European Journal of Nutrition & Food Safety

12(7): 35-48, 2020; Article no.EJNFS.58600
ISSN: 2347-5641

Review on Ethno-botany, Virucidal Activity, Phytochemistry and Toxicology of *Solanum* genus: Potential Bio-resources for the Therapeutic Management of Covid-19

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Authors' contributions

This work was carried out in collaboration among all authors. Authors CMM, KNN and PTM wrote the first draft of the manuscript. Authors BZG, JTK, DSTT, CLI, EML, DTM and CMF collected information on plants bioactivity. Authors AM, EMN and DDT collected information on plant phytochemistry. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJNFS/2020/v12i730246
Editor(s):
(1) Dr. Johnson Akinwumi Adejuyitan, Ladoke Akintola University of Technology (LAUTECH), Nigeria.
Reviewers:
(1) Addis Kokeb Alemu, University of Gondar, Ethiopia.
(2) Estrada Jimenez, Rolando, Universidad Nacional Mayor de San Marcos, Peru.
Complete Peer review History: http://www.sdiarticle4.com/review-history/58600

Review Article

Received 16 June 2020
Accepted 02 July 2020
Published 13 July 2020

ABSTRACT

Background and Aim: Condiment plants are not only a source of food, flavors or food additives but also antivirals. The aim of the present work consisted in compiling ethno-botanical, phytochemical, toxicological and biological activities literature data reported on some species of the *Solanum* genus, precisely their antiviral potential.

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Methodology: The literature review was based mainly on the usual databases such as PubMed, PubMed Central, Science Direct, SCIELO, DOAJ, Science alert and Google scholar.
Results: The ethnobotanical studies show that *Solanum* species are used in traditional medicine for the treatment of several ailments, particularly those affecting the respiratory system. With regard to studies on their bioactivity, the literature indicates that the *Solanum* genus is full of species used in food and/or traditional medicine, in most cases presenting several biological properties such as antiviral potential. Among the viruses sensitive to extracts from *Solanum* species, are: Herpes virus type 1 or 2, viral hepatitis virus and HIV. Some phytochemical studies identified several compounds responsible for the antiviral activity, but polyphenolic compounds precisely glycoalkaloids have been shown to interact with SARS-CoV-2 protease such as quercetin, kaempferol and apigenin in some *Solanum* species (*S. melongena, S. nigrum and S. torvum*). Furthermore, the immunostimulant, haematopoietic or antioxidant potentials of some species of *Solanum* genus would be an asset for the management of Covid-19. There is little or no information in the literature on the toxicity of *Solanum* species used as food or drugs in traditional medicine.
Conclusion: The antiviral activity of *Solanum* species is linked to the presence of polyphenolic compounds. It is advisable to consume these *Solanum* species which are less toxic during this pandemic as they are considered to be nutraceuticals. Molecular docking study of the interaction of these compounds with SARS-CoV-2 protease is in progress.

Keywords: Solanum sp; Covid-19; antiviral activity; SARS-CoV-2; phytochemicals.

1. INTRODUCTION

Viral diseases are the major sources of death worldwide and significantly affect global health. This is the case with Covid-19, a disease caused by a virus called, SARS-CoV-2. This is a new strain of coronavirus identified in Wuhan, China in 2019. Covid-19 is a pandemic currently considered as a global health problem and is responsible for thousands of deaths worldwide. No specific treatment or vaccine has been developed so far though some are still in clinical trials [1]. Given the difficulties in finding an effective vaccine in record time and the inaccessibility to poor populations to the conventional drugs proposed for the treatment of Covid-19, it is imperative during this calamitous period of international mourning to conduct investigations to identify plants that could be used against this disease. Moreover, the possible emergence of new strains resistant to the proposed drugs, the high cost of these antivirals or their side effects raise the need to identify new effective and safe alternatives against Covid-19 [2,3]. The exploration of the plant kingdom constitutes for researchers nowadays an unavoidable path for the discovery or development of new antivirals. However, medicinal plants are widely used to cure various infectious diseases in humans and can serve as a source of new antiviral therapeutic agents due to the presence of various bioactive compounds [4,5]. Parvez [6] reported that 21,000 plants are used in traditional medicine and about 30% of these plants are exploited directly or indirectly for the manufacture of modern medicines. In the current work, *Solanum* genus of Solanaceae family was the main focus of this review. In fact, the solanaceae family is one of the most important angiosperms families from an economic and medical point of view [6,7]. It comprises 90 genera and about 3000 species [6,8]. However, *Solanum* genus appears to be the hyper-diverse taxon of this family.

