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# Medicinal plants and functional foods sold by market vendors and used by their clients for COVID-19 in Gondar City, Ethiopia

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## Abstract

**Background**: Many Ethiopians use traditional medicines. However, little is known about the role of open markets as sources of alternative medicines in preventing and treating COVID-19. Objectives. The objectives of this study are to identify medicinal plants and plant products sold by vendors in the markets of Gondar City and used by their clients to treat the COVID-19-related symptoms of fever, cough, and headache.

**Methods and Materials**: Questionnaires were used to interview vendors and clients.

**Results**: The research identified 38 vendors who sold traditional medicines and 37 clients who reported using medicines for fever, cough, and headache. Of the 14 medicinal, food, and spice plants and plant products sold, the most common were garlic *(Allium sativum*) followed by black cumin (*Nigella sativa*) seeds, *haregresa (Zehneria scabra*) leaves, and basil (*Ocimum trifolium*) leaves. The plant materials most commonly used were *haregresa* leaves, garlic, and flax seeds. Four of the plants have active anti-coronavirus, immune-modulatory, and anti-inflammatory compounds. The sale and use of medicinal plants and functional foods reflects traditional cultural practices in Ethiopia.

**Conclusion**: Open-air markets are a major source of indigenous foods and medicines that may be valuable in the management of COVID-19. Medicinal plant products sold for fever, headache, and cough in Gondar City may have mostly palliative and immuno-modulatory benefits. Several areas needing further study are identified.

**Keywords:** COVID-19; Traditional medicines; Market vendors; Clients; Ethiopia

## 1. Introduction

COVID-19, caused by the SARS-CoV-2 virus, is causing extensive morbidity and mortality worldwide, including in Ethiopia. In the absence of effective treatment for COVID-19, some Ethiopians are using traditional medicines to manage the major symptoms caused by this infection, including fever, cough, headache, and other pain [1]. COVID-19 is difficult to treat in severely ill patients with a history of respiratory disorders, diabetes, cardiovascular diseases, and other chronic diseases as it results in high fatality. Oxygen supplementation has been widely used for severely ill patients in Ethiopia [2] and anti-COVID vaccines have been administered as their supply has increased. By January 8, 2022, only 8.0% of the Ethiopian population was reported to have completed the initial vaccination protocol [3].

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### 1.1. Medicinal plants used for COVID-19

Since the outbreak of the COVID-19 pandemic in 2020, traditional medicines have increasingly been used for the treatment and prevention of the disease throughout the world [4, 5] in the absence of or difficulty of accessing proven curative treatments [6]. The Word Health Organization (WHO) promotes the use of traditional, complementary, and alternative medicine [7]. Populations, researchers, and public health officials in many developing countries increasingly look for effective, affordable, accessible, culturally acceptable, and affordable indigenous medicines but there is still a need to move beyond in-vitro clinical trials and anecdotal clinical information to more rigorous studies to ensure their safety and regulatory compliance [8].

Ethiopians are using medicinal plants or COVID-19-related symptoms characteristic of influenza, common cold, febrile illness, and other viral diseases, which have traditionally been treated at home with plant materials obtained from the wild, fields, home gardens or open markets. and by traditional healers [9-12]. A review of 111 Ethiopian medicinal plants revealed 56 species with antiviral components that were considered promising for the treatment of COVID-19 [1]. Another review reported that 24.9% of common colds and influenza infections were treated with plant medicines [12]. Several other studies in Ethiopia reported the use of traditional medicines for viral infections, including hepatitis, rabies and COVID-19 (13, 14). A web-based and phone survey of foods, homemade beverages and plants found that 41.3% of the participants used medicinal plants at least once a day for COVID-19 prevention [15]. However, considerable information needs persist in the population largely due to lack of evidence of the efficacy of medicinal plants and misconceptions about the prevention, transmission, and treatment of COVID-19. For example, 18% of 929 respondents in an internet survey believed that there are indigenous medicines and foods for the prevention or treatment of COVID-19 in Ethiopia; 49.0% stated they eat garlic, onions, and honey to prevent COVID-19, and 24.4% reported eating these foods to cure this disease [16]. Moreover, two-thirds (67.8%) of 410 Ethiopian traditional healers and religious clerics considered their treatments and management of COVID-19 cases to be better than those of physicians [17].

