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Traditional plant-based remedies as supportive care for COVID-19 and diabetes in rural Bangladesh: A case study and exploratory review

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COVID-19 has significantly impacted populations worldwide, particularly in resource-limited regions with limited access to conventional treatments. In some regions, traditional plant-based remedies are often used to reduce medication costs. However, their efficacy is usually not warranted. This study presents a case report of a woman from rural Bangladesh diagnosed with COVID-19 and with diabetes as a comorbidity. The patient used home remedies, including medicinal fruit intake and herbal steam inhalation, alongside conventional medications to manage her COVID-19 symptoms. No medication was taken for her diabetes due to costs. After a few months, the patient underwent another PCR test and was confirmed free of the virus. The potential alleviation of the patient's diabetes or blood sugar levels was coincidental due to the presence of antidiabetic phytochemicals in the remedies. An exploratory literature review examines the therapeutic potential of the phytochemicals present in the food and herbal medicines taken by the patient. The findings suggest that these plant-based interventions may support immune function and glycemic control, although further clinical studies are needed. This case highlights the importance of exploring culturally relevant, affordable, and accessible therapeutic options for managing COVID-19 and comorbidities in low-resource settings.

Keywords: Anti-diabetic, Comorbidity, COVID-19, Herbal medicine, Phytochemicals, SARS-COV-2

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Introduction

COVID-19, caused by SARS-CoV-2, became a global health crisis[1]. Diabetes mellitus is widely recognised as one of the most critical comorbidities contributing to increased morbidity and mortality in COVID-19 patients. Individuals with diabetes are more susceptible to severe COVID-19 outcomes due to a combination of impaired immune response, chronic systemic inflammation, and increased oxidative stress[2]. These underlying conditions may exacerbate viral replication and trigger a hyperinflammatory state, commonly referred to as a "cytokine storm," which can lead to acute respiratory distress syndrome (ARDS), multi-organ failure, and prolonged recovery times[3]. COVID-19 can also disrupt glycemic control, especially in patients receiving corticosteroids or experiencing metabolic stress[4]. Studies have shown that diabetic patients are more likely to be hospitalised, require intensive care, and have higher case fatality rates compared to non-diabetic individuals[2-4]. In low-resource settings such as rural Bangladesh, this dual burden is particularly alarming due to limited access to consistent medical

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care and medications. This underscores the need for affordable, culturally appropriate, and integrative strategies to manage both conditions effectively[5-6].

Traditional plant-based remedies have gained renewed interest during the COVID-19 pandemic, particularly in communities with strong ethnomedicinal traditions and limited access to conventional healthcare. In many parts of the world, including South Asia and sub-Saharan Africa, traditional remedies have been employed as supportive care to manage viral symptoms, boost immunity, and address comorbidities[7-9]. Herbal medicines rich in bioactive secondary metabolites have been used for centuries to treat respiratory infections, fever, inflammation, and metabolic disorders—symptoms and conditions commonly seen in COVID-19 patients. Despite concerns over efficacy and standardisation, these remedies remain vital for many households, especially in rural areas, due to their accessibility, affordability, and cultural acceptance[10-11].

Although geographically small, with an area of 148,460 km^2, Bangladesh boasts remarkable plant biodiversity, harbouring over 6,000 plant species, including 300 exotics and eight endemic species[12]. Many plants produce secondary metabolites that protect against environmental stressors and possess various pharmacological activities, such as antiviral, anti-inflammatory, antioxidant, and antidiabetic effects. These properties make traditional medicinal plants a promising source of supportive therapies in managing COVID-19, particularly among patients with comorbid diabetes[7-11].

This paper presents a case study of a rural Bangladeshi woman with COVID-19 and pre-existing diabetes who recovered using a combination of conventional care and traditional plant-based home remedies. Existing literature reports that herbal medicine successfully treated COVID-19 patients. Girija and Sivan reported in 2022[13] that a COVID-19 patient was treated entirely with Ayurveda, an ancient traditional medicine system. This was supported by another case report that an Ayurvedic diet resolved persistent severe COVID-19 symptoms in a 71-year-old patient in India[14]. In a separate case report, Nibima and Immunim, two Ghanaian herbal medicines, managed mild COVID-19 within 7 days[15]. These case reports provide evidence of the efficacy of traditional medicines in managing COVID-19, supporting the current study.

The study further integrates a phytochemical literature review to assess the bioactivities of known remedies. This combined ethnomedicinal and phytochemical approach is new in its effort to contextualise lived experiences during the pandemic, examine traditional practices, and explore their potential therapeutic relevance. By doing so, the study seeks to contribute to broader discussions on culturally grounded, integrative health strategies in low-resource settings during public health emergencies.

Methodology

This research adopted a qualitative case study design and an exploratory review of the phytochemical literature. The case study focused on an individual who recovered from COVID-19 while managing comorbid diabetes using a combination of conventional medicines and traditional plant-based home remedies. The lone patient-participant was identified through a referral from a concerned citizen. Data were collected in late 2020 through phone interviews with the patient-participant and her one primary caregiver, for a total of two key informants for this case study. Verbal informed consent was obtained before the interviews. A semi-structured interview guide was used to gather information about the symptoms experienced, conventional medicines taken, and traditional remedies used throughout the illness. The remedies noted include inhalation therapies and fruit-based dietary intake. A narrative analysis of the patient's recovery experience was conducted.

