaceutical research in the areas of various diseases such as arthritis, tuberculosis (TB), cancer, diabetes, bacterial and viral infections etc. is needed (Sharma, 2019, Semenya and Maroyi, 2013,2018). Medicinal plants possess many potentially valuable therapeutic agents which needs further research to investigate their effectiveness.

In this study, we documented the plant species (indigenous and alien) used in the treatment of covid-19 by respondent specifically, sepedi speaking population that resides in Sekukhune district Municipality, South Africa with a view to providing baseline data for future studies into the phytochemical and pharmacological potential of these plants in relation to the management of covid-19. The main objectives were to (1) specifically investigate and record medicinal plants used for the treatment of covid-19 and related symptoms in Sekhukhune, and (2) document the methods of preparation and administration of these medicinal plants during the treatment of different types of covid-19 and related symptoms.

METHODOLOGY

Description of study area

The study was conducted in five local municipalities Elias Motswaledi, Ephraim Mogale ,Tubatse, Fetakgomo and Makhuduthamaga. of the Sekhukhune District, Limpopo Province, South Africa. Geographically Sekhukhune District lies between 24°50′S and 29°50′E (Fig. 1). The district is located in the south east part of Limpopo Province, and covers an area of 13,528 km^2, making it the largest district in the province. A large portion of the district is identified as rural areas. Semenya et al. (2013) noted that the high floristic diversity of the area coupled with high unemployment rate resulted in a heavy reliance of natural resources such as plants to meet livelihood needs. The vegetation of the district was classified by as aris-semi savannas. It is characterized by a mixture of trees, shrubs and grasses. This type of vegetation has provided a diverse flora with rich medicinal plants that the people of the study areas have always used to treat many illnesses. The ethnic group use herbal medication either alone or in combination with orthodox medicines for the treatment of several infections (Sharma,2019).

Table 1 Demographic Data of Participants

Parameters		**Participants(N)**	**N(%)**
Gender	Female	10	29
	Male	25	71
Age	36–46	3	8

	47–57	6	17
	58–68	7	20
	69–79	11	32
	80-90	6	17
	90-100	2	6
Education	No Formal Education	10	29
	Primary	13	37
	Secondary	7	20
	Tertiary	2	6
	Others	3	8
Collaboration with modern medicine	Collaboration	15	43
	Non-Collaboration	20	57
Occupation	Herbalists	30	86
	Retirees	4	11
	Housewives	1	3
Residence	Urban	3	9
	Rural	32	91
Marital status	Single	13	37
	Married	15	44
	Widowed	6	17
	Divorced	1	2

Ethnobotanical and Identification Methods

Information was sourced from the Farmers and traditional healers through oral interview with some structured questions administered as questionnaires after several exploration visits. The total number of Farmers and traditional healers per study site was 35. The questions focused on medicinal plants used by the local people from the study area for the treatment of various Covid-19 related symptoms. Furthermore, information about the plant parts used, method preparation and methods of recipe administration were documented during the study. Informed consent of the Farmers and traditional healers who participated in the interview was obtained, including the usage of information given with respect to this study. Plants were collected for voucher number assignment after obtaining collecting permit. Plants collection trip involved the, Farmers or/and traditional healers and research student from the University of Pretoria. Voucher number assignment was done by Magda Nel and the voucher specimens deposited at the H.G.W.J. Schweickerdt Herbarium, University of Pretoria.

Statistical analysis

Data were presented using descriptive statistics such as percentages and frequencies. Frequency index of each plant species was calculated using the formula:

$FI = FC/N \times 100$

Where FI is % of frequency of citation for one plant species by respondents (Famers and traditional practitioners), FC is the number of traditional practitioners who cited the use of a particular plant species, and N is the number of respondents (Masevhe et al 2015)