There are about 2000 species of *Solanum* worldwide, mainly distributed in the tropics and subtropics, with a small number in temperate zones [7]. This genus includes species that are important foods such as potatoes (*S. tuberosum* L.), tomatoes (*S. lycopersicum* L.) and eggplants (*S. melongena* L.) (Fig. 1). Others are used in traditional medicine (*S. torvum* Sw, *S. americanum* Mill. *S. bulbocastanum* Dunal, *S. nigrescens* Mart and Gal., etc.) [9]. According to Valadaresa et al. [10], *Solanum* species are generally used against herpes virus (human herpes virus type 1: HHV-1) or cancer. We believe that species of *Solanum* genus used in the treatment of pathologies from viral origin or from which antiviral properties have been revealed by previous studies (*S. melongena, S. tuberosum, S. torvum, S. nigrum*). These constitute potential sources of compounds against Covid-19, since the active principles of plants are capable of acting on multiple targets. Henceforth, data from ethno-botanical and phytochemical studies as well as biological

Fig. 1. Some *Solanum* species fruits

activities of some commonly used species of *Solanum* genus, with particular emphasis on their antiviral activities can help to promote the use of Solanaceae species against Covid-19 as nutraceuticals. The aim of this study is to summarize plant species of *Solanum* genus and their secondary metabolites with antiviral properties, which can also prevent human against Covid-19.

2. METHODOLOGY

Various databases were used for the search of information on *Solanum* species, namely PubMed, PubMed Central, Science Direct, SCIELO, DOAJ, Science alert, semantic scholar and Google scholar. In addition to the scientific names of the species of *Solanum* genus, other keywords were used during the search: antiviral compounds, Virucidal/antiviral activity and toxicology.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Ethno-botanical study

The species of the genus solanium have different uses in the traditional medicine (Table 1).

3.1.2 Biological properties

Data on the biological properties of some species of *Solanum* are presented (Table 2).

Different viruses susceptible to extracts of *Solanum* species as well as some antiviral ingredients isolated from these species were studied (Table 3).

3.1.3 Phytochemical studies

Phytochemical results for *Solanum* species are recorded in the Table 4.

3.1.4 Toxicological studies

Many studies reports that solanaceous species used as ornamentals are in most cases considered toxic [8,38]. Meanwhile, others authors state that unripe fruits of some edible *Solanum* species (e.g. *S. nigrum*) are toxic [18]. Fouzia [18] and Chauban et al. [34] assert that the variety of *S. nigrum* with black fruits is toxic; only the reddish-brown fruits are used for edible purposes. On the other hand, it has been shown that glycoalkaloids present in most species of the *Solanum* genus are potentially toxic [11]. However, several toxicological studies on glycoalkaloids from members of the Solanaceae were carried out in different animal models like in rats, mice, hamsters and rabbits. The LD_{50} for solanine, chaconine and tomatin in mice were 27, 30 and 34 mg/kg body weight intraperitoneally, respectively, and for most animals. Furthermore, other studies reveal that solanidanes appear to be more toxic than their corresponding spirosolanes, solamargine, solasonine and solasodine [11]. It should be noticed that there is little or no information on the toxicity for *Solanum* edible species and/or those used in traditional medicine to humans [11].