Telephone interviews were audio-recorded and transcribed verbatim. The researchers read the transcripts carefully to gain an overall understanding of the key informant's narrative. The narratives were manually analysed following an inductive approach. Each transcript was examined line by line to identify contextual details regarding how the patient-participant managed COVID-19 infections and diabetes. Initial codes were assigned by annotating the transcripts. Similar codes were then grouped into broader categories. These categories were subsequently synthesised into principal narrative themes that reflected common patterns across the patient-participant and her caregiver. Coding and theme development were refined through iterative review until a coherent thematic structure was achieved. Finally, the emerging themes were revisited against the original transcripts to ensure that interpretations accurately represented participants' responses[16-17].

The exploratory literature review aimed at assessing the scientific basis of the reported remedies. Literature searching and synthesis were based on existing guidance for conducting literature reviews[18-19]. The studies were selected based on relevance to the review objectives. The evidence was synthesized narratively through thematic analysis. Each plant-based ingredient mentioned in the case was reviewed through secondary data sources, including PubMed, Google Scholar, and Scopus, to identify its bioactive compounds and reported pharmacological activities. Published literature and phytochemical databases were consulted to explore evidence of antiviral, anti-inflammatory, antioxidant, and antidiabetic properties.

The case report

This case report highlights one COVID-19 patient, confirmed through PCR testing in August 2020, with diabetes for about five years. The patient was a female in her early fifties from a village in Puthia Upazila, Rajshahi district, Bangladesh. Conventional doctors diagnosed her, but the participants could not provide medical results or prescriptions. The participants identified the following conventional medicines prescribed by an allopathic doctor: Erythromycin (antibiotic) for 5 days, Fexo 120 (fexofenadine hydrochloride 120 mg) for 2 months, Monas (Montelukast 10 mg) for 2 months, Vitamin B-complex, zinc supplement, and D-rise (vitamin D, 40,000 IU per capsule) for 15 days, and Doxiva (doxophylline) 200 mg for 15 days.

The patient-participant also used home remedies. She inhaled steam several times daily for two months from boiling water infused with Ginger (*Zingiber officinale*), Bay leaves (*Cinnamomum tamala*), Cloves (*Syzygium aromaticum*), and Black cumin seeds (*Nigella sativa*). She also ate four (4) hard-boiled eggs taken daily for 2 months while sick, 1-2 oranges daily (*Citrus sinensis*); fruit juice from 3-4 lemons (*Citrus limon*) or Limes (*Citrus aurantifolia*); 1 Sweet blood orange (*Citrus sinensis*) for 2 months while sick, 1-2 Red dragon fruits (*Hylocereus polyrhizus)* daily orally for 2 months, and Indian gooseberry (*Phyllanthus emblica*) daily orally for 2 months.

Regarding diabetes, the patient-participant reported never having taken conventional diabetic medications due to costs. Instead, the patient reduced her intake of rice and other carbohydrate-rich foods at her doctor's advice. At the time of the survey, the patient-participant could not provide information on her current diabetic status or any diabetes-related complications. By the end of September 2020, she had undergone another PCR test and was confirmed to be free of the virus. The remedies taken were intended solely for COVID-19, and any potential alleviation of her diabetes or blood sugar levels due to the presence of antidiabetic phytochemicals in the remedies was coincidental. According to the participants, these remedies were typical practice in her village and nearby areas for those infected with SARS-CoV-2 who had diabetes as a comorbidity. Fig. 1 presents the clinical decision pathway illustrating the prescribed treatment and the patient's actual management of COVID-19.

Home remedies used against COVID-19

The patient's home remedies included two primary approaches: steam inhalation and fruit-based dietary therapies. Inhalation therapy was done by inhaling steam from water containing herbs and/or spices heated to around 70°C. The latter refers to consuming several types of fruits several times daily.

Steam inhalation therapy

Steam inhalation was done by the patient during the onset of the infection, using boiling water with either of the slices of Ginger rhizome (*Zingiber officinale*), 2-3 Bay leaves (*Cinnamomum tamala*), 2-3 dried floral buds of Cloves (*Syzygium aromaticum*), and a pinch of Black cumin (*Nigella sativa*) (Fig. 2), with Ginger being the most used, while Black cumin the least. Inhalation was done several times daily for 2 months while she was sick. All the spices are commonly used in Bangladeshi cooking and are recognised for their pharmacological and traditional functions in maintaining respiratory health.

All the ingredients provide bioactive substances with anti-inflammatory, antioxidant, immune-

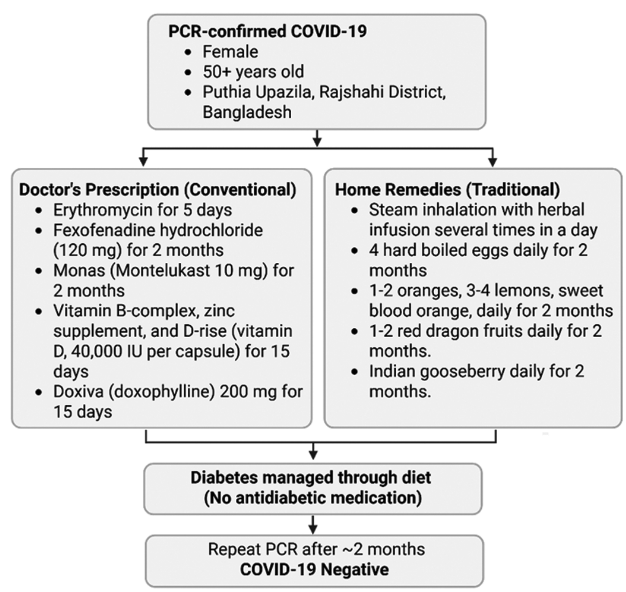

Fig. 1 — Clinical decision pathway illustrating the prescribed treatment and the patient's actual management of COVID-19.

modulatory, and, in some instances, antiviral or glycemic activities pertinent to COVID-19 and comorbid conditions such as diabetes[20-21]. For instance, eugenol from Clove and thymoquinone from Black cumin have exhibited promise in modulating cytokine storms and viral replication[22-23].