RESULTS AND DISCUSSION

Interviews with Traditional Practitioners

A total number of five famers and thirty traditional healers (Respondent) who were willing to provide information on their scope of work and ready to share their operational methods responded to the questionnaires. Seventy-one percent (71%) of the traditional healers in both locations were males and 29%

were females. This is in consonance to the reports of (Luseba and Van der Merwe,2006, Maphosa and Masika ,2010 and Khunoana et al 2019)., where males above the age of 40 were the mainly conversant age group when coming to the use of plants as ethnoveterinary medicine. The younger generation had no clue about EVM which is generally due to lack of curiosity and movement to urban areas (Luseba and Van der Merwe, 2006). Ninety-eight percent (98%) of the respondent in our study were between the ages 40 years and above with over twenty years' practice experience. Khunoana et al (2019). also reported the ages of the majority respondent interviewed in their ethnoveterinary study to be between 40 and above years. The ages of the remaining 2% respondent were below 40 years with less than 10 years' experience suggesting less concern in livestock farming and traditional practice by the younger generation.

Table 2: Local/scientific names, types and preparation of plants used for the treatment of Covid-19 and related symptoms in Sekhukhune, Limpopo, South Africa.

Scientific Name	Voucher No	Botanical Family	Vernacular Name	Part(s) Used	Related Ailment/Infections	Frequency Citation (FC)	Frequency Index (FI)
Eucalyptus camaldulensis (Dehnh)	PRU0130638	Myrtaceae	Unknown	Leaves	Tuberculosis/Respiratory infection	35	100%
Aloe zebrina Baker	PRU0130631	Asphodelaceae	Kgokgopa ya pitsi	Root	Tuberculosis	34	97%
Aloe globuligemma Mill.	PRU0130662	Asphodelaceae	Kgopha-ya-fase	Root	HIV/AIDS, Tuberculosis	16	46%
Aloe marlothii A. Berger subsp. marlothii	PRU0130665	Asphodelaceae	Kgopha-ya-go-ema	Leaves & root	Diabetes mellitus, Tuberculosis, Chlamydia	34	97%
Artemisia afra Jacq. ex Willd. var. afra	PRU0130652	Asteraceae	Lengana	Leaves	Tuberculosis	35	100%
Ximenia caffra Sond.	PRU0130637	Olacaceae	Morokologa/ Mochidi	Leaves	Fever	20	57%
Boscia albitrunca (Burch.) Gilg & Gilg-Ben.	PRU0130630	Capparaceae	Mohlophi	Root	HIV/AIDS	30	86%
Cannabis sativa L.	PRU0130650	Cannabaceae	Mopatse	Leaves	Tuberculosis	35	100%

Carpobrotus edulis (L.) L. Bolus subsp. edulis	PRU0130660	Mesembryanthemaceae	Lepolomo-la-go-naba	Leaves	Diabetes mellitus, Goiter	26	74%
Argemone ochroleuca Sweet	PRU0130639	Papaveraceae	—	Leaves/Flowers	Blood clotting, Diabetes, Tuberculosis	27	77%
Citrus limon (L.) Osbeck	PRU0130635	Rutaceae	Suru	Leaves	Sore throats, fevers, high blood pressure, chest pain	35	100%
Dodonaea viscosa Jacq.	PRU0130629	Sapindaceae	Mofenshe	Root	HIV/AIDS	17	49%
Elephantorrhiza elephantina (Burch.) Skeels	PRU0130632	Fabaceae	Moshisane	Root	HIV/AIDS, Blood clotting, Blood purifier, Tuberculosis	34	97%
Euphorbia schinzii Pax	PRU0130647	Euphorbiaceae	—	Roots	Fever	10	29%
Ficus abutifolia (Miq.) Miq.	PRU0130653	Moraceae	Mofeiye	Bark	Tuberculosis	14	40%
Schinus molle L.	PRU0130651	Anacardiaceae	Thoba	Leaves/Bark	Asthma	26	74%
Ricinus communis L.	PRU0130641	Euphorbiaceae	—	Roots	Diabetes mellitus, Hypertension, Asthma	24	69%
Datura stramonium L.	PRU0130642	Solanaceae	Unknown	Leaves	Fever, Asthma, Bronchitis	25	71%
Aloe cryptopoda Baker	PRU0130648	Asphodelaceae	Kgokgopana	Tuber/Leaves	HIV/AIDS, Tuberculosis	16	46%
Conyza bonariensis (L.) Cronquist	PRU0130655	Asteraceae	—	Root/Leaves	Fever	17	49%
Tagetes minuta L.	PRU0130654	Asteraceae	—	Leaves	Chest complaint, Tuberculosis, Nose bleeding	24	69%