Traditional medicines are receiving increasing attention as potential anti-COVID-19 agents also in other countries, especially in China, where they have shown promise in the treatment of COV-SAR-2 infections [17-19]. Hordofa and Kiros [12] called for further studies to fully evaluate the beneficial and adverse effects of antiviral agents in the treatment of COVID-19.

Increasing attention in being given to the role of foods and diets in the disparate distribution of COVID-19 world-wide. Spices in particular have been associated with successful COVID-19 treatment; an inverse relationship has been reported between the quantity of spices use by people in various countries and COVID-19 prevalence [20].

In Ethiopia, no studies have been carried out in open-air markets on the sale of foods, spices, and indigenous medicinal products specifically for the treatment of COVID-19 although a large number of medicinal plants has been documented in markets [26]. The scarcity of anti-COVID pharmaceutical drugs in Ethiopia, the potential of indigenous medicines and spices for palliative care, and the immunomodulatory properties of the indigenous medicines make studies of the availability and use of these products important. The objectives of this study are to identify plants and plant products used for the treatment of the COVID-19-related symptoms of fever, headache, and cough, describe their sale by vendors in the open-air markets of Gondar City and their use by clients of market vendors and emphasize the importance of open markets as sources of medicinal plants.

### 1.2. Traditional medicines and functional foods in open markets

Open markets, also known s open-air markets, exist in all developing and many developed countries. In developing countries, they play a prominent role in the distribution of staple foods, spices, condiments, traditional medicines, clothes, tools, household wares, and increasingly also electronic goods in both rural and urban communities [21-23]. Most communities in Ethiopia and other African and Asian countries have open-air markets, both periodic markets in rural areas on certain days of the week and daily markets in towns. In 11 Southern African cities, about 70% of poor households regularly bought food from street and market vendors in 2015, and in some cities over 95% of households purchased food from the informal sector [22].

Reasons for many people preferring to purchase their basic goods from market vendors include greater availability, greater freshness, and lower cost of agricultural produce in markets than supermarkets; greater familiarity with the products; and the preference for purchasing these goods on a person-to-person basis rather than using banking and credit card services in supermarkets [21,23]. Market medicines are typically purchased by poor people from similarly poor vendors who share their traditional medical knowledge with clients, further facilitating the continuing use of market medicines [21, 22]. The sale of traditional medicines in markets has been reported mainly from countries in Asia

[24, 25] and Africa [22, 27-36]. The economic values of the Sub-Saharan market for traditional medicines were estimated at $1.4 billion in 2003 and to grow at an annual rate of 5-15% [36].

## 2. Materials and methods

### 2.1. Study design and sampling

Thirty-eight vendors selling medicines for the three COVID 19-related symptoms of fever, headache, and cough in the two markets in Gondar City were identified using the snowball method and interviewed during walk-throughs; 37 of their clients were also interviewed. A qualitative approach was used that consisted of in-depth interviewing of vendors and their customers about their knowledge and practices concerning the sale and use of traditional medicines.

### 2.2. Data collection methods

Two separate questionnaires, one for the sale of plant medicines for COVID-19 by vendors and one regarding the use of these medicines by their clients, were used to interview all study participants. The questionnaires were pre-tested with 10 vendors and 7 clients to ensure their validity. Specimens of plants used to treat COVID-19-related symptoms were purchased from the vendors to identify plant species and to facilitate the interviews.

The purpose of the survey was explained to both vendors and clients, and their questions were answered in detail to facilitate the cooperation of participants who were reluctant to be interviewed because of their fear they may be accused of selling or using unauthorized alternative medicines for COVID-19 and their business transactions may be interrupted. Two pharmacy graduate students and a senior pharmacist carried out the interviews under the supervision of the principal author, a medical anthropologist (TCW). Although the interviewers assured the vendors and clients that there was no ban on the sale and use of plant medicines for COVID-19 and that they would be anonymous, 11 vendors and 8 clients refused to be interviewed.

