3.3.3 Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during year

List of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during year

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Date –

Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during year 2021-22

Sl. No.	Name of the teacher	Title of the book/chapters published	Title of the paper	Title of the proceedings of the conference	Name of the conference	National / International	Year of publication	ISBN/ISSN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher
1	Dr.Sabyasachi Chatterjee	Spatial Modeling and Assessment of Environmental Contaminants	Phytoremediation of Arsenic Using Allium sativum L. as a Model System			International	2021	ISBN 978-3-030-63421-6 ISBN 978-3-030-63422-3 (eBook)	Ramananda College	Springer - https://link.springer.com/book/10.1007/978-3-030-63422-3
2	Dr.Sabyasachi Chatterjee	Soil Health and Environmental Sustainability	Phytoremediation of Arsenic Polluted Soil by Brassica Nigra L.			International	2022	ISBN 978-3-031-09269-5 eBook ISBN978-3-031-09270-1	Ramananda College	Springer - https://doi.org/10.1007/978-3-031-09270-1
3	Asish Mandal	Hand Book of Agriculture and Plant Sciences	Herbal Drug: a Natural Bioactive Formulation and its scope against Viral Diseases			National	2021	978-93-91002-25-1	Ramananda College	ABS Books Publisher and Exporter
4	Subrata Acharyya	Sikashya Sangathon ebong proshason				National	April ,2022 0	978-81-949780-2-2	Ramananda College	Alpana Enterprise

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5	Subrata Acharyya	Jiboner Smritikanai				National	JUNE, 2022	978-81-949780-8-4	Ramananda College	Alpana Enterprise
6	Sonam Jalan	Amitav Ghosh: A Writer with a Difference				National	2021	978-81-8043-162-3	Ramananda College	Creative Books, New Delhi
7	Somnath Basu	Chapter Title: Indemnity and Indebtedness: Reflections on T. S. Eliot's 'What Dante Means to Me'. Book Title: The Unspoken Words: A Study of T.S. Eliot's Critical Writings				National	2021	987-93-85512-63-6	Ramananda College	Alfa Publications, New Delhi
8	Dr. Bishnupada Malik	Samaj Itihaser Dharai Dhaksin Paschimbanga				National	2022	938410492	Ramananda College	Grantham itra
9	Surajit Bosu, **Baibaswata Bhattacharjee**	Book's Title : Algorithms for Intelligent Systems (AIS), Book Chapter: All-Optical Frequency Encoded Dibit-Based Half Subtractor Using Reflective				International	2022	ISBN: 978-981-16-5746-7	Ramananda College	Springer, Singapore

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		Semiconductor Optical Amplifier with Simulative Verification								
10	Surajit Bosu, **Baibaswata Bhattacharjee**		*All-Optical Frequency Encoded Dibit-based Half Adder using Reflective Semiconductor Optical Amplifier with Simulative Verification*			International	2021	Electronic ISBN:978-1-7281-9955-9 Print on Demand(PoD) ISBN:978-1-7281-9956-6	Ramanada College	International conference on Devices for Integrated Circuit (DevIC-2021), 19-20th May, 2021, Kalyani Govt. Engineering College, West Bengal, India
11	Surajit Bosu, **Baibaswata Bhattacharjee**		*A Design of Frequency Encoded Dibit-based Comparator Using Reflective Semiconductor Optical Amplifier with Simulative Verification*			International	2021	Electronic ISBN:978-1-7281-9955-9 Print on Demand(PoD) ISBN:978-1-7281-9956-6	Ramanada College	International conference on Devices for Integrated Circuit (DevIC-2021), 19-20th May, 2021, Kalyani Govt. Engineering College, West

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										Bengal, India
12	Surajit Bosu, **Baibaswata Bhattacharjee**	Book's Title: Lecture Notes in Electrical Engineering (LNEE, Vol. 902) Book Chapter: Dibit-Based 4-bit Parity Generator using Reflective Semiconductor Optical Amplifier and Frequency Encoding Scheme'				International	2022	Online ISBN: 978-981-19-2004-2 Print ISBN: 978-981-19-2003-5	Ramananda College	Springer, Singapore
13	Surajit Bosu, **Baibaswata Bhattacharjee**	Book's Title: Lecture Notes in Electrical Engineering (LNEE, Vol. 902) Book Chapter: All-Optical Feynman Gate Using Frequency Encoding Scheme, Add/Drop Multiplexer and Reflective Semiconductor Optical Amplifier with Simulative Verification				International	2022	Online ISBN: 978-981-19-2004-2 Print ISBN: 978-981-19-2003-5	Ramananda College	Springer, Singapore

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14	Surajit Bosu, **Baibaswata Bhattacharjee**	Book's Title : Lecture Notes in Networks and Systems book series (LNNS,volume 461) Book Chapter: A Design of Frequency Encoded Dibit-Based Inhibitor Logic Using Reflective Semiconductor Optical Amplifier with Simulative Verification				International	2022	Print ISBN: 978-981-19-2129-2 Online ISBN: 978-981-19-2130-8	Ramananda College	Springer, Singapore
15	Dr. Arpan Bhattacharya	Emerging Trends In India's Foreign Policy	India's Naval Diplomacy And Great Power Competition			International	2022	9781-91-393617-4	Ramananda College	Hp Hamilton Press
16	Prof. Bimal Kumar Dutta	Politics In India	Social Movements			National	2022	978-93-5529-369-5	Ramananda College	Authors Press, New Delhi

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Supporting Documents

Dr. Asish Mandal

10

Herbal Drugs: A Natural Bioactive Formulation & its Scope Against Viral Diseases

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Introduction

Herbal drugs are any crude or purified constituent isolated and seperated from raw botanical materials, containing bioactive ingredients that have therapeutic significance. Man uses plants and plant derived products from the pre-historic times to treat different ailments. Medicinal plants were found even on the frozen body of an 'ice man' in Swiss Alps which was more than 5,000 years old (Goldman, 2001). It is thought that the man used those herbs

to treat an intestinal disorder. The indigenous concept and knowledge about medicinal herbs and therapies isaccumulated and passed on orally from one generation to another. Herbal products have gained increasing popularity in western countries as 'Complementary and Alternative Medicine' (Hermann & Richter, 2012).