Cylindropuntia fulgida (Engelm.) F.M. Knuth	PRU0130663	Cactaceae	—	Fruits	Fever	9	26%
Euphorbia tirucalli L.	PRU0130664	Euphorbiaceae	Motlhoko	Leaves	Asthma, Cough	28	80%
Peltophorum africanum Sond.	PRU0130633	Fabaceae	Mosehla	Bark	HIV/AIDS/TB, Hypertension	32	91%
Searsia pyroides (Burch.) Moffett	PRU0130643	Anacardiaceae	Motshakhutshakhu	Fruit/Seed	Chest complaint, Tuberculosis	13	37%
Sclerocarya birrea (A.Rich.) Hochst.	PRU0130636	Anacardiaceae	Morula	Bark	Blood clotting	30	37%
Senna didymobotrya (Fresen.) H.S.Irwin & Barneby	PRU0130649	Fabaceae	Mothekele / Morotwanaditshoshi wa goema	Leaves	Blood clotting	29	83%
Solanum incanum L.	PRU0130657	Solanaceae	Thola	Leaves	Sore throat	6	17%
Opuntia ficus-indica (L.) Mill	PRU0130645	Cactaceae	Motoro o mohwibidu	Leaves/Fruits	Diabetes	32	91%
Carica papaya L.	PRU0130634	Caricaceae	Mophopho "wapoo"	Root	Diabetes mellitus	31	89%
Malva parviflora L.	PRU0130661	Malvaceae	Jikalelanga	Seed	Coughs	15	43%
Musa × paradisiaca L.	PRU0130640	Musaceae	Mobanana	Leaves	Coughs, Bronchitis, Tuberculosis	8	23%
Euphorbia cooperis N.E. Br. ex Berger	PRU0130659	Euphorbiaceae	—	Roots	HIV/AIDS	11	31%
Jacaranda mimosifolia D. Don	PRU0130656	Bignoniaceae	Molope	Bark/Seed peel	Tuberculosis, HIV/AIDS	28	80%

Plant Frequency index, Habits and Parts Mostly Used for Covid-19 related symptoms Treatment

Eucalyptus camaldulensis (Myrtaceae), Citrus limon *(*Rutaceae), Cannabis sativa *(*Cannabaceae) and Artemisia afra *(*Asteraceae) recorded the highest frequency index i.e. they are the mostly used plant species by the respondent in the study locations for Covid-19 related symptoms treatment. They have a long history of usage in the treatment of various respiratory diseases according to the folklore medicine ((Semenya and Maroyi, 2013 and 2019). The plants least mentioned were

Solanum incanum (Table 2). Based on the recognized plants and the citation frequency during the survey, plants habit was in the order: climber < trees < bulbs < herbs = shrubs. Shrubs and herbs were more preferred by the respondent over other plant habits, which may be linked to the potential for respiratory infections and over other plant habits, which may be linked to the ever-present status of shrubs and herbs throughout the season of the year. In conformity to the above declaration, factors such as accessibility right the way through the season of the year, shape, smell, colour and size of plants (shrubs and herbs) were accredited to the choice of plants used for treatment in the study (Maema et al,2019, Semenya and Maroyi, 2013 and 2018). The plant parts mostly used in the therapeutic preparations by the traditional practitioners were leaves > roots > barks > Fruits > Flowers>seeds> Tuber (Figure 1). Several ethnobotanical surveys have reported leaves as the mostly used plant parts for treatment of diseases by locals. For example, Raimi et al in their ethnobotanical survey of medicinal plants used by traditional healers for the treatment of cancer in Hamman kraal and Winterveld, South Africa noted the leaves as the mostly used plant part. Savikin et al. reported that leaves were the mostly used plant part in their ethnobotanical study in South-western Serbia. Thorns, latex, flowers, and corms were rarely used for recipe during treatment.