### 2.3. Data analysis

The data, summarized in tables, were reported as percentages, and means were determined in order to examine the use of traditional medicines among different socio-demographic respondents as well as their knowledge/awareness of COVID-19. The scientific names of plant species were determined from ethno-botanical classification keys and verified through examination of plant samples by a botanist in the Department of Biology of the University of Gondar.

The results of this study were categorized into the following four basic thematic areas: socio-demographic characteristics of vendors and clients, knowledge about COVID-19, the sale of medicines, and the use of medicines for COVID-19-related symptoms.

### 2.4. Ethical approval and consent to participate

The study was carried out with permission from the Ethical Review Board of the University of Gondar (R/C/S/V/P/05/80 /2021). The individual vendors and clients were invited to give written informed consent before the interview. Confidentiality was ensured by providing respondents privacy as they filled out the questionnaire. We also informed the participants they could withdrew even during the interview All personal identifies, such as the names of the participants, were coded in the database.

## 3. Results

### 3.1. Socio-demographic characteristics of respondents

Forty-six (61.3%) of the 75 study subjects were females; male-female distribution was nearly identical for both vendors and clients. The mean age of the participants was 46.8±11years (SD). Nearly twice as many vendors (39.5%) as clients (21.6%) were illiterate and vendors were less represented at all levels of education beyond primary school. Similarly, whereas all male vendors were also housewives, 29.7% of the clients were salaried government workers. More than three times as many vendors as clients were Moslems; clients were predominantly Orthodox Christians.

### 3.2. Knowledge of vendors and clients about COVID-19

All vendors and clients had heard or read about COVID-19. Nearly half (45.3%) of the respondents considered inhaling the virus to be the main route of transmission, 35.9% named contact with other persons and touching surfaces as risk

factors, and 34.7% considered poor facial hygiene and other factors to be involved in transmission. One-fifth of the respondents did not know how COVID-19 is transmitted. The majority (46.7 %) of vendors and clients named fever and 26.7% named headache as symptoms of COVID-19 but 34.7% of the respondents did not know any symptoms. There were no major differences in knowledge between vendors and clients**.** Nearly all respondents had obtained their information from secondary sources as the majority of respondents (85.3%) had never been tested for COVID-19 and only 4 (36.4%) vendors tested positive (Table 1).

**Table 1** Knowledge about and infection with COVID-19 among 38 vendors and 37 clients in Gondar, October, 2022

| | **Vendors** | **Clients** |
|---|---|---|
| **Characteristic** | **Number (percent)** | **Number (percent)** |
| Do you know what COVID-19 is? | | |
| Yes | 38(100) | 37(100) |
| No | 0 | 0 |
| What are the major symptoms of COVID-19? | | |
| Fever | 31 (81.7) | 34 (91.8) |
| Headache | 26 (68.4) | 30 (81) |
| Other symptoms, including cough, loss of smell, muscle pain, general weakness, chilliness, running nose, sweating, loss of taste | 20 (52.8) | 22(59.4) |
| Don't know | 16 (42.1) | 10 (27.0) |
| Major mode of transmission | | |
| Inhaling virus | 18 (47.4) | 16(43.2) |
| Contact with persons or objects | 12 (31.6) | 16(43.2) |
| Others (poor facial/oral hygiene, sharing materials etc.) | 13(34.2) | 13 (35.1) |
| Have you ever been tested for COVID-19? | | |
| Yes | 6 (15.7) | 5(13.5) |
| No | 32 (85.3) | 32(86.5) |
| Was the test result positive? | | |
| Yes | 4 (66.7) | 0 |

### 3.3. The sale of traditional medicines

The 38 vendors sold and the 37 clients purchased a total of 14 plant species and plant products belonging to 14 plant families for fever, headache, and cough (tables 2 and 3). Ten plants and plant products were seeds; 7 were leaves; 4 were rhizomes, bulbs, or roots; 1 was bark; and 1 was nut. Nearly all (94.7%) of the vendors sold garlic *(Allium sativum*), 20 (52.6%) sold black cumin (*Nigella sativa*) seeds, 14 (36.8%) sold *haregresa (Zehneria scabra)* leaves, 12 (31.6%) sold basil (*Ocimum latifolium*) leaves, 11 sold garden cress *(Lepidium sativum),* and 10 (26.3%) sold ginger (Zingiber officinale) rhizomes. Each of the remaining eight plant species and plant products were sold by three to seven vendors (Table 2). Whereas between 10 and 36 vendors sold garlic, black cumin seeds, *haregresa* leaves, basil leaves, garden cress, and ginger, only three vendors sold coriander seeds, blue gum eucalyptus leaves, and niger seeds.