In spite of the great development in the world of allopathic medicine, traditional ethno-medicines still provide a major contribution to health care system. The belief on natural medicines that they are much safer than synthetic drugs has gained great acceptance in current years and it led to a considerable development of phyto-pharmaceutical practice. Traditional herbal medicines are mostly used for primary health care requirement worldwide (WHO, 2018). In fastly developing countries like China and India, herbal drugs constitute as much as 80%. On the other hand, in well developed countries such as United Sates, the involvement is as much as 25% (Devi et al., 2018).

The increasing resistance to existing drug molecules for many emerging and re-emerging viral diseases along with their side effects and systemic toxicity is a major concern globally (Ganjhu et al., 2015). Thus, naturally based pharmacotherapy as well as traditional herbs provides enormous scope to reveal viable alternatives against various viral diseases (Gyawali et al., 2020). Study of the antiviral mechanisms of the herbal compounds has highlighted the interaction with the life cycle of the virus, viz. entry, replication, assembly and release along with the targeting of viral host-specific interactions.

An Overview of Herbal Drugs

Herbal drug or botanical drug products represent a crude or purified mixture of organic chemicals derived from raw vegetal or processed parts of plants, such as leaf, seed, root – rhizome, bark, flowers or fruits, or their combination thereof (Hermann & Richter, 2012). These plant parts may be entire, fragmented or in powdered form. Those plant materials are processed through roasting, steaming or stir-baking with alcoholic beverages, honey, or other materials.

The term 'herbal drug'referes to phyto-pharmaceuticals obtained from plants or plant parts through harvesting, drying and storage (Kunle et al., 2012).The word "drug" has its origin from a French word 'drogue', meaning 'dried herb'(Fleming, 1810). Herbal medicines consist ofsome particular terms - *herbal materials*, *herbal preparations* and *finished herbal products*.

Herbal materials contain crude products derived from plants, which show any organic structure, such as essential oil, fatty oil, resin and gums. In some countries, traditional herbal drugs may contain natural organic or inorganic active ingredients that are not from plant origin (e.g., mineral or animal materials), but used as an active principle in medicines. Beside this, isolated compounds that are went through any semi-synthetic or chemical modification process cannot be treated as herbal drugs.

Herbal preparations may include processed herbal materials or crude extracts, such as, fresh juices, gums, tinctures, fatty oils, essential oils of herbs and are used as the basis for finished herbal products. They are prepared through extraction, distillation, fractionation, purification, concentration, or by means of other physical or biological processes (WHO, 2018). They also include infusions made by steeping the herbal materials in boining water or alcoholic beverages.

Finished herbal products contain one or more herbal preparations. If more than one herbsare used, it is termed as *mixture herbal product*. They both are made up of excipients in addition to the active ingredients. However, they are devoid of any chemically-derived active substances.

Herbalism is the traditional medicine practice or folk medicine practice based on use of plant and plant extracts known as herbal medicine, phytotherapy, herbology etc. Herbal drug technology is used to convert plant substances into phytomedicines through the integration of traditional knowledge and modern scientific technologies. Plants had been used for medicinal purposes from ancient times. It is becoming more conventional with the improvement of modern machinery and analytical tools.

Historical Background

Herbal medicines have an ancient history. The medical use of *Ginkgo* tree has been practiced in China and Japan over more than 1,000 years. They used to make herbal tea from ginkgo seeds for patients suffering with asthma and memory loss (Zhou et al., 2014; Massey, 1999). Before the advent of modern and synthetic drugs in the nineteenth century, the United States had its own folk medicine tradition.

India is a great ancient heritage of traditional medicine. The country is a large fountain of herbal drugs. It has become one of the biggest centres and cascade in the field of herbal therapy.

Treatment through herbs was very popular in the ancient time in Indian subcontinent and now approaching to new possibilities and boundaries. Indian traditional or indigenous medicine is based on various systems, including Ayurveda, Siddha and Unani (Devi et al., 2018). Among these, Ayurveda is widely practiced and most developed indigenous system of medicine in India (Devi et al., 2018; Kar et al., 2009). In ancient era, Vaidyas used to treat people on individual basis and prepare drug according to the requirement of the patients. The antiviral field came of a stage of development with the scientific invention by Gertrude B. Elion in the year 1959, who discovered the first antiviral molecule, acyclovir and established its way to the clinical world. (Elion et al., 1993).

Herbal Practices Against Viruses

In traditional practice, herbal medicinal plant extracts have been used widely because of their antimicrobial and antiviral effects as well as more tolerable side effects. Numerous medicinal plants have been scientifically discovered and found effective against lethal infectious viral diseases (Ganjhu et al., 2015).

Initially, the development of anti-viral drugs was focused only on Western medicines.Methylisatin-thiosemicarbazone (Methisazone) was the first clinically useful antiviral drug, which was effective against pox viruses (Mukherjee, 2019). However, over 75% of the antiviral drugs were obtained from natural products, approved from 1981-2002 (Hung et al., 2015). About 400 plant species showed a significant antiviral activity *in vitro* (Glatthaar- Saalmüller et al., 2011). The *in vitro* antiviral activity of 41 plant species was investigated in Nepal (Gyawali et al., 2020).

Classic antiviral drugs such as ribavirin isproved to be effective against most viruses in laboratory, but often becomes ineffective in patients (Ben- Shabat et al., 2019).However, for the majorityof species studied so far, systematic investigation as well as genetic study of their activity against a broad panel of viruses still remains to be done (Glatthaar- Saalmüller et al., 2011).

Viruses are acellular, sub-microscopic, obligate intracellular parasitethat are capable of self-replication within the living host cell. Their genetic material (DNA or RNA) is surrounded by a covering composed of a proteinaceous layer. Viruses display a wide variability of shape and size. Most viruses have diameter between 10-300 nm. They are almost 100 times smaller than bacteria and

are not capable to be seen under light microscope.Only scanning electron microscopes (SEM) and transmission electron microscopes (TEM) are used to visualize the viral particle.