Employed for centuries in cultures worldwide, inhalation therapy delivers plant constituents directly into the lungs and has gained popularity during the pandemic. Regular exposure to aromatic spices during cooking in rural homes could extend respiratory advantages[24].

The process of inhalation therapy being conducted in Bangladesh is shown in Fig. 3. Note that the figure presents an impersonation. The person impersonated is one of the co-authors who gave his consent. No COVID-19 patients were involved.

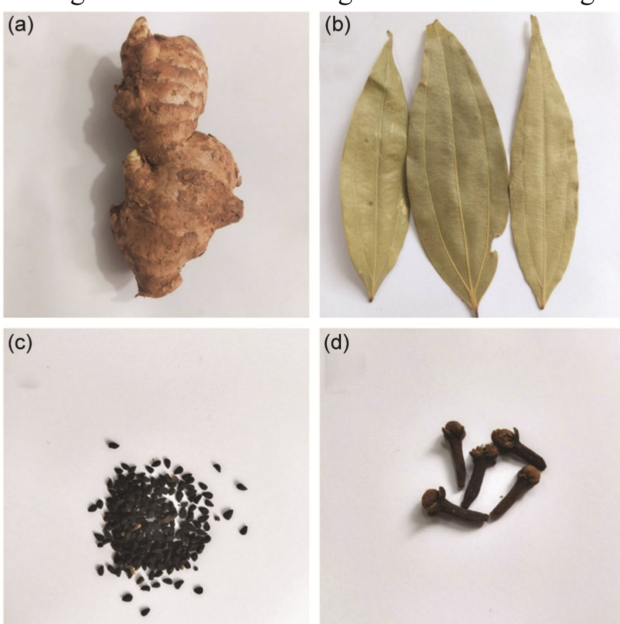

Fig. 2 — Ingredients of inhalation therapy. (a) Ginger, (b) Bay leaves, (c) Black cumin, and (d) Cloves.

Bioactive profile of ginger in steam therapy

SARS-CoV-2 entry factors are highly expressed in nasal epithelial cells[25]. Therefore, intranasal administration of drugs/vaccines can effectively limit spread. One component of the inhalation therapy used by COVID-19 patients is Ginger, which offers numerous benefits for managing COVID-19 and its comorbidities, whether taken nasally or orally. These benefits include anti-inflammatory[26], immunomodulatory[27], antioxidative[26], anti-diabetic[28], neuroprotective[29], cardiovascular protective[30], and respiratory protective[31] properties. Several phenolic components of Ginger, such as 6-gingerol, 8-gingerol, 10-gingerol, 6-shogaol, 6-hydroshogaol, and oleoresin, play significant roles in these pharmacological effects[32].

Bay leaf volatile organic compounds (VOCs) and respiratory health

Plants can bolster the immune system through the bioactive volatile organic compounds (VOCs) they emit[33]. The lower mortality of COVID-19 in Italian forested areas has been attributed to the emission of VOCs by plants like bay leaf or bay laurel (*Laurus nobilis*), in which anti-COVID-19 glycosides, laurusides, have been demonstrated in an *in silico* study[34]. Some volatile plant terpenes and terpenoids can also have protective effects, as demonstrated by their ability to reduce airway inflammation in animal models[35]. Some essential oil components can also reduce pulmonary inflammation induced by air pollution[36]. 'Forest bathing' or walking through forest areas can boost immune function by increasing the

Fig. 3 — Inhalation therapy in COVID-19: (a) Ingredients are boiled in water in a pot and cooled to a safe temperature for inhalation, (b) the patient holds their face over the pot, and (c) the patient's face and the pot are covered with a towel to facilitate efficient inhalation of the steam.

number of natural killer (NK) cells and the release of intracellular granulysin, perforin, and granzymes A/B, with reported effects on virus-infected cells[37]. Steam inhalation therapy, as practiced in Bangladesh, is simply the delivery of compounds that target organs via steam.

Volatile components of essential oil from leaves of *Laurus nobilis* (bay leaf) include β-caryophyllene, 1,8-cineole, sabinene, α-terpinyl acetate, α-pinene, bornyl acetate, linalool, methyl eugenol, β-pinene, eugenol, camphene, and α-terpineol[34,38]. The clinical efficacy of 1,8-cineole has been demonstrated in inflammatory airway diseases like COPD and asthma[39-40]. Bornyl acetate is present in twigs, leaves, and fruits of *L. nobilis*[41]. This volatile compound showed promise in treating lung inflammation in animal models of acute lung injury, and this effect correlated with the regulation of myeloperoxidase activity. This leucocyte-derived enzyme catalyses the formation of several reactive oxidant species[42]. Nam and others[43] showed that α-pinene was effective in treating allergic rhinitis. Anti-inflammatory and antinociceptive effects have been reported for β-caryophyllene[44-46]. Another recent review has pointed out that spices' general anti-inflammatory properties may alleviate the cytokine storm induced by SARS-CoV-2 and prevent COVID-19 severity[46]. This is an important step toward alleviating excessive cytokine storms associated with COVID-19, which can cause multiple organ disorders. Excessive production of pro-inflammatory cytokines leads to organ damage and fatalities.