Vendors described garlic, black cumin seeds, *haregresa, basil, ginger,* and campion roots as useful remedies for both headache and fever or cough and the other medicines for only one of these symptoms. Nine of the 14 plant materials sold are widely used foods and spices in Ethiopia and five *haregresa leaves, garden* cress seeds, violet tree bark, campion root, and eucalyptus leaves) were said to be used exclusively as medicines (Table 2).

**Table 2** Medicinal plants and plant products sold by vendors (*n*=38) in Gondar markets for the management of COVID-19-related symptoms in October, 2022

| **Common names and local names (Amharic)** | **Species (Family)** | **Part of the plant used** | **No. (%) of vendors reported\plant use** | **No. of vendors selling plants for** |
|---|---|---|---|---|
| Garlic *(nech shinkurt)* | Allium sativum( (Amaryllidaceae) | Bulb | 36 (94.7) | Cough (16), fever (15), headache (5) |
| Black cumin (tikur azmud) | *Nigella sativa* (Ranunculaceae) | Seeds | 20 (52.6) | Headache (12), cough (8) |
| *Haregresa* | *Zehneria scabra* (Cucurbitaceae) | Leaves | 14 (36.8) | Headache (8), fever (6) |
| Basil *(damakase)* | Ocimum lamiifolium (Lamiaceae) | Leaves | 12 (31.6) | Headache (8), fever (4) |
| Garden cress *(feto)* | *Lepidium sativum* (Brassicaceae) | Seeds | 11 (28.9) | Headache (11) |
| Ginger (gingible) | *Zingiber officinale* (Zingiberaceae) | Rhizome | 10 (26.3) | Fever (6), cough (4) |
| Peanuts *(ocholon)* | *Arachis hypaea* (Fabeaceae) | Nut | 7 (18.4) | Cough (7) |
| Flax seeds *(talba)* | *Linum usitatissimum* (Linaceae) | Seeds | 7 (18.4) | Cough (7) |
| Violet tree *(temenay)* | *Securidaca longepedunculata* (Polygalaceae) | Bark | 7 (18.4) | Cough (7) |
| Campion or catchfly (*wogert)* | *Silene macroselen* (Caryophyllaceae) | Root | 7 (18.4) | Headache (4), fever (3) |
| Coffee *(bunna)* | *Coffea arabica* (Rubiacease) | Leaves | 5 (13.2) | Headache (5) |
| Coriander *(dimbelal)* | *Coriandrum sativum* (Apiaceae) | Seeds | 3 (7.9) | Fever (3) |
| Blue gum (eucalyptus *(nech bahirzaf)* | *Eucalyptus globulus* (Myrtaceae) | Leaves | 3 (7.9) | Fever (3) |
| Niger seeds *(nug)* | *Guizotia abyssinica* (Asteraceae) | Seeds | 3 (7.9) | Cough (3) |

### 3.4. The use of traditional medicines by clients

The 37 **c**lients reportedly used 11 plant species, all of which were sold by the vendors for COVID-19-related symptoms. Clients reported 38 plant uses for fever, 33 for cough, and 12 for headache. Twenty-two (59.5%) clients used *haregresa* for fever and 4 (10.8%) for headache; 8 (21.6%) clients used garlic for cough and 4 (10.8%) for fever; 10 (27.0%) of the clients used flax seeds for cough. Fewer than 10 clients used each of the remaining plants for fever, headache, or cough (Table 3). Two clients used only two plants, one using garlic and *haregresa* for fever and the other coriander seeds and flax seeds for headache**.** Three clients reported not using any plant medicines for the three symptoms (Table 3).