Research on the antiviral potentiality of plants was initiated in 1952 where 12 out of 288 studied plants were found to be effective against influenza infection (Chattopadhyay and Naik, 2007). A few numbers of medicinal plants from British Colombian showed antiviral efficiency against respiratory syncytial virus (RSV), corona virus, herpes simplex virus and influenza virus (McCutcheon et al., 1995). The acetone extract of *Phyllanthus urinaria*, can also suppressHerpes Simplex Virus-1 and HSV-2 (Yang et al., 2007).

The algal diversity also showed important roles against various viral infections. *Spirulina*, a marine algae showed immunomodulatory, antimutagenic and antiviral activities (Chamorro et al., 1996). Remarkably, Cyanovirin N, a protein from blue green algae *Nostocellipsosporum*, with molecular weight of 11 -kD, inactivates HIV-1 by binding with its glycoprotein 120 (Clercq, 2000).

Inhibition of Viral Life Cycle

Viruses are truly distinctive by their simple organization and mechanism of replication. The viral particle i.e., virion, is metabolically inert and does not carry out respiratory or bio-synthesis functions. It utilizes the cellular factors of the host cell for its propagation. This unique feature makes virus resistant to many antiviral treatments. Thus, designing a drugforinhibition of viral replicationcycle without causing any adverse effects on the infected host cell becomes difficult (Kitazato et al., 2007). The development of drug-resistant viruses emphasizes the necessity of developing new antiviral drugs targeting different steps of the viral replicative cycle.

In theory, majority of the clinically used antiviral drugs are the substances which can aim one or more viral enzyme specifically, that play crucial role in viral replication. Moreover, the specificity in target makes the drug less toxic to the host (Clercq, 2002). Drugs that target cellular molecules (those are involved in viral replication) may have a broad-spectrum antiviral activity as well as less risk to develop resistance against viruses. However, those drugs may be more toxic to the host cell. Preferably, effective therapeutic agents are more likely desirable that specifically target one or several stages of the replication cycle of viral particle and must have negligible toxicity (Kitazato et al., 2007). Many viruses essentially depend on the host

cell enzymes like, polymerases, proteases and other vital enzymes to survive and propagate. Some enzymes are virally encoded, for example, viral polymerase, reverse transcriptase, integrase etc. that are crutial for viral replication and assembly of the mature viral particle. The inhibition of various phases of viral life cycle (drawn with Microsoft office paint) may provide the key strategies to control the infections (Fig. 1.). For example, the popularly known antiviral drug acyclovir, also named acycloguanosine, has been found to limit the rate of Herpes Simplex Virus (HSV) infection. This drug shows activity by inhibiting the function of some essential viral enzymes (Wagner and Hewlett, 1999).

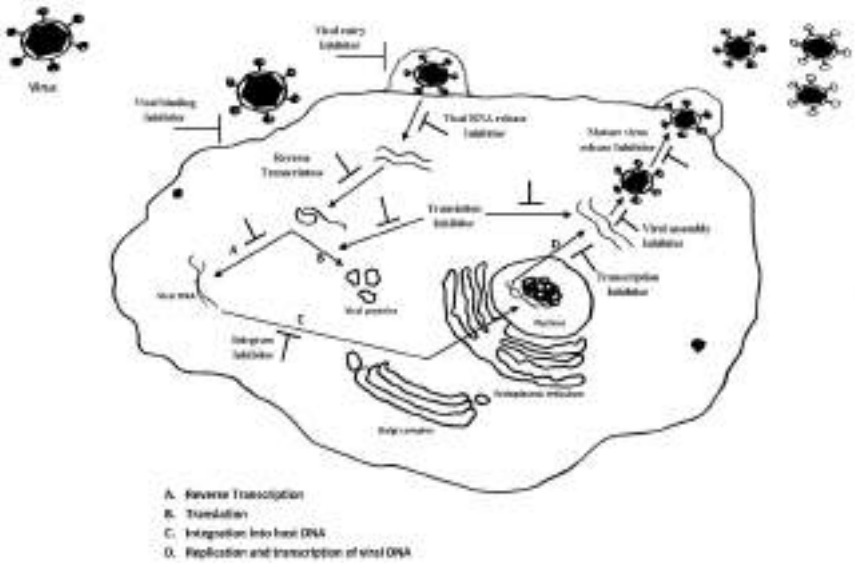


Fig. 1. Potential inhibitors that can be used at different stages of viral life cycle.

Common Antiviral Compounds Present in Medicinal Plants

A wide variety of compounds derived naturally from medicinal plants (herbs) (Table 1) have been extensively examined and studiedregarding their antiviral activity. Many of natural compounds possess complementary and overlapping mechanisms of action, either inhibition of viral replication, or viral genome synthesis. These natural active compounds provide key prospects for discovering novel herbal therapeutics which are effective against a comprehensive range of targets. Additionally, biologically active natural products

are readily absorbed and metabolized in the body. Therefore, the production costs of herbal medicines are much lower compared to that of biotechnological products. Therefore, natural herbal products offer huge promises as potentially effective novel antiviral drugs. Many antiviral agents that have been isolated from natural sources are partly or completely characterized. There are certain bioactive phytochemicals like polyphenols, flavonoids, alkaloids, quinones, saponins, terpenes, proanthocyanidins, tannins, lignins, polysaccharides, steroids, thiosulfonates, and coumarins that have been observed to be effective against viral infections (Mukherjee, 2019). The structures of some potential phyto-constituents that show antiviral activity are depicted with ChemDraw in Fig. 2.

Table 1: Phytochemicals with antiviral activity.