Phytochemicals in clove relevant to COVID-19

Clove essential oil is rich in various bioactive compounds, and the most prominent among them are eugenol, β-caryophyllene, chavibetol, and eugenyl acetate. GC-MS and solvent extraction research have also revealed α-humulene, limonin, ferulic aldehyde, quercetin, kaempferol, and several phenolic acids. Minor but significant constituents are sesquiterpenes (α-cubebene, γ-cadinene), vanillin, oleanolic acid, and rhamnetin[47-48].

These phytochemicals present varied medicinal properties: antimicrobial, antidiabetic, antioxidant, anti-inflammatory, anti-obesity, and antiviral. Eugenol and its derivatives, for instance, exhibit antiviral activity against HSV and dengue virus proteases, whereas the anti-inflammatory effects of clove are attributed to the inhibition of COX-2 and the NF-κB pathway, and modulation of MAPK and JNK signaling. In animal models, Clove extracts decreased inflammation and protected from pyelonephritis, a renal complication linked to COVID-19[49-52].

Clove's long history of use in traditional herbal COVID-19 treatment in India and Morocco is supported by recent scientific findings. Computational research revealed that kaempferol, biflorin, and bicornin strongly bind to SARS-CoV-2's principal protease (Mpro) and block viral replication. A Clove decoction is also used for preventive measures in these nations and may help account for their lower COVID-19 mortality rates[53-55].

Metabolically, clove extracts suppress α-amylase and α-glucosidase activity, replicate insulin-responsive gene expression, and enhance glucose uptake. Clinical evidence has reported decreased postprandial glucose and enhanced wound healing in diabetic models. Eugenol can also increase NRF2-activated antioxidant response, which is central to diabetic recovery[46-57].

Black cumin and thymoquinone in viral defence

The chemical composition of *Nigella sativa* seeds and essential oils is geographically varied[58]. Major volatile constituents in Bangladesh are p-cymene, thymoquinone (TQ), α-thujene, carvacrol, β-pinene, and limonene[59-60]. Iranian and Indian essential oils have varying volatiles, such as thymohydroquinone (THQ) and dithymoquinone (DTQ), and volatiles like α-phellandrene, ocimene, citronellyl acetate, and aromadendrene[58,61]. More than 40 volatiles and a variety of alkaloids (nigellone, nigellicimine), sterols, flavonoids (quercetin, kaempferol), saponins (α-herein), and tocopherols have been reported[62].

Thymoquinone (TQ) is the most researched for its potential against COVID-19. TQ has antioxidant, anti-inflammatory, antiviral, immunomodulatory, and anticoagulant activities. TQ suppresses several viruses, including CMV and HIV, and recent research suggests it may inhibit SARS-CoV-2 by binding to ACE2 and other viral targets. A clinical trial of *N. sativa* oil in patients with mild COVID-19 reported faster recovery, with TQ and associated compounds reducing IL-2, IL-4, IL-6, and IL-12 while enhancing IFN-γ and IgG levels[22].

In silico models, TQ and its related compounds bind well with viral proteins like Mpro, Nsp15, RdRp, and ACE2 receptors. α-hederin, nigellidine, and nigellamine A2 compounds exhibit robust binding affinities like reference inhibitors. Nigellidine also influences IL1R pathways involved in cytokine storms[63-64].

The broad-spectrum activity of *N. sativa* is also corroborated by its therapeutic efficacy against comorbidities associated with COVID-19, such as diabetes, cardiovascular disease, and respiratory diseases. It is also promising against mucormycosis, an invasive fungal infection common in diabetic COVID-19 patients. The daily consumption of such spices in Bangladeshi kitchens - particularly in non-ventilated kitchens - may provide incidental health benefits by inhalation of bioactive volatiles, especially among women[65-66].

N. sativa makes a strong argument for integration into respiratory disease management, with both conventional use and contemporary pharmacology attesting to its application in the case of COVID-19.

Fruits taken as home remedies for COVID-19

The fruits taken by the COVID-19 patient included mainly *citrus* fruits (orange, lemon, and 'malta') along with dragon fruits and Indian gooseberries (Fig. 4).

Citrus fruits such as oranges and lemons are rich sources of flavonoids, polyphenols, carotenoids, and vitamins, especially vitamin C. These bioactive compounds are well-documented for their antioxidant, anti-inflammatory, and immunomodulatory properties[67]. Key *citrus* flavonoids, such as hesperidin, narirutin, quercetin, and eriocitrin, have been shown to modulate oxidative stress and suppress pro-inflammatory cytokines, which are critical processes involved in COVID-19 severity and the development or worsening of comorbidities like diabetes[68]. Although the antiviral effects of many of these flavonoids are mainly established through computational modeling, their ability to support immune balance and reduce inflammation is well supported[69].

The chemical composition of *Citrus* fruits can vary significantly depending on the cultivar, region, and climatic conditions. For instance, differences in ascorbic acid, carotenoids, and phenolic content have been observed among multiple cultivars. Despite this variability, *Citrus* intake remains a reliable dietary source of vitamin C, with sweet oranges reportedly containing over 58 mg per 100 g of fruit. Since humans cannot synthesise vitamin C endogenously, dietary intake becomes essential, especially during infections with heightened oxidative stress[67-70].