3.2 Discussion

3.2.1 Ethno-botanical studies

Several species of *Solanum* are used in traditional medicine in different countries around the world (Table 1). Many of the studies focused on the following species: *S. melongena, S. macrocarpon, S. nigrum, S. aethiopicum, S. paniculatum, S. torvum, S. trilobatum, S. maunse, S. palinacanthum, S. incanum, S. xanthocarpum, S. tomentosum, S. indicum, S. nigrescens, S. Erythracanthu, S. americanum and S. tuberosum.*

Table 1. Common uses of some species of *Solanum* in traditional medicine

Scientific names	Uses	Parts used	References
S. melongena L.	Treatment of asthma, bronchitis, cholera and dysuria or as analgesic, expectorant, sedative, etc. the leaves are applied to ulcers, wounds, and inflammations or used for skin pathologies while the fruits are used for the treatment of diabetes, diarrhea, and eye diseases or as an antipyretic. The young shoots are administered for skin diseases and psoriasis. The root bark is laxative, useful in ear, eye and nose diseases or for ulcers, throat burns and inflammation of the liver. Seeds are laxative etc.	All parts	[11,12]
S. macrocarpon L	asthma, allergic rhinitis, nasal catarrh, skin infections, rheumatic disease, swollen joint pains, gastro-esophageal reflux disease, constipation, dyspepsia	Nd	[13]
S. nigrum L.	Treatment of mouth ulcers, hepatitis, pain, fever, cough, cold, skin diseases (psoriasis, ringworm, etc.), painful periods, diarrhea, eye diseases, or against tumours (liver cancer, etc.) and sexually transmitted diseases (STIs). It is also used as an anti-inflammatory, diuretic, anticonvulsant, antiulcer. Fruits, seeds and leaves are used for kidney problems, haemorrhoids and as an antifungal agent.	All parts	[14,15,16,4,17,18]
S. aethiopicum L.	It is used for the treatment of asthma, allergic rhinitis, nasal catarrh, skin infections, rheumatic disease, swollen joint pains, gastro-esophageal reflux disease, constipation, dyspepsia	Nd	[13,18]
S. paniculatum L.	Treatment of viral infections, bronchitis, cough, jaundice, arthritis, hepatitis and stomach disorders	Nd	[10]
S. torvum Sw.	Treatment of liver problems, cough, sore throat and stomach, seizures, epilepsy, diarrhea, skin diseases, diabetes, toothache (tooth decay), sores, painful periods, jaundice, colds, pain, fever, stomach upset or as a sedative, diuretic, haemostatic or poison antidote, The fruits are used in the treatment of hypertension, cough, enlarged spleen and liver, anemia, or as an analgesic, The leaf juice and unripe fruits are used to reduce body, to strengthen the immunity of the body, haemostatic, haemopoietic or to treat wounds and female infertility	Leaves, fruit, roots	[19,20,21,22,23]
S. trilobatum L.	Hepatoprotective, treatment of lung cancer and respiratory diseases (asthma, coughs, colds, acute and chronic bronchitis etc.), tuberculosis, stomach ache, throat infections, flu, bone diseases (as it is rich in calcium), eosinophilia, constipation. It boosts memory and energy, improves fertility and vitality of men, improves blood circulation, The leaves is used to treat dullness in hearing by making ear drops, cancer of the mouth, uterus and throat, while the flower is used to treat rheumatism, constipation and gastritis problems.	Leaf, flower	[24,5]