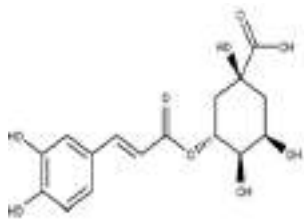
Plant	Kind of extract	Infected virus	Phytochemicals	References
Achillea fragrantissima	Hydro-alcoholic extract	Poliomyelitis-1 virus (POLIO)	Unknown	Soltan et al, 2009
Aegle marmelos	Aqueous extract	Human coxsackieviruses B1-B6	Unknown	Brijesh et al., 2009
Aloe vera	Glycerine extract	HSV-2	Unknown	Moradi et al., 2016
Artocarpus integrifolia	Aqueous extract	(SA-11) and human (HCR3) rotaviruses	Unknown	Goncalves et al., 2005
Balanites aegyptiaca	n-Hexane extract	VSV T2	Unknown	Maregesi et al., 2008
Camellia sinensis	Aqueous extracts	HBV	Epigallocathechin-3-gallate	Karamese et al., 2015
Capparis spinosa	Methanolic extract	HSV-2 HIV-1	Unknown Protein	Lam et al., 2009
Cassinexy locarpa	Aqueous extract	HIV	Pentacyclic lupane-type triterpenoids	Callies et al., 2015
Cistus incanus	Polyphenol-rich extract (CYSTUS052)	Avian and human influenza strains of different subtypes HIV-1 and HIV-2	Unknown Unknown	Droebner et al., 2007, Ehrhardt et al., 2007, Rebensburg et al., 2016
Curcuma longa	Aqueous extract	HSV-1	Curcumin	Moradi et al., 2016
Cyperus rotundus	Hydro-alcoholic extract	HSV-1 HBV	Unknown cyperene-3, 8-dione, 14-hydroxy cyperotundone, 14-acetoxy cyperotundone, 36-hydroxycyperenoic acid and sugetriol-3, 9-diacetate	Soltan et al, 2009, Xu et al., 2015

Daphne gnidium	Hydro-alcoholic extract	HIV	Daphnetoxin, gnidicin, gniditrin and excoecariatoxin	Vidal et al., 2012
Diospyros kaki	Aqueous extract	Human rotavirus	Licocoumarone, licoflavonol, glyasperin D, 18 ß-glycyrrhetinic acid,apigenin-7-O-glucoside, vitexin, luteolin	Goncalves et al., 2005
Dittrichiaviscosa	Aqueous extract	VSV, HSV-1, poliovirus type 1	Unknown	Abad et al., 2000
Euphorbia hirta	Aqueous extracts, methanol extracts	HIV-1, HIV-2, SIV mac 251	Unknown	Gyuris et al., 2009
Euphorbia spinidens	Methanol extract	HSV-1	Unknown	Moradi et al., 2016
Ficus benjamina	Ethanol extract	HSV-1, HSV-2	Rutin, kaempferol 3-O-rutinoside and kaempferol 3-O-robinobioside	Yarmolinsky et al., 2012
Ficus carica	Aqueous extract The hexanic and hexane-ethyl acetate from latex of fig fruit Hexanic extract	HSV-1 HSV-1, ECV-11 and ADV influenza virus	Unknown	Wang et al., 2004, LazregAref et al., 2011, Asl Najjari et al., 2015
Globularia arabica	Hydro-alcoholic extract	Poliomyelitis-1 virus (POLIO)	Unknown	Soltan et al, 2009
Glycyrrhiza glabra	Methanolic extract	NDV	Unknown	Ashraf et al., 2017
Glycyrrhiza uralensis	Metabolic extract	Rotavirus diarrhea	Unknown	Alfajaro et al., 2012
Hyssopus officinalis	Methanolic extract	HSV-1	Unknown	Moradi et al., 2016
Leucojum vernum	Methanolic extract	HIV-1	Homolycorine and 2-O-acetyllycorine	Szlavik et al., 2004
Lilium candidum	Ethanol extract	HSV-1, HSV-2	Kaempferol	Yarmolinsky et al., 2009
Magnolia officinalis	Methanol extract	Dengue Virus Type 2	Honokiol	Fang et al., 2015
Maytenus cuzcoina	Aqueous extract	HIV	Pentacyclic lupane-type triterpenoids	Callies et al., 2015
Melissa officinalis	Aqueous extract	HSV-1 HSV-1, HSV-2 HIV	Unknown	Astani et al., 2012, Nolkemper et al., 2006, Geuenich et al., 2008
Mentha pulegium	Methanolic extract	HSV-1	Unknown	Parsania et al., 2017
Moringa peregrina	Hydro-alcoholic extract	HSV-1	Unknown	Soltan et al, 2009
Myristica fragrans	Aqueous extract	Human rotavirus	Unknown	Goncalves et al., 2005

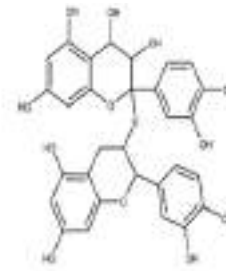
Olea europaea	Hexanic extract	Influenza virus subtype H9N2	Unknown	Asl Najjari et al., 2015
Panax ginseng	Methanolic extract	Human rotavirus	Epigalloc atechin gallate, genistein, theaflavin digallate, hesperidin, diosmin, neohesperidin, pectic polysaccharides	Goncalves et al., 2005
Panax notoginseng	Aqueous extract	Influenza A virus	Unknown	Choi et al., 2017
Phyllanthus acidus	Aqueous extract	HBV	Highly oxygenated norbisabolane sesquiterpenoids, phyllanthacidoid acid methyl ester	Lv et al., 2014
Phyllanthus emblica	Aqueous extract Aqueous extract	Influenza A virus strain H3N2 HBV	Highly oxygenated norbisabolane sesquiterpenoids Sesquiterpenoid glycoside dimers	Lv et al., 2015 Lv et al., 2014
Prunella vulgaris	Aqueous extract	HIV-1 Ebola virus	Unknown	Oh et al., 2011, Zhang et al., 2016
Quercus brantii	Ethanol extract	HSV-1	Unknown	Karimi et al., 2016
Quercus persica	Hydroalchoholic extract	HSV-1	Unknown	Karimi et al., 2013
Salacia reticulata	Aqueous extract	H1N1 influenza	Unknown	Romero- Perez et al., 2016
Sanguisorba minor	Aqueous extract	VSV, HSV-1 HIV		Abad et al., 2000, Bedoya et al., 2001
Securiger asecuridaca	Methanol extract	HSV-1, HSV-2	Unknown	Moradi et al., 2016
Solanum nigrum	Methanol and chloroform extracts of seeds	HCV	Unknown	Javed et al., 2011
Spondias lutea	Aqueous extract	Human rotavirus	Unknown	Goncalves et al., 2005
Tamarixnilotica	Hydro-alcoholic extract	HSV-1	Unknown	Soltan et al, 2009
Taraxacum officinale	Methanol extract Aqueous extract	HCV Influenza virus type A, H1N1.	Unknown	Rehman et al., 2016, He et al., 2011
Thymus carmanicus	Methanol extract	HIV-1	Unknown	Soleimani et al., 2016
Thymus daenensis	Methanol extract	HIV-1	Unknown	Soleimani et al., 2016
Thymus kotschyanus	Methanol extract	HIV-1	Unknown	Soleimani et al., 2016
Thymus vulgaris	Methanol extract	HIV-1	Unknown	Soleimani et al., 2016