Oxidative stress and inflammation are central to the pathogenesis of COVID-19 and its comorbidities. *Citrus* polyphenols and vitamins, particularly vitamin C, can mitigate these effects through several pathways, including scavenging reactive oxygen species (ROS), modulating redox-sensitive transcription factors (e.g., NF-κB, Nrf2), and reducing the expression of pro-inflammatory markers[71-72]. The beneficial effects of *Citrus* flavonoids and related compounds in COVID-19 and diabetes are further outlined in Table 1.

While this case report illustrates a potentially beneficial traditional dietary strategy, clinical trials are needed to establish standardised evidence. Nonetheless, integrating culturally accepted and nutritionally

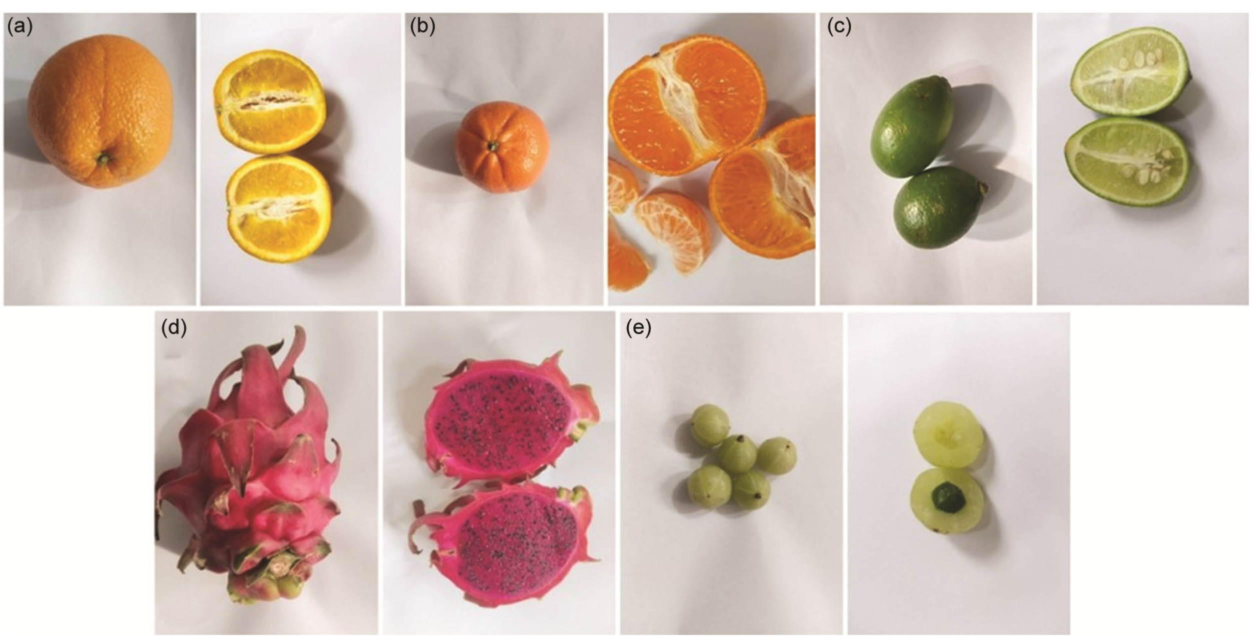

Fig. 4 — Whole and cut fruits of (a) Sweet orange, (b) Malta, (c) Lime fruit, (d) Dragon fruit, and (e) Indian gooseberry.

Table 1 — Phytochemical composition and reported biological activities of common Citrus fruits

Citrus fruit	Key phytochemicals	Biological/Pharmacological activities	References
Sweet orange (*C. sinensis*)	Hesperidin, Narirutin, Nobiletin, Naringenin, Quercetin, Luteolin, Apigenin, Naringin, Didymin, Vicenin-2	Antioxidant, anti-inflammatory, immunomodulatory, antidiabetic, antiviral (*in silico*)	67,70,72-74
Malta orange (various *Citrus* sp.)	Flavonoids similar to those of *C. sinensis,* depending on cultivar	Same as above; cultivar-dependent	67,70,75–76
Lemon (*C. limon*)	Eriocitrin, Hesperidin, Rutin, Diosmetin, Luteolin, Apigenin, Quercetin, Isorhamnetin	Antioxidant, anti-inflammatory, potential antiviral, antidiabetic	67,70,77-78
Lime (*C. aurantiifolia*)	Neohesperidin, Limonin, Hesperidin, Limonexic acid	Antioxidant, cholesterol-lowering, anticancer, antiviral	67,70,77-78
All *Citrus* fruits	Vitamin C, Vitamin E, Carotenoids (Î²-cryptoxanthin, lutein, zeaxanthin), Polyphenols, Coumarins (Auraptene, Umbelliferone)	Reduces oxidative stress, modulates immune responses, improves antioxidant defence	67-79