Scientific names	Uses	Parts used	References
S. mauense Bitter	Treatment of bacterial infections, cancer, tuberculosis, chest conditions, or used as an antihelmintic and purgative.	Nd	[25]
S. palinacanthum Dunal	Treatment of skin diseases	Nd	[26,27]
S. incanum L.	Treatment of angina, headache, throat or stomach ache, painful periods, pain, rheumatism,	Nd	
S. xanthocarpum Schrad et Wendl.	Treatment of gonorrhea, rheumatism, cough, asthma, catarrhal fever, and sore throat or used as an anthelmintic, antipyretic, laxative, anti-inflammatory, antiasthmatic, and aphrodisiac. The dried fruit decoction is used to treat cough, fever and heart disease.	Fruits, stems, flowers	[28,15]
S. tomentosum L.	Treatment of syphilis, sore throat, boils.	Nd	[29]
S. indicum L.	Treatment of hypertension, diabetes	Nd	[15]
S. nigrescens M. Martens et Galeotti	Vaginal infections	Nd	[30,31]
S. erythracanthum Bojer	Cough	Fruit	[31]
S. americanum Mill.	Sinusitis, flu, colds	Nd	[32]
S. tuberosum L	Bronchitis and other respiratory diseases	Nd	[32]

Legend: nd: Not determined

Table 2. Biological properties of some *Solanum* species

Scientific names	Biological properties	References
S. melongena L.	analgesic, antiviral, anti-inflammatory, antiasthmatic, anti-glaucoma, hypoglycemic, hypolipidemic, cholesterol-lowering, antioxidant, antiallergic, antiangiogenic, anticancer	[11,12,13,33,35]
S. nigrum L.	Antioxidant, anti-tumorigenic, antiviral, antiinflammatory, hepato-protective, diuretic, antipyretic, anti-diabetic, antimicrobial, antihepatitis C, anti-helminthic, anticonvulsive, anti-ulcer, anti-cancer, cardio-protective, analgesic, antidiabetic, immunosecretory, antiulcerogenic activities, nephroprotective, angiotensin and serotonin receptor blocking activities.	[18,23,34]
S. torvum Sw.	Antiviral, antibacterial, cytotoxic, antioxydant, antidiabetic, antiinflammatory, analgesic, anti-hypertensive, antipyretic, anti-diarrhoeic , anti-platelet, antitussive, immunostimulant, hepato-protectrive, anti-convulsive, anti- tumour, cardiovascular, nephroprotective, antiulcerogenic, systolic blood-pressure modification, cytotoxic, sédatif, duirétique, enhanced cytotoxicity of some chemotherapy drugs in HT-29 human colorectal carcinoma cells, antinociceptive, antineoplastic, antiulcerogenic	[7,17,20,21,22,34,36]
S. trilobatum L.	Antioxidant, antidiabetic and antimicrobial	[5]
S. palinacanthum Dunal	Antibacterial, antifungal, antiviral	[26]
S. incanum L.	Antibacterial (*Staphylococcus aureus, Salmonella typhi, Vibrio, cholerae*, etc.)	[27]
S. xanthocarpum Schrad et Wendl.	Bronchodilator effect	[15]
S. tomentosum L.	Antimicrobial	[29]
S. indicum L.	Antihypertensive, anti-carcinogenic effects	[15]
Solanum nigrescens M. Martens et Galeotti	Vaginal infections	[30]

Table 3. Antiviral action of extracts from some *Solanum* species

Scientific names	Active compounds	Virus name	Mechanisms of action	References
S. paniculatum L.	Neotigogenin, Δ25 (27) tigogenin-3-O-β-Dglucopyranoside (steroidal saponins) Neotigogenin (steroidal saponins)	HHV-1 vaccinia virus HHV-1	Inhibits the viral replication	[10]
S. americanum Mill.	nd	HSV-1	Nd	[37]
S. melongena L.	Delphinidin-3-rutinoside (anthocyanin)	HSV-1	Inhibits the viral replication and reduces the expression of viral proteins	[2]
S. tuberosum L.	Pelanin (anthocyanin) Pelargonidin (anthocyanin) pelargonidin 3-p-coumaroylglucose-5-glucose (anthocyanin) pelargonidin 3-p-coumaroylglucose-5-malonylgluco (anthocyanin)	InfV A et B	Inhibits the attachment and adsorption of the virus in the host cell and/or Interacts with viral biomolecules	[2]
S. torvum Sw	Torvanol A (Isoflavonoids) Torvoside H (steroidal glycoside) Solasonine (glycoalcaloïde)	HSV-1 et 2 HSV-1 HSV-1	Inhibits the viral replication	[21]
S. nigrum L.	Nd Nd	HVC SINV	Inhibits the expression or protease NS3 Nd	[16,34] [14]
S. sanitwongsei W.G. Craib	spirostanol-glycosides (saponins)	HSV-1	Nd	[38]
S. nodiflorum Jacq.	spirostanol-glycosides (saponins)	HSV-1	Nd	[38]
S. khasianum Clarke	Solamargine (glycoalkaloid)	VIH	Nd	[30]