Tuberari alignosa	An aqueous extract	HIV	Ellagic acid derivative	Bedoya et al., 2010
Viola diffusa	Ethanol extract	HBV	2ß-hydroxy-3, 4-seco-friedelolactone-27-oic acid, 2ß, 28ß-dihydroxy-3,4-seco-friedelolactone27-oic acid, 2ß, 30ß-dihydroxy-3,4seco-friedelolactone-27-lactone and stigmastane, stigmast-25-ene-3ß, 5α,6ß-triol	Dai et al., 2015
Vitis labrusca	Methanol extract	(SA-11) and human (HCR3) rotaviruses	Piceatannol, resveratrol, trans-arachidin-1 and-3	Goncalves et al., 2005
Vitis macrocarpon	Methanol extract	(SA-11) and human (HCR3) rotaviruses	Abietic acid, hesperidin,mangostin, α-glucosyl proanthocyanidins and all-trans-retinoic acid	Goncalves et al., 2005
Zataria multiflora	Methanolic extract	HSV-1	Rosmarinic acid	Arabzadeh et al., 2013

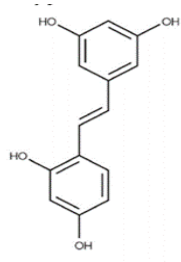
An important feature of these phytochemicals is that, they are harmless to the systems of the human body. Some selected anthraquinone and its derivatives are also noted for their antiviral and virucidal activities against viruses representing several taxonomic groups.



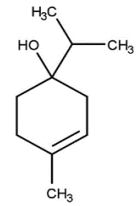
Chlorogenic acid



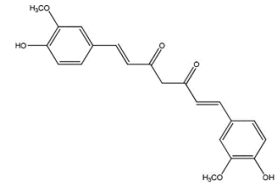
Curcumin



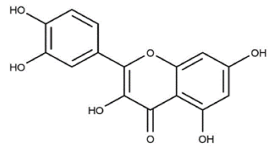
Oxyresveratrol



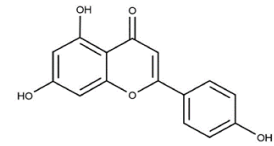
Terpinen-4-ol



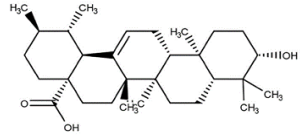
Procyanidin



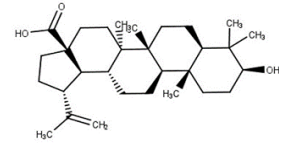
Quercetin



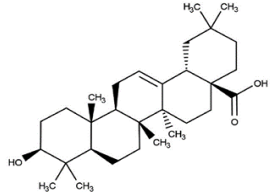
Apigenin



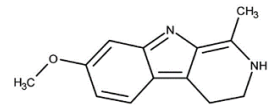
Ursolic acid



Betulinic acid



Oleanolic acid



Harmaline

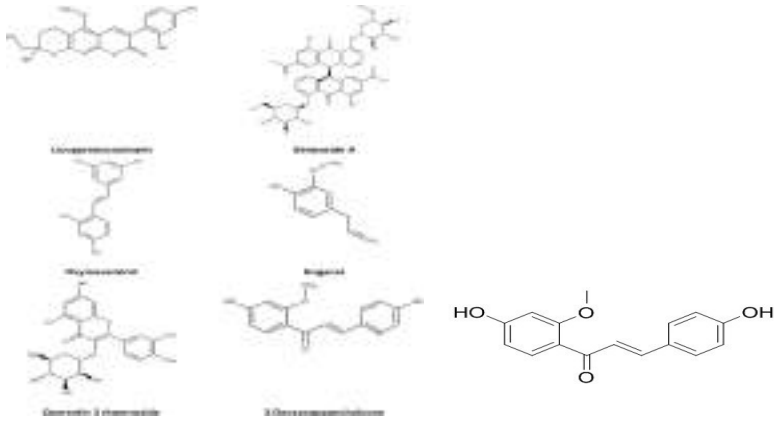
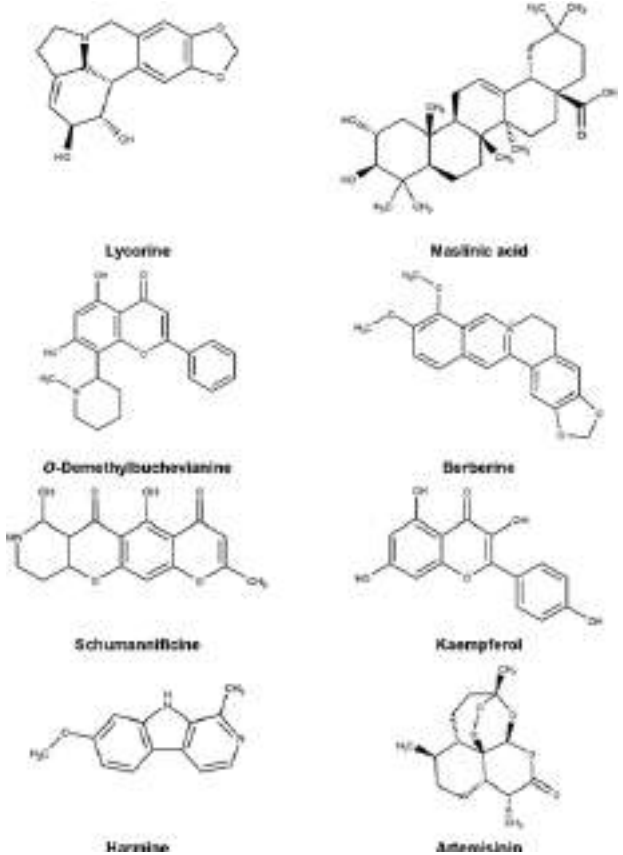
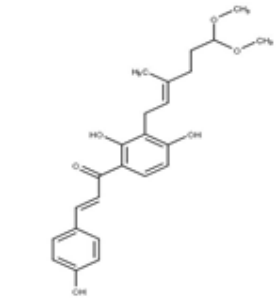
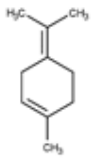