**Table 3** Traditional medicines used by clients (*n*=37) for three COVID-19-related symptoms in Gondar in October, 2022

| Common plant names (local names) | Species (Family) | Part of Plant | No. (%) of clients reportedly used | No. of uses by symptoms |
|---|---|---|---|---|
| *(Haregresa)* | *Zehneria scabra* (Cucurbitaceae*)* | Leaves | 26 (70.3) | Fever (23), headache (4) |
| Garlic *(nech shinkurt)* | *Allium sativum* (Amaryllidaceae*)* | Bulb | 12 (32.4) | Cough (8), fever (5) |
| Flax seeds *(talba)* | *Linum usitatissimum* (Lineaceae) | Seeds | 10 (27.0) | Cough (10) |
| Niger seeds (*nug*) | *Guizotia abyssinica* (Asteraceae) | Seeds | 7(18.9) | Cough (7) |
| Garden cress (f*eto)*, | *Lepidium sativum* (Brassicaceae) | Seeds | 7 (18.9) | Fever (7) |
| Ginger *(gingible)* | *Zingiber officinale* (Zingiberaceae*)* | Rhizomes | 5 (13.5) | Cough (5) |
| Basil *(damakase)* | *Ocimum lamiifolium (*Lamiaceae) | Leaves | 3 (8.1) | Fever (3) |
| Coriander *(dimbelal)* | *Coriandrum sativum* (Apiaceae) | Seeds | 3 (8.1) | Headache (4) |
| Blue gum eucalyptus *(nech bahirzaf)* | *Eucalyptus globulus* (Myrtaceae) | Leaves | 3 (8.1) | Cough (3) |
| Black cumin *(tikur azmud)* | *Nigella sativa* (Ranuculaceae*)* | Seeds | 2 (5.4) | Headache (2) |
| Coffee *(bunna)* | *Coffea arabica L* (Rubiaceae) | Seeds | 2 (5.4) | Headache (2) |
| *Total* | | | 36 (97.3) | Fever (33), cough (33), headache (12) |

## 4. Discussion

This survey in the markets of Gondar City identified 14 well-known plants and plant products sold by vendors and used by clients for the COVID-19-related symptoms of fever, headache, and cough. These plants were reported in other market surveys in various regions of Ethiopia to be used for various illnesses prior to the COVID-19 epidemic [1,26], indicating their wide utilization by the population. Widespread uses of medicinal plants for these COVID-19- related symptoms were also reported in Peru [37], South Africa [38], and Morocco [39].

The common use of medicinal plants for these symptoms by clients reflects traditional cultural practices in the Ethiopian population before the pandemic. For example, viral febrile and respiratory illnesses have traditionally been treated with *haregresa,* [1], basil leaves [1, 13], garlic, ginger, and eucalyptus leaves [1,40]; chronic respiratory disorders have been treated with garden cress [41]. Flax seeds and oil are also broad-spectrum traditional medicines that have been found to have anti-inflammatory and immune-modulatory properties [39, 42].

Garlic, sold by more vendors than any other plant and the second most widely used medicine by clients, has been used as a treatment for febrile and numerous other diseases worldwide for many centuries [43]. Garlic, as well as black cumin (*Nigella sativa*) seeds, basil leaves, ginger, peanuts (*Arachis hypaea*), coffee (*Coffea arabica*) seeds, coriander (*Coriandrum sativum*) seeds, flax (*Linum utitatissimum*) seeds, and *nug (Guizotia abyssinica*) oil, are predominantly food plants in Ethiopia. The widespread use of these functional foods for food and medicinal purposes ensures their widespread and continued utilization that may modulate the COVID-19 epidemic [44]. This topic demands further studies considering that, according to Panyod et al. [45], there is overwhelming evidence that foods and medicinal herbs have a potential antiviral capacity against coronavirus and to prevent its disease.

The climbing plant *haregresa* was used by 22 (55.5%) clients for the treatment of fever and by 4 clients for headaches. *Haregresa* is a popular folk medicine in Ethiopia for the management of febrile illnesses, inflammation, headache, and malaise [46-49]. Hence, further biomedical screening of its properties against COVID-19 may be considered. Furthermore, 5.4% of the clients said they used garden cress (*Lepidium sativum*) for headache, 18.9% used it for fever. Hordofa and Kiros [12] reported the use of garden cress leaves and oil for headache and cough, and garden cress seeds have shown analgesic effects in animal studies [50].