Legend: Nd: Not determined, INSV: Sindbis virus, HVC: Hepatitis C virus, HSV-1 and 2: Herpes simplex virus types 1 and 2, InfV A and B: Influenza viruses A and B, HHV-1: Human herpes virus type 1, HIV: Human Immunodeficiency Virus

Table 4. Chemical composition of some *Solanum* species

Scientific name	Chemical composition	References
S. melongena L.	**Secondary metabolites** Phenols, anthocyanin, glycoalkaloids, α-chaconin, flavonoids (myricetin, quercetin, kaempferol, luteolin and apigenin), hydroxycinnamic acids, nasunin (anthocyanidin), ellagitannins, proanthocyanidins.	[33,39,40]
	Macro and micronutrients	
	Fiber, proteins (comprising several necessary amino acids including: histidine, valine, isoleucine, leucine, Phe + Tyr, lysine, aspartate + asparagine glutamine + serine, alanine, proline, arginine, glycine), lipids, carbohydrates, ascorbic acid or vitamin C, vitamins A, E, magnesium, calcium, sodium, potassium, selenium, manganese, zinc, copper, aluminium, iron.	
S. aethiopicum L.	**Micro and macronutrients**	
-	Protein, fat, ash, crude fibre, carbohydrates, calcium, magnesium, iron.	[13]
S. macrocarpon L.	**Secondary metabolites**	
	Alcaloids, saponins, tanins, terpenoids, **Micro and macronutrients** protein, fat, ash, crude fibre, carbohydrates, calcium, magnesium, iron	[13]
S. paniculatum L.	**Secondary metabolites**	[10]
	Alcaloids (jurubin, solanin, solanidin, and solamargin)	
S. torvum Sw.	**Secondary metabolites**	
	- Fruits: 3-O-acétyl-stigmasta-5,25-diène-2,3-diol, isoflavonoid, (torvanol A), steroidal glycoside (torvoside H, torvoside A), solanolactosides A et B (steroidal lactone saponin), sapogenin, steroid, chlorogenin, chlorogenin, solasodine. - Leaves: torvosides J, K, L, M, N, torvonine-B, Torvonine-A, hydroxy-(5α)-spirostanol glycosides, 22-β-*O*-spirostanol oligoglycosides, isoquercetin, rutin, kaempferol and quercetin	[7,20,21,22]
	Macro and micronutrients	
	Proteins, lipids, carbohydrates, fibers, As, Fe Mn, Ca, Cu, Zn, vitamins A, C, B-carotene	[22]
S. nigrum L.	**Secondary metabolites**	
	Tannins, flavonoids, steroids, saponins, glycoalkaloids (solamargine, solasonine, solanine, α and β-solamagrine, solasodinsolanidine, O-acetyl solasodine, soladulcoside A), saponins (degalactotigonin), polyphenolic compounds (gallic acid, catechin, protocolatechic acid, caffeic acid, epicatechin, rutin), tannins, diosgenin, gitogenin, etc.	[15,17,18,34]
	Macro and micronutrients	
	Na, K, Ca, Mg, Fe, P et Zn	[34]