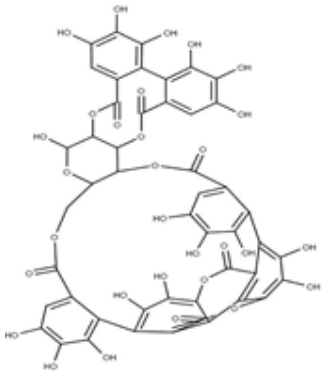
Figure. 2: Somepredominant antiviral herbal compounds (continued



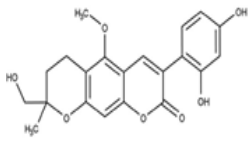


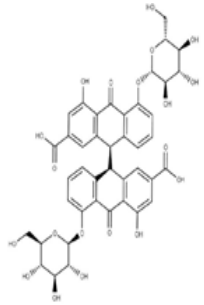
Xanthokeistal A

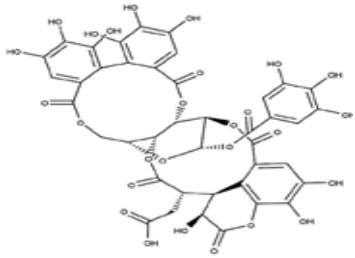




Luteolin





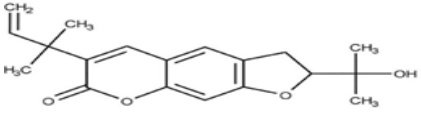


Licopyranocoumarin

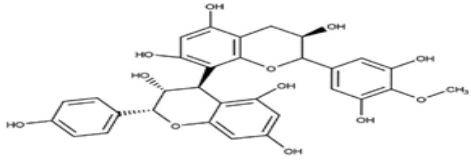
Sennoside A

Chebulagic acid

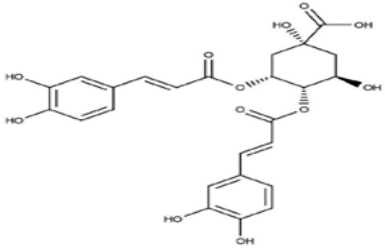
Figure. 3: Somepredominant antiviral herbal compounds (continued)



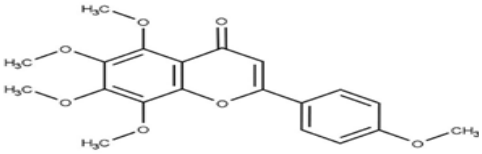
Chalepin



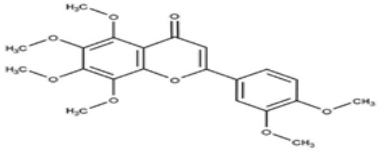
Proanthocyanidin



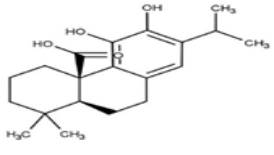
Dicaffeoylquinic acid



Tangeretin



Nobiletin



Carnosic acid

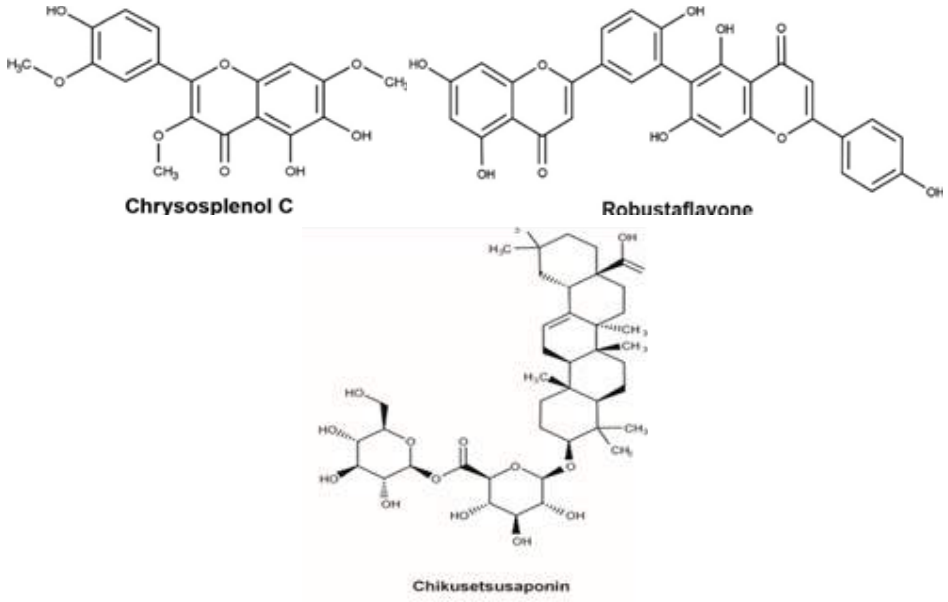


Figure. 4: Some predominant antiviral herbal compounds.