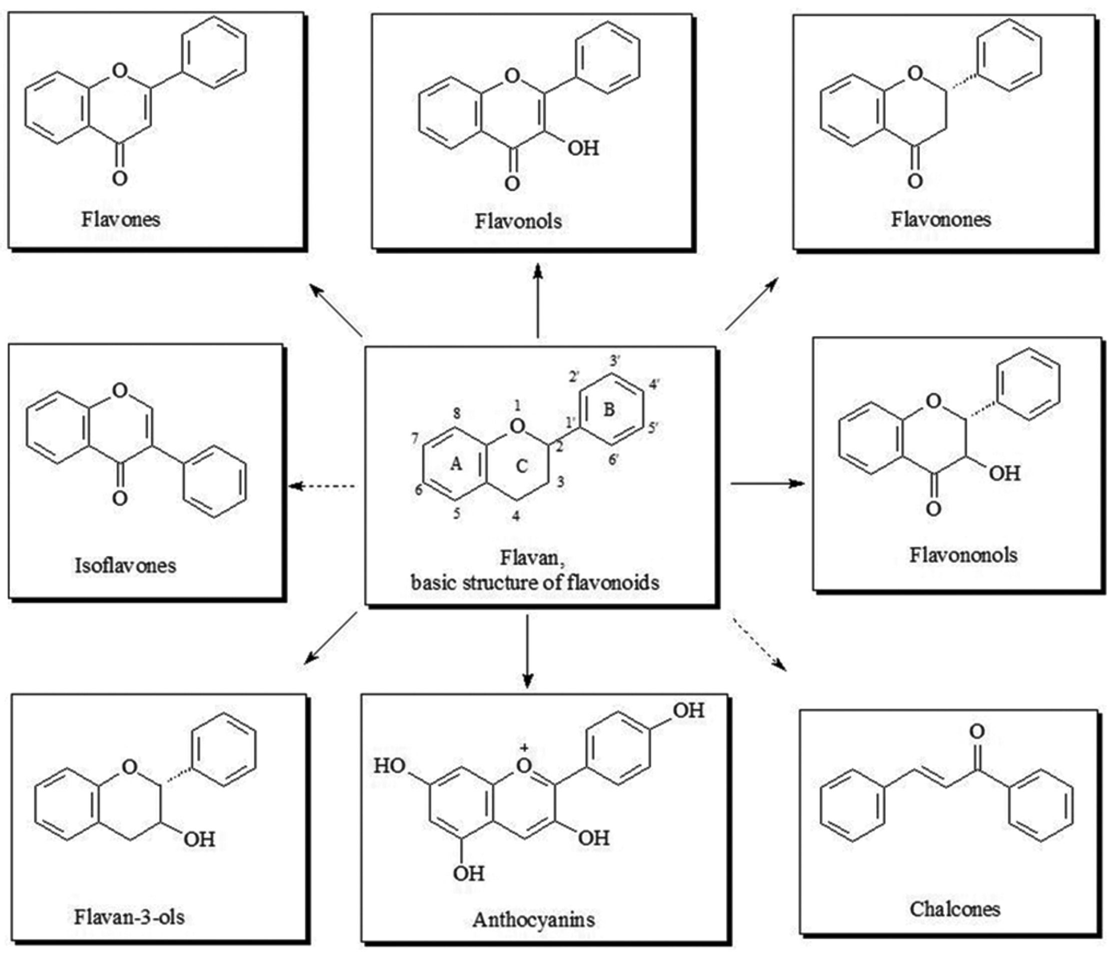

Fig. 5 — Structures of various groups of flavonoids.

valuable foods like *Citrus* fruits holds promise for public health, particularly in low-resource contexts.

***Citrus* fruit flavonoids and COVID-19**

Scientists have a consensus regarding the importance of flavonoids in prophylaxis and therapeutics compared to other compounds. This is due to the diversity of flavonoids and their availability, along with their diverse biological effects, which can play beneficial roles in preventing and treating diseases[79]. Fig. 5 presents the structures of various flavonoids. *Citrus* fruits are a significant source of flavonoids and several vitamins.

The high amounts of carotenoids, ascorbic acid, and tocopherols in *Citrus* fruits and flavonoids have made *Citrus* extracts an attractive base for studying the treatment of COVID-19 and its comorbidities. For instance, quercetin has been noted as the most promising flavonoid for alleviating lingering post-COVID-19 symptoms[79]. Flavonoids are known for their immunomodulatory abilities, which can help alleviate the cytokine storm in COVID-19 patients. These abilities result from the regulation of inflammatory mediators (quercetin, rutin, apigenin, vitexin, and diosmin)[80], inhibition of endothelial activation (hesperidin, naringenin, naringin)[81], NLRP3 inflammasome (apigenin, quercetin, kaempferol)[82], toll-like receptors (TLRs) (quercetin, apigenin, luteolin, rutin)[83], bromodomain-containing protein 4 (BRD4) (fisetin, amentoflavone)[84], and activation of nuclear factor erythroid-derived 2-related factor 2 (Nrf2) (luteolin, apigenin, quercetin, myricetin, rutin, naringenin, epicatechin, and genistein)[85].

Flavonoids can also inhibit DPP4 and 3CLpro and influence gut microbiota to regulate the immune response[86]. Quercetin, scutellarin, and myricetin (all found in oranges) are promising candidates to inhibit 3CLpro[87]. The poor bioavailability of quercetin can be improved by the quercetin-phospholipid complex (Quercetin Phytosome® in humans)[88]. DPP4 inhibitors, known as antidiabetic drugs, can potentially help control SARS-CoV-2-induced inflammation[89-92]. *Citrus* bioflavonoids rutin, hesperidin, and eriodictyol are reported to be effective DPP4 inhibitors[93].