Scientific name	Chemical composition	References
S. tribolatum L.	**Secondary and primary metabolites**	
	Glyco-alkaloids (solasoline), flavonoids, tannins, saponins, glycosides, terpenoids, proteins	[5]
S. incanum L.	**Secondary and primary metabolites**	
	carbohydrates, proteins, alkaloids, flavonoids, glycosides, saponins, tri-terpenes, tannins and steroids	[25]
S. xanthocarpum Schrad et Wendl.	**Secondary and primary metabolites**	
	carbohydrates, vitamin C, anthocyanin and solasonin	[28]

Data from ethno-botanical studies indicated that several *Solanum* species are used in traditional medicine for the treatment of several diseases affecting the respiratory system. These diseases include asthma, cold or catarrh, which indicates the inflammation of mucous membranes located in the upper airways (nose, pharynx or throat), which sometimes characterize certain forms of influenza and the angina. Therefore, we believe that from the reported data that these plants used for the treatment of numerous pathologies affecting the respiratory system are considered as good candidates for the search of potential sources of active ingredients against Covid-19. Some upper respiratory tract pathologies are of viral origin like pneumonia (Coxsackievirus group A or B), the common cold (entero-rhinovirus, adenovirus, parainfluenza virus, coronavirus), angina (enterovirus, adenovirus), lanrygitis (para-influenza virus), bronchiolitis (enterorhinovirus, respiratory syncytial virus, metapneumovirus, parainfluenza virus) or Covid-19 [41,42].

Despite the pathologies of the respiratory system, species of *Solanum* genus are also used in traditional medicine to treat infectious diseases such as: cholera, tuberculosis, Sexually Transmitted Infections (gonorrhoea, syphilis), vaginal infections, or helminth diseases along with diseases of the digestive system as well as metabolic diseases (diabetes, jaundice). It has to be noticed that (Table 2) *Solanum* species are also used as antipyretics, analgesic, antiulcerogenic, for the treatment of wounds or skin diseases, boils, female infertility, rheumatism, hepatitis, epileptic seizures, kidney problems, haemorrhoids, tooth decay, hypertension, enlarged spleen and liver. Also they might be immunostimulant, haemostatic, aphrodisiac, slimming, purgative, diuretic, antiallergic or as an antidote against poison, hepatoprotective, anticonvulsant, to boost memory and improve fertility and vitality in men.

Plants having antipyretic, analgesic, immunostimulant or haematopoietic potentials are good candidates for the management of Covid-19. Besides their likely virucidal effect, they can also stimulate the production of immune cells that can fight the infection of the Covid-19 virus, but also other blood cells such as red blood cells, specialized in oxygen transport, thus alleviating the respiratory distress characteristic of Covid-19. At the same time, they can also prevent the rise in temperature in patients, which is characteristic of SARS-CoV-2 infection [43].

However, *Solanum* species are also used in food. This is the case for the leaves and fruits of *S. melongena*, which are eaten cooked in water or fried, as condiments in sauces or as a side dish vegetable [33]. The same is true for the fruits and leaves of *S. torvum* that are incorporated in soups and sauces [22]. With regards to eggplants, it should be noted that there are at least three frequently cultivated eggplants species that can be easily distinguished by the characteristics of the flowers and fruits: the bitter eggplants with elongated fruits (*S. esculentum*), the bitter eggplants with spherical fruits (*S. incanum*), and the sweet eggplant (*S. melongena*) [33]. *S. nigrum* has two varieties, of which one bears black fruits and the other has reddish-brown fruits. The black fruits are poisonous whereas the reddish brown fruits are used for edible purposes [18,34].

In addition, the literature indicated that *S. trilobatum* leaves are also used in food in the preparation of certain food and juice recipes [5].