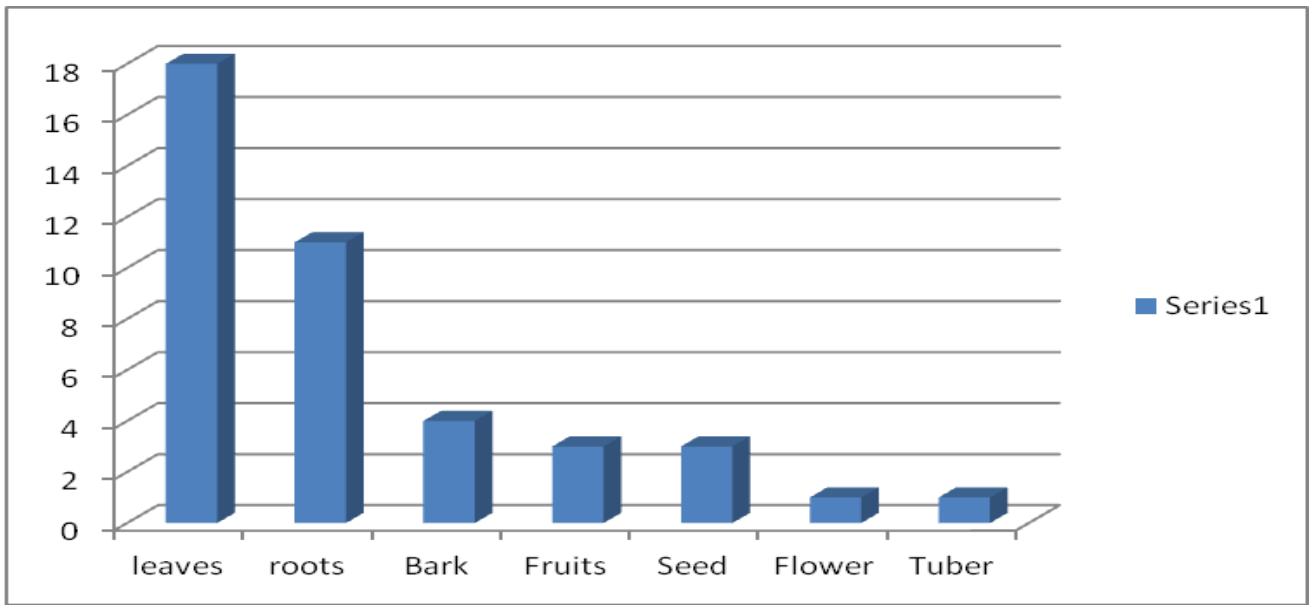

Figure 1 Plant parts used in the herbal preparation

Individual versus combination use

Plants were used either alone or in combinations with and other plants to enhance the efficacy of remedies. Plants like Eucalyptus camaldulensis, Artemisia afra, Cannabis sativa and citrus lemon can be use alone only if they are no suspicion of week immunes systems or diabetic or blood clothing stress or in the pet or animal. Traditional health practitioners in the region of the world have relied on combinational treatment to improve effectiveness (van Vuuren and Viljoen, 2011). In KwaZulu-Natal, de Wet et al. (2012) noted that indigenous people preferred combinations of medicinal plants to extravagance sexually transmitted infections. Likewise, traditional health practitioners in Zambia used some medicinal plants alone, but combinations with other plant species were noted (Ndubani and Höjer, 1999). In the synergistic studies, plant extract can have antimicrobial activity when tested alone, while the combination plant extracts could also result in synergism, additive, non-interactive and opposed activities (Naidoo et al., 2013). In Sekhukhune Limpopo, Madisha et al. (2017) noted

combinations of medicinal plants of Aloe Marlothii *(*Ethanol) and Elephantorrize Elephantina (Hydro-Alcohol) testes for Tubercolosis against M. Tubercolosis (0.39) and M. Smegmatis(0.78) showed significance results. This demonstrates that a combination of plants with other plants species can be an important practice in areas.