Citrus fruit alkaloids and COVID-19

Since synephrine (an alkaloid found in *Citrus* fruits) has a good bronchodilatory effect[94-95], it is postulated to alleviate COVID-19-induced dyspnea[96]. Synephrine reportedly exhibits potent antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *Proteus mirabilis*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Staphylococcus aureus*, *Enterococcus faecalis*, and *Bacillus subtilis*, which can develop opportunistic infections in COVID-19 patients[97]. Oranges (sweet and blood red), lemons, and limes do not appear rich in alkaloids. However, other *Citrus* fruits contain several alkaloids, including (±)-octopamine, tyramine, N-methyl tyramine, and hordenine in bitter orange, *Citrus aurantium*[98-100]. Although a literature search did not reveal any antiviral reports of these alkaloids, a combination of synephrine, octopamine, and hispidulin improved obesity in high-fat diet-induced obesity in mice[101]. A combination of synephrine and hispidulin showed antiadipogenic effects on 3T3-L1 adipocytes[102]. Both obesity and diabetes are significant comorbidities of COVID-19, and the presence of obesity can shift the severity of COVID-19 to a younger age. The appearance of bacteria in COVID-19 patients with obesity and/or diabetes can cause severe lung injury due to bacterial-viral interactions[103]. Additionally, obese individuals are more prone to develop diabetes and its various complications[104-105].

Other fruits taken by the COVID-19 patient: dragon fruit and Indian gooseberry

The COVID-19 patient took two other fruits during her COVID-19 infection: Indian gooseberry and dragon fruit (pitaya). Although indigenous to other regions of Asia and subtropical countries, dragon fruit is a new import to Bangladesh. Of the three varieties known, the pink-skinned with white pulp, red-skinned with red pulp, and yellow-skinned with white pulp, the red-skinned, red-pulped variety is now the most popular and was taken by the patient.

This variety of dragon fruit has been linked in various studies to antioxidant, anti-inflammatory, and antidiabetic activities. A systematic review and meta-analysis found that it significantly reduced fasting plasma glucose in prediabetic patients. However, the effect was weaker in diabetic patients unless taken at high doses. These effects are primarily attributed to the bioactive constituents of the fruit, which are summarised in Table 2.

Since both diabetes mellitus and COVID-19 are associated with oxidative stress and inflammation, the patient's intake of dragon fruit might have helped counteract these shared pathological processes. Considering the current body of literature, the fruit's ability to potentially lower oxidative damage, regulate blood glucose levels, and provide cardiovascular benefits implies a positive effect on both diseases[106-109].

Indian gooseberry (*Phyllanthus emblica*) is well known in traditional medicine for its wide range of therapeutic uses. It forms the main constituent of the traditional Ayurvedic remedy Triphala, commonly defined as a Rasayana or rejuvenating medicine known to strengthen immunity, aid digestion, and maintain respiratory function[111]. All these attributes will be helpful for patients suffering from viral

Table 2 — Classification of phytochemicals and their associated pharmacological properties

Phytochemical class	Compounds	Reported activities	References
Phenolic acids	Gallic acid	Antioxidant	106
	Caffeic acid	Antioxidant	
	Ferulic acid	Antioxidant	
	p-Coumaric acid	Antioxidant	
	Sinapic acid	Antioxidant	
Flavonoids	Kaempferol	Anti-inflammatory, Antioxidant	107
	Quercetin	Anti-inflammatory, Antioxidant	
	Epicatechin	Antioxidant	
	Epigallocatechin gallate	Antioxidant, Enzyme inhibition	
	Rutin	Cognitive support, Anti-inflammatory	
Betalains	Betanin	Antioxidant	108
	Isobetanin	Antioxidant	
	Phyllocactin	Antioxidant	
	Gomphrenin I	Antioxidant	
	Indicaxanthin	Antioxidant	
Anthocyanins	Cyanidin 3-glucoside	Antioxidant, Anti-inflammatory	109
	Delphinidin 3-glucoside	Antioxidant, Anti-inflammatory	
	Pelargonidin 3-glucoside	Antioxidant	
	Peonidin 3-O-diglucoside	Antioxidant	
	Petunidin 3-O-(6"-p-coumaroyl-glucoside)	Antioxidant	
Triterpenoids	Î±-Amyrin	Lipid-lowering, Cytotoxic	110
	Î²-Amyrin	Lipid-lowering, Cytotoxic	
	Octacosane	Lipid-lowering, Cytotoxic	
	Î²-Sitosterol	Lipid-lowering, Cytotoxic	

illnesses like COVID-19, especially with comorbid conditions like diabetes.

P. emblica contains many bioactive compounds, such as flavonoids, tannins, and vitamin C. Among its significant constituents are gallic acid, ellagic acid, chebulagic acid, corilagin, and quercetin, which have shown antioxidant, anti-inflammatory, and immune-modulatory activities in some preclinical research[111]. These phytochemicals reduce oxidative stress and inflammatory reactions, forming the nidus of COVID-19 and diabetes pathology[99-101].

Vitamin C, which is one of the richest constituents of *P. emblica*, is responsible for modulating immune responses and inhibiting oxidative damage. Its antioxidant activity could protect pancreatic β-cells from oxidative damage caused by chronic hyperglycemia, thereby improving glycemic control and preventing diabetic complications[82]. In addition, compounds like gallic acid and corilagin have been demonstrated to suppress pro-inflammatory cytokines (e.g., TNF-α, IL-1β, IL-6) and enzymes like COX-2 and iNOS, possibly curtailing the cytokine storm in severe cases of COVID-19[112].

Experimental research has also indicated that *P. emblica* extracts can inhibit inflammation markers in immune cells and show protective actions against viral infection and tissue injury. These observations imply that amloki might have a double advantage: alleviating symptoms of COVID-19 and aiding the treatment of metabolic disorders like diabetes, primarily through shared mechanisms such as inflammation and oxidative stress[113].

Scientific evidence validates the incorporation of *P. emblica* as a constituent of an integral plant-based pharmacological treatment protocol. Its phyto-component composition renders it highly appropriate for diabetes and COVID-19 management through immunomodulation, antioxidant activity, and glycemic therapy[113-114]. A list of phytochemicals found in *P. emblica* fruit and their structure is given below in Fig. 6.