3.2.2 Biological activities

The species of *Solanum* genus exhibited a variety of biological activities including antiviral properties (Tables 2 and Table 3). Several species of *Solanum* genus have activity against human herpes virus type 1 or 2 (*S. paniculatum, S. americanum, S. melongena, S. torvum, S. sanitwongsei, S. nodiflorum*) (Table 3). This corroborates with the work of Valadaresa et al. [10], who showed that *Solanum* species are generally used against herpes virus. Although the actions of *Solanum* species, notably *S. tuberosum, S. nigrum and S. khasianum*, on other types of viruses like Influenza viruses A and B, viral hepatitis C virus (HCV) and HIV respectively, have also been reported in several studies [2,16,30,34].

Different antiviral ingredients of the *Solanum* species listed in Table 3 could have an effect on SARS-CoV-2 since the herbicides act on multiple targets. Therefore, with respect to their immunomodulatory effect, these species could contribute to the enhancement of the immune defense.

3.2.3 Phytochemical studies

The phytochemical data presented in Table 4 showed that different *Solanum* species explored have various types of secondary metabolites as well as micronutrients and macronutrients.

However, with respect to their antiviral activities, several chemical ingredients of *Solanum* species have been identified.

According to previous reports, Glycoalkaloids (solasonin, solamargine), anthocyanins and saponins are responsible for most of the antiviral actions of *Solanum* species (Table 3) [2,38]. Mohammadi et al. [2] reported that only red-fleshed potato anthocyanins (*S. tuberosum*) showed the antiviral activity. They showed that the antiviral activity of *S. tuberosum* anthocyanins depends on their structures and synergistic effects with other plant compounds. According to Morillo et al. [44], glycosides containing chacotriose are consistently more active than their solatriose-containing counterparts with respect to antiviral, anti-estrogenic, anti-inflammatory, anti-tumour, antibacterial and other activities. Furthermore, numerous studies have shown *in silico* that certain polyphenolic compounds (Kaempferol, quercetin, catechin and its derivatives) may interact with SARS-CoV-2 protease [3,45]. The presence of catechin and epicatechin was revealed in *S. nigrum*, while the presence of Kaemferol and quercetin in the leaves of *S. torvum* was reported [7,34]. Moreover, Abdou [33] had shown the presence of quercetin, kaempferol and apigenin in *S. melongena*. Secondary metabolites present in the genus *Solanum* namely alkaloids, saponins, flavonoids, terpenoids, etc. can be used to treat Covid-19 because their properties have been demonstrated *in silico*. [46-54].

3.2.4 Toxicology

Toxicity studies have shown that most species of *Solanum* genus used in food and/or traditional medicine are less toxic except *S. nigrum*. However, the consumption of unripe fruits should be avoided due to the toxicity of these one [18,45]. Glycoalkaloids, a class of nitrogen-containing steroidal glycosides, are biologically active secondary plant metabolites and are commonly found in plants of the *Solanum* genus [55]. Due to its toxicity, which is evident, we would recommend for the use of edible species only for the management of Covid-19.

4. CONCLUSION

It is evident that species of Solanaceae family in general and those of *Solanum* genus are potential sources of drugs against Covid-19 virus or would contribute to the management of Covid-19 as most of these species are nutraceuticals. For, they are used in traditional medicine for the treatment of pathologies affecting the respiratory system or with regard to their actions on other types of viruses or their immunostimulant, haematopoietic and antioxidant properties along with their richness in certain phytoconstituents (quercetin, kaempferol, apigenin) which interact with the SARS-CoV-2 protease. The antiviral activity of *Solanum* species is linked to the presence of glycoalkaloids, saponins, anthocyanins and isoflavonoids. Molecular docking study of the interaction of these compounds with SARS-CoV-2 protease is in progress.

ACKNOWLEDGEMENT

Clement M Mbadiko thanks International Foundation for Science (IFS) and Pius T Mpiana the TWAS and the Swedish International Development Agency (SIDA) for the grant.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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DOI: 10.1021/jf200439q

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/58600