In the present study, 27.0%, 18.9%, 13.5% and 8.1% of the clients used flax seeds (*Linum usitatissimum*), nug oil (*Guizotia abysinica*), ginger (*Zingiber officinale*) and eucalyptus leaves (*Eucalyptus globosus*), respectively, for cough suppression (Table 3). Eucalyptus essential oil is particularly promising in the management of cough and inflammation caused by SARS-CoV-2 and influenza viruses because of its anti-inflammatory, mucolytic, and spasmolytic effects [51]. Black cumin seeds, sold by 36 (94.7%) vendors, have been found to have anti-viral activity against the human immunodeficiency virus, hepatitis C, HIV, avian influenza (H9N2), and murine cytomegalovirus [52].

Pharmacological analyses found that some compounds in the plants studied in our surveys, including allicin in *Allium sativum* [53,54], nigelledine and *a*-hederinin in *Nigella sativa seeds* [55,56, lignans in *Linum usitatissimum* [57), and gingerol in *Zingiber officinale* [58], may be active against coronavirus or modulate the immune system and reduce inflammation. Garlic has immune-modulatory effects in both animal and human models because it contains bioactive compounds such as polysaccharides, organosulfur, and flavonoids that have anti-inflammatory and anti-viral effects [59]. A review by Rouf et al. [60] reported anti-viral activity of garlic against COVID-19, influenza and hepatitis A and a preventive effect in pre-clinical and clinical studies. These various findings indicate the potential of the plant medicines in this study in the management of cough, fever, and headache in COVID-19 cases, through use both as foods and as supplements in clinical treatment.

### *Limitations of the study*

The major limitation of this study is the small sample size, largely due to the reluctance of vendors and clients to participate in the study because of their fear of disruption of their business from engaging in what they feared might be unauthorized activities (selling and using traditional medicines for COVID-19) and the disruption of their business activities by the interviews. This hesitancy necessitated the use of short questionnaires that may have resulted in underreporting of the use of traditional medicines for COVID-19-related symptoms. We recommend that future studies compensate vendors for their time in order to promote cooperation.

## 5. Conclusion

This study indicates that open markets in Ethiopia are a major source of plants and plant materials used for headache, fever and cough that may be associated with COVID-19. The medicinal and functional food plants found in the markets of Gondar have traditionally been widely used in Ethiopia by healers and as household remedies for cough, fever, headache, and other COVID-19-related symptoms. Their continued use is ensured by the scarcity of anti-coronavirus vaccines, therapeutic drugs, and diagnostic tests, as well as the tradition of using well-known, accessible, and affordable indigenous medicines. These medicines may have primarily palliative and immune-boosting applications in the prevention, treatment, and management of COVID-19 and its complications. Open-air markets may thus play a major role in mitigating the effects of this disease.

Larger plant databases of open-air markets in different communities and- their phytochemical screening may identify additional promising plants and permit analysis of the relationship between plant knowledge and use for COVID-19-related symptoms in different socioeconomic, demographic, and cultural groups. With the expected increase in the availability of biomedical therapies and vaccines for COVID-19 in Ethiopia, studies will also be required that examine the outcome of combined and alternating treatments with traditional medicines and pharmaceutical drugs and of vaccinations.

### *Compliance with ethical standards*

### *Acknowledgement*

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### *Disclosure of conflict of interest*

The authors declare that they do not have any competing interest.

### *Availability of Data and Materials*

Data and materials are available from the corresponding author upon request.

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### *Authors Contributions*

TW directed the focus groups, key informant interviews, and participatory observation; performed the coding; categorized the emerged themes; and drafted the original manuscript.TC, AE, AD, AT, and HK all participated in the study design and data analysis. AE, AD, AT, and HK served as supervisors of all data collection and analysis and reviewed the original paper. All authors read and affirmed the final version of the manuscript.

### *Statement of informed consent*

All participants were sked to give their oral permission to interviewed. They were informed that they could withdraw any time from the study and ensured that all information recorded would be confidential and anonymous.

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