Table 3. Farmers and traditional healers' concept about symptoms of the Covid-19 disease and combination used

Symptoms	Plants combination	Participants
Fever, General weakness, Runny nose, Loss of smell, Loss of taste	Eucalyptus camaldulensis/ Artemisia afra/ Cannabis sativa +Aloe Marlothii/Zebrina/ Schotia brachy petala	6
Fever, Shortness of breath at rest, Loss of smell, Loss of taste	Eucalyptus camaldulensis/ Artemisia afra/ Cannabis sativa+Carpobrotus edulis	5
Sore throat, Fever, Runny nose, Shortness of breath at rest, Chills, Fatigue, General weakness, Loss of appetite, headache	Eucalyptus camaldulensis/ Artemisia afra/ Cannabis sativa+ Peltophorum africanum/ Sclerocarya birrea/ Aloe marlothii	8
Sore throat, Fever, Shortness of breath at rest, General weakness, headache, Loss of smell, Loss of taste	Eucalyptus camaldulensis/ Artemisia afra/ Cannabis sativa+ Aloe marlothii	9
Sore throat, Fever, Runny nose, Shortness of breath at rest	Eucalyptus camaldulensis/ Artemisia afra/ Cannabis sativa +Aloe marlothii/ Senna didymobotrya	4
Sore throat, Fever, Runny nose, Shortness of breath at rest, Chills, Fatigue, General weakness, Loss of appetite, headache, Loss of smell, Loss of taste	Eucalyptus camaldulensis/ Artemisia afra/ Cannabis sativa+ Aloe marlothii Senna didymobotrya	3

Mode of preparation, Administration and dosage of Recipe

In traditional herbal medicine systems, herbal remedies are prepared in several rather standardized ways which usually vary based upon the plant utilized, and sometimes, what condition is being treated. Some of these methods include: infusions 8% (hot teas), decoctions 67% (boiled teas), tinctures 20% (alcohol and water extracts), and macerations 5%(cold-soaking). This result is in concordance with the report of (Semenya and Maroyi ,2018) where decoction was reported as the preferred method of recipe preparation in their study. Others include preparing plants in hot baths (in which the patient is soaked in it or bathed with it), inhalation of powdered plants 2% (like snuff), steam/smoke inhalation 6% of various aromatic plants boiled in hot water, and even aromatherapy. Ninety-two (92%) percent preparations were prescribed orally with a tin cup (300 ml) goats/sheep and two litres for large animals like cows or donkey (Table 2). Maema et al,2019 in their study of invasive plant species used for the treatment of diseases also recorded oral administration as the preferred method of medication on patients during treatment course. The preferred vehicle for administration of pounded/powdered oral medicine was either warm water or cooked and allowed to cold down and other mixed with food or administered as feed. Same medicinal remedies were taken until a animals health show a positive sign. The improvement of symptoms was perceived as independent indicators of a successful treatment of respiratory. The traditional health practitioners reported powder and juice administered orally as a method of choice that will not destroy active compounds, ultimately resulting in high efficacy. According to Yang and Ross in their study on the theories and concepts in the composition of Chinese herbal formulas, decoction with oral administration was reported to be absorbed quickly and have the strongest action among all the traditional types of recipe preparation and administration. Explanations such as speeding-up the extraction process, extracting active compounds and cytotoxic evaluation of compounds are central goals in phytomedicine studies (Sharma, 2019). The preparation methods depended on types of infections symptoms such as Coughing, flu and fever. Medicinal plants are subjects to phytochemical screening worldwide. All traditional

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health practitioners used water, which is limited to extract non-polar and intermediate polar compounds. The aqueous extracts may result with limited biological activities. Nevertheless, the nontoxic solvent such as acetone was excellent in extracting a wide range of compounds (Patton,1990). The dosage administered was consistent with previous studies of human and but the application only twice time as animals in rural move to the bush early and return late. This suggests that traditional health practitioners have some model dosage measurement of remedies being administered for a particular set of infections on different types of animals.