Development of Screening System for Antiviral Agents

The detection, isolation and extraction of antiviral compounds from higher medicinal plants are carried out by multidisciplinary research team. The antiviral screening system should meet all requirements of any good assay, including validity, accuracy, avoidance of ambiguity, simplicity, reproducibility and sensible cost. Moreover, the screening should be highly selective, specific and sensitive, because it is dealing with plant extracts. Most of the aforementioned requirements are better met by *in vitro* testing but only *in vitro* assay is not enough to discriminate a true antiviral activity from a plant extract. The antiviral activity of the pure compounds then has to be confirmed by in vivo assays in later stage (Vanden Berghe et al., 1986).

The plant kingdom is extremely diverse and ranges from microscopic unicellular planktons to huge trees. The screening of each and every plant or their individual parts for the identification of antiviral components is a massive task. However, there are several examples of plants having antiviral properties and newly identified active compounds from them are reported consistently in various journals.

Antiviral Activity of Herbal Medicines

The entire world is witnessing pandemic as a result of coronavirus outbreak. The novel coronavirus (SARS-CoV-2) is posing a serious threat to the mankind with its massive infection rate and potential fatality (Gorbalenya et al. 2020; Ganguly et al., 2020). Currently, there are very few clinically proven herbal antiviral agents against SARS-CoV-2. Certain therapeutic agents are processing under *in vitro* assay, such as, Remdevisir/GS-5734, Chloroquine and hydroxychloroquine etc. (Huang et al., 2020). Recently, an immunomodulatory herbal extract, named EGYVIR is discovered that shows potent antiviral activity against SARS-CoV-2 *in vitro* (Roshdy et al., 2020). To combat that global concern, crude drugs from a variety of plants have been articulated and used against several human ailments and diseases for centuries. Medicinal plants with broad-spectrum antiviral activity have a huge repertoire today.

There are different features of viruses that serve as potential targets for antiviral therapy, such as, their structure, strategies for multiplication by replication, reverse transcription, or translation (Mishra et al., 2013). The survival and propagation of viruses may vary with their perspective mechanisms. Viruses often depend on the host enzymes, like proteases, polymerases and other vital enzymes, while some enzymes are virally encoded. Some enzymes like proteolytic viral enzymes, integrase, viral polymerase, reverse transcriptase is necessary for viral replication and assemblage of the mature viral particle.The antiviral mechanism of such herbal compounds from medicinal plants is represented in Table 2.

Table 2: Antiviral effects of several natural products from medicinal herbs against viruses.

Virus	Natural product(s) evaluated	Proposed mechanism(s)	References
Coronavirus	EGYVIR from *Curcuma longa* (Turmeeric) root and *Piper nigrum* seeds against SARS-CoV-2.	Inhibits attachment of virus to infected cell membrane, destroy virus surface protein and inhibits viral replication.	Roshdy et al., 2020
	Saikosaponins (A, B_2, C, D) against HCoV-22E9	Saikosaponin B_2inhibits viral attachment and penetration stages	Cheng et al., 2006
	Amentoflavone isolated from *Torreya nucifera*against SARS-CoV	SARS-CoV 3CL protease inhibitor	Ryu et al., 2010
	Lycoris radiata and its active component lycorine, *Artemisia annua*, *Pyrrosialingua*, and *Lindera aggregata* against SARS-CoV	Unclear	Lin et al., 2014
	Glycyrrhizin from *Glycyrrhiza glabra*	Anti-SARS-CoV	Fiore et al., 2008
	Phenolic compounds of *Isatisindigotica* against SARS-CoV	SARS-CoV 3CL protease inhibitor	Lin et al., 2005
	Water extract of *Houttuynia cordata* against SARS-CoV	SARS-CoV3CL inhibit protease and viral polymerase	Lau et al., 2008
	Scutellarein and myricetin against SARS-CoV	SARS-CoV helicase inhibitor	Yu et al., 2012
Human immunod-eficiency virus	*Artemisia annua* and *Artemisia afra* against HIV-1	Unclear	Lin et al., 2014
	Tricyclic coumarin from *Calophyllumbrasiliense*stem bark against HIV-1	Suppress NF-κB activation resulting inhibition of viral replication in both acute and chronic infections	Lin et al., 2014
	O-demethylbuchenavianine from *Buchenavia capitata*	Produces partial protection against the cytopathic effect of HIV in cultured human lymphoblastoid cells	Vlietinck et al., 1997
	Michellamines D andMichellamines F from *AncistrocladuskorupensisD. Thomas* and Gereau	Exhibited in vitro HIV-inhibitory activity	Halloch et al., 1997
	Schumannificine from *Schumanniophytonmagnificum*	Activity against HIV and antianti-HSV	Vlietinck et al., 1997
	Berberine from *Berberis vulgaris*	Antiviral effects against HIV-1	Manske and Brossi, 1990

	Licopyranocoumarin from *Glycyrrhiza glabra*	Inhibit giant cell formation in HIV-infected cell cultures without any observable cytotoxicity	Vlietinck et al., 1997
	Melittin against HIV	Disruption of the viral lipid envelope resulting inactivation of virus	Lin et al., 2014
	Curcumin from *Curcuma longa*	Unclear	Mathew and Hsu, 2018
	Sennoside A from *Rheum palmatum*	Active against HIV-1	Esposito et al., 2016
	Kaempferol from *Securigerasecuridaca*	Active against HIV-1	Behbahani et al., 2014
	Maslinic acid from *Olea europaea*	Anti-HIV	Qian et al., 2011
	Artemisinin from *Artemisia annua*	Anti-HIV activity	Lubbe et al., 2012
	Uvaol and Ursolic acid	Protease inhibitor	Min et al., 1999
	GarciosaterpeneA,C	Reverse transcriptase Inhibition in syncytium	Rukachai-sirikul et al., 2003
	Vaticinone	Inhibited replication	Zhang et al., 2003
	Betulinic acid from *Syzygium claviflorum*	Inhibited maturation	Kashiwada., 1996; Li et al., 2003; Yu et al., 2005; Yu et al., 2007
	Glycyrrhizin	Inhibited Infectivity, cytopathic activity, replication	Ito et al., 1988
	Flavonoids Baicalin	Reverse transcriptase infection/entry, replication	Li et al., 2000; Kitamura et al., 1998
	Taxifolin (dihydroquercetin)	Inhibited cytopathic activity	Min et al., 2002
	(-)-Epigallocatechin-3-gallate (EGCG)	Reverse transcriptase	Fassina et al., 2002
	Flavonoid glucuronide	Integrase	Lee et al., 2003
	Coumarins Calanolide A	Reverse transcriptase	Creagh et al., 2001; Assres et al., 2005; Kostova, 2006