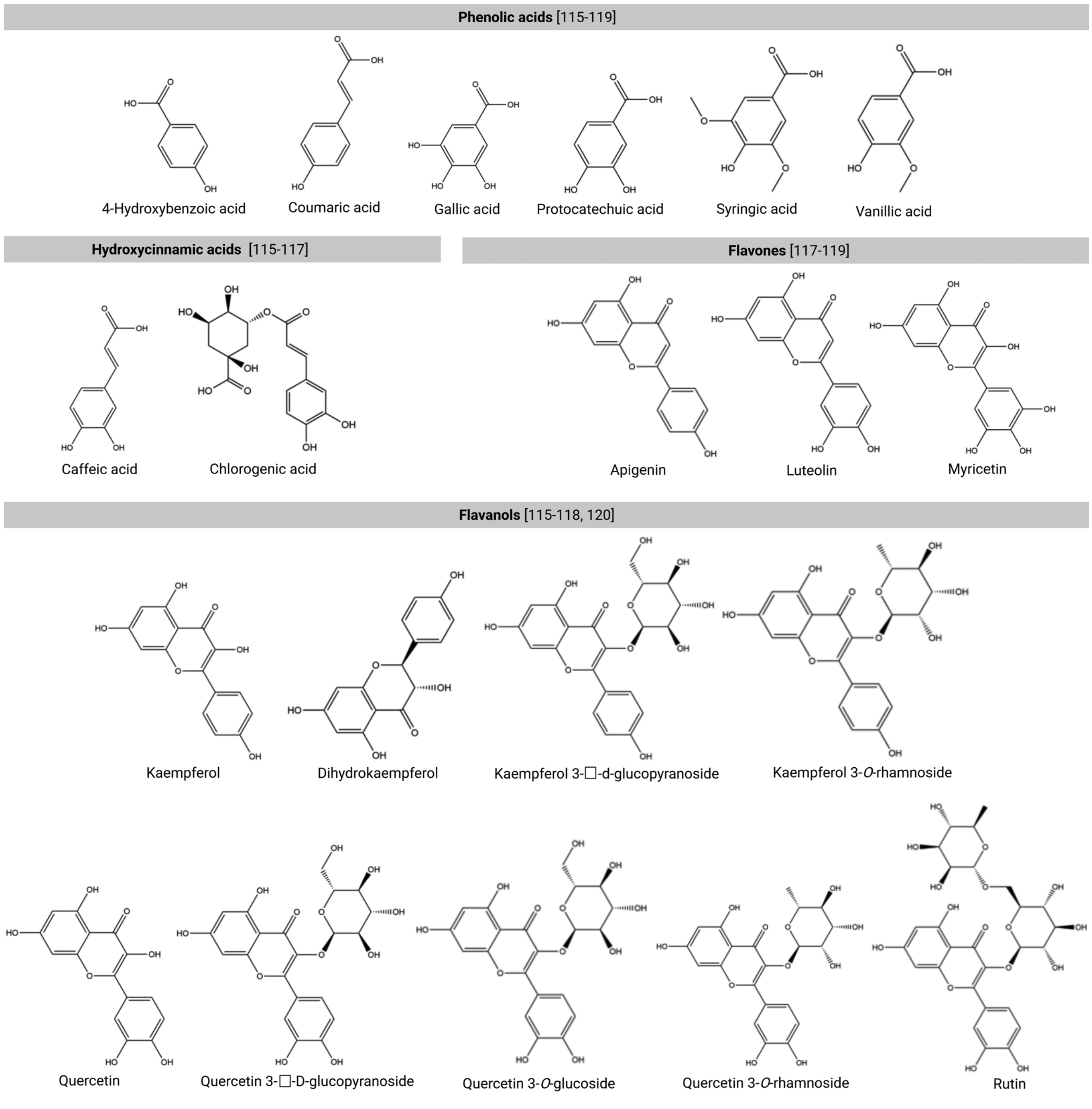

Fig. 6 — Phytoconstituents of *Phyllanthus emblica* fruits.

Conclusion

This case study documents the use of traditional plant-based remedies by a woman in rural Bangladesh diagnosed with COVID-19 and with diabetes as a comorbidity. The findings of this study contribute to the growing body of evidence regarding how cultural practices, economic constraints, and limited access to healthcare can influence treatment decisions during a public health emergency. The patient recovered from COVID-19 after using these remedies, but this observation should not be interpreted as evidence of therapeutic efficacy. The accompanying exploratory literature review indicates that several documented plant species contain phytochemicals with reported antioxidant, anti-inflammatory, immunomodulatory, and antidiabetic properties. This suggests their potential as supportive care rather than substitutes for evidence-based medical treatment. This study underscores the importance of systematically documenting traditional health practices. It provides a rationale for future pharmacological, clinical, and ethnobotanical investigations to evaluate the safety, efficacy, and potential integration of selected plant-based remedies into supportive care strategies.

Conflict of interest

The authors declare no conflict of interest.

AI use disclosure

The authors used an artificial intelligence (AI)-assisted language model (ChatGPT, OpenAI) to improve the clarity, grammar, and readability of portions of the manuscript and to assist in language editing. The AI tool was not used to generate, analyse, or interpret research data, nor to formulate the study's scientific conclusions. All outputs were critically reviewed, verified, and edited by the authors, who take full responsibility for the accuracy, integrity, and originality of the manuscript.

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