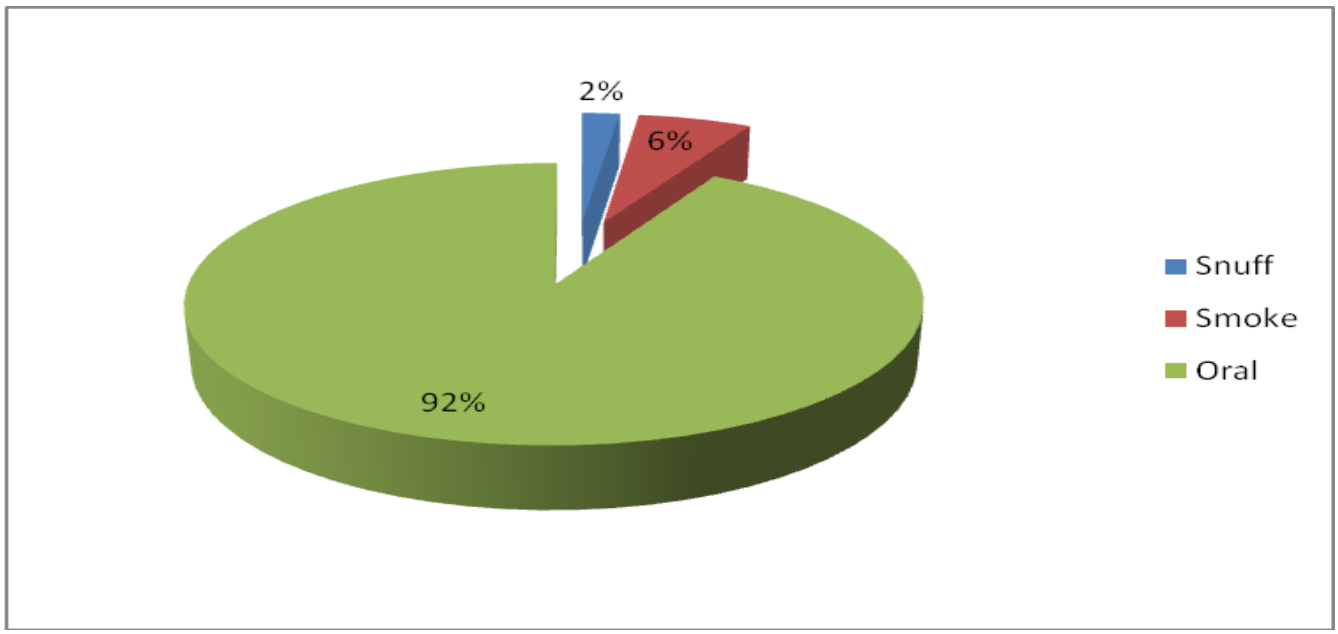

Figure 2 Administration of recipe

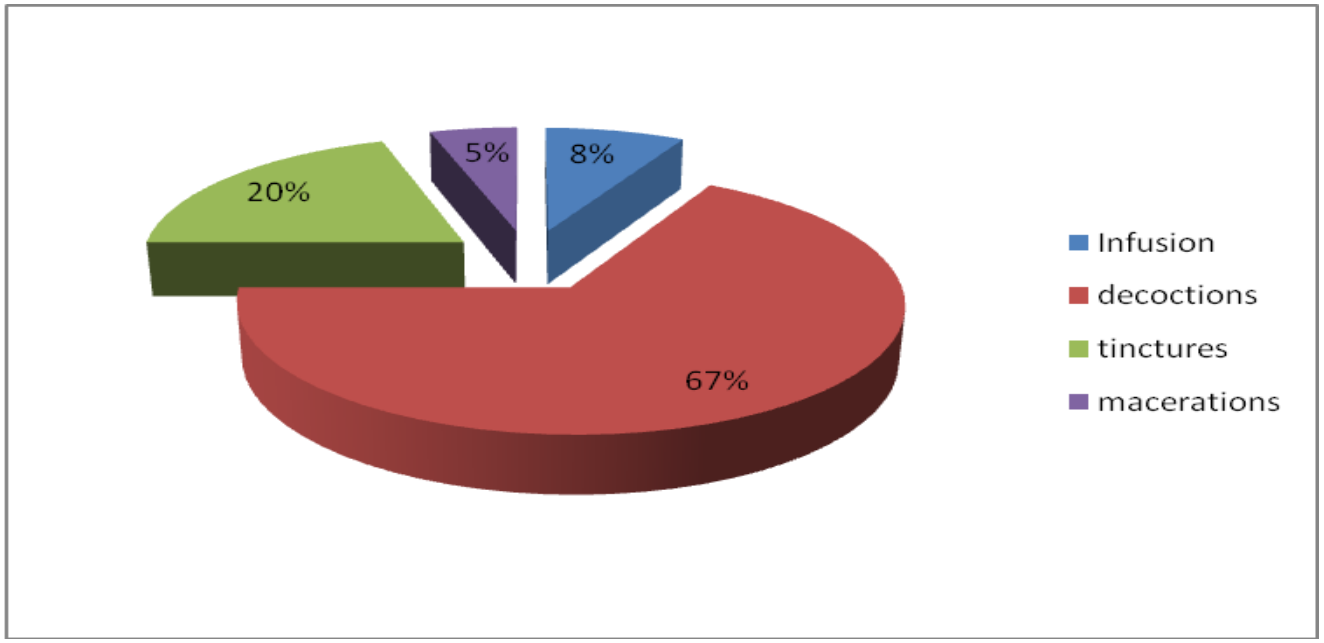

Figure 3 Methods of preparation of recipe

Covid-19 and related symptoms prevalence and plant species with their families

High mortality rate from covid-19 among inhabitants of low-income countries is a great threat to the population growth as projected by the World Health Organization. Conservatively, over 26 million South Africans get indigenous medicine as their first choice of treatment (Raimi ,2021). The increased patronage of traditional herbal healing systems by patients is due to apparent limitations and reported side effects in conventional care (Van Wyk,2015). This present study recorded twenty-eight (34) plant genera distributed in eighteen (21) different families (Table 1) in Sekhukhune areas of Limpopo Province, South Africa. In this

study, the most prevalent type of Covid-19 and related symptoms treated by the respondent (Table 1). The plants used for the treatment of Covid-19 and related symptoms come from more than half of the reported families in this survey where leaves were the plant part mostly used. Lung cancer and TB is the next prominent type of Covid-19 related symptoms treated by the respondent as recorded in this survey (Table 1). Factors such as pollution from industries and lifestyle habits such as smoking have been suggested as the probable reason for lung cancer and TB prevalence as recorded during this study. Plants recorded from this survey for treatment include; Eucalyptus camaldulensis , Aloe zebrina. Aloe marlothii , Artemisia afra, Cannabis sativa, Citrus limon, Opuntia ficus-indica, Schinus molle, Jacaranda mimosifolia. The respondent also reported that plants like Eucalyptus camaldulensis and Artemisia afra should be use for only as emergency on animals and pets as they are mostly needed for human corona virus and that concentrations of indigenous is on leaves and aloe as they are in abundance. Different