Influenza virus	Eugenol from *Syzygium aromaticum*	Inhibit the activation of extracellular signal-regulated kinase, p38-mitogen-activated protein kinase, IkB kinase (IKK)/ NF-kB signal pathways	Dai et al., 2013
	Elderberry liquid extract from *Sambucus nigra* against IFA and IFB	Unclear	Lin et al., 2014
	Extract from *Pelargonium sidoides* roots against IFA	Inhibits viral hemagglutination and NA activity along with viral entry and release	Theisen et al., 2012
	Aqueous extract from *Taraxacum officinale* (dandelion)	Inhibits polymerase activity and viral NP RNA levels against IFA	He et al., 2011
	Quercetin 3 rhamnoside from *Houttuynia cordata*	Interact with Influenza A virus indirectly and inhibit replication in the initial stage of infection	Choi et al., 2009
	3-Deoxysappanchalcone from *Caesalpinia sappan*	Antiinfluenza, antiinflammation and apoptosis	Yang et al., 2012
	Xanthokeistal A from *Angelica keiskei*	Neuraminidase inhibitor	Park et al., 2011
	Gallic acid from *Rubus coreanus*	Influenza virus	Lee et al., 2016
	Chlorogenic acid from *Lonicera japonica Thunb*	Influenza A (H1N1/H3N2) virus	Ding et al., 2017
	Terpinen-4-ol, terpinolene from *Melaleuca alternifolia*	Anti-A/PR/8 virus (H1N1)	Garozzo et al., 2011
	Berries' extracts	Improve T cells functionand modify immunity	Zakay-Rones et al., 2004
	Flavonoids biflavonoids (Ginkgetin)	influenza virus sialidase	Miki et al., 2007
	tetrahydroxyflavone	influenza virus sialidase	Nagai et al., 1992
	Baicalin against Influenza A	Neuraminidase inhibitor, virus budding prevention	Ding et al., 2014
	Alkaloids Thalimonine	influenza virus replication	Serkedjieva et al., 2003
	Indole alkaloid	influenza virus replication	Rajbhandari et al., 2001
	Lignans RhinacanthinE,F	Influenza virus	Kernan et al., 1997

	Glycyrrhizin Licorice roots extract against Influenza virus A, A2 (H2N2), H5N1 virus	Stimulate production of interferon-gamma by T cells, anti-inflammation, immunomodulation, reduce virus uptake activity by host cells	Utsunomiya et al., 1997; Wolkers-torfer et al., 2009
Hepatitis B virus	LPRP-Et-97543 from *Liriope platyphylla*	Inhibit viral gene expression and replication. Inhibit viral promoter activity	Huanga et al., 2014
	Piperine from *Piper longum* Linn.	Inhibition of HBV surface antigen secretion	Jiang et al., 2013
	Swermacrolactones and luteolin from *Swertia macrosperma*	Inhibition of HBV surface antigen secretion	Wang et al., 2013
	Nirtetralin A from *Phyllanthus niruri*	Anti-HBV activities	Wei et al., 2012
	Ellagic acid from *Phyllanthus urinaria*	Effective against hepatitis B	Kang et al., 2006
	Saikosaponins (C, D) from *Bupleurum* species	Saikosaponin C inhibits HBeAg expression and HBV DNA replication	Chiang et al., 2003
	Ethanol extract from *Polygonum cuspidatum*Sieb. et Zucc.	Unclear	Lin et al., 2014
	Curcumin from *Curcuma longa*	Viral transcription suppressor via down-regulation of the coactivator PGC-1α	Rechtman et al., 2010
	Oxymatrine and matrine from *Sophora* roots	Inhibition of viral replication, reduction of destruction of liver cells, inhibition of liver fibrosis and promotion of the flow of bile.	Kitazato et al., 2007
Hepatitis C virus	Standardized extracts of*Silybum marianum*	Antiviral effect (partly) by enhancing the IFN-associated JAK-STAT pathway	Polyak et al., 2007
	Flavonolignans from *Silybum marianum*/ silymarin	Unknown	Polyak et al., 2010
	Curcumin from *Curcuma longa*	Inhibits viral replication bysuppressing Akt-SREBP-1 pathway, distresses the fluidity of theviral envelope and inhibits viral entry	Lin et al., 2014
	Saikosaponin b2 from *Bupleurum kaoi*	Inhibit early viral entry,prevents viral attachment by neutralizing virus particles	Lin et al., 2015

	Chalepin and pseudane IX from *Ruta angustifolia*	Inhibit HCV at thepostentry step,reduce the levels of viral RNA replication and protein synthesis	Wahyuni et al., 2014
	Ursolic acid from *Syncephalastrumracemosum*	Anti-HCV activity	Fu et al. (2013)
	Quercetin from *Embeliaribes*	Active against HCV	Bachmetov et al. (2012)
	Proanthocyanidin from *Vaccinium virgatum*Aiton	Inhibit HCV replication	Takeshita et al. (2009)
	Chebulagic acid and punicalagin isolated from *Terminalia chebula* Retz.	Inactivate free virus particles; interfere with viral binding, fusion, and post-infection cell-to-cell spread	Lin et al., 2014

Herpes simplex virus	ent-Epiafzelechin-(4α→8)-epiafzelech inisolated from *Cassia javanica*	Inhibits viral replication against HSV-2	Cheng et al., 2006
	Herbal prescription Long-Dan-Xie-Gan-Tan	Inactivation of virus particles, against HSV-1 and HSV-2	Cheng et al., 2008
	Herbal prescription Yin