plant species belonging to the Myrtaceae ,Olacaceae,Capparaceae,Cannabaceae,Mesembyanthemaceae,Papaveraceae,Rutaceae,Sapindaceae,Euphorbiaceae,Moraceae,Solanaceae,Asphodelaceae,Asteraceae,Cactaceae,Fabaceae, Anacardiaceae, Solanaceae, Caricaceae, Malvaceae, Musaceae, Ebenaceae families have all been reported in literature for traditional use or mostly in vitro studies.

CONCLUSIONS

The practice of EVM is an age long practice in South Africa and plays a significant role in healthcare management practices. This study acknowledged plants that have been in use by the farmers and traditional healers for different covid-19 related symptoms treatments from areas in Sekhukhune district Municipality. Literature have shown that a number of these acknowledged plants are yet to undergo in vivo evaluation and clinical trials for acute respiratory management. This study therefore increases the records of acknowledged plants for further investigation. Further studies on these acknowledged plants are required and this should include research that will examine the anti- SARS-CoV-2 ability of these plants without compromising the immune system of the animals when administered. Effectiveness of the recognized plant species in vivo assays, followed by clinical trials where there are promising results is further required.

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Authors' contributions

All authors read the final manuscript and agreed to its submission.

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Availability of data and materials

Not Applicable.

Ethics approval and consent to participate

Verbal consent was taken from participants before carrying out the study as most if the participants were illiterate. Present study was carefully designed with strict compliance of bio-ethics and approved by the University of Pretoria ethics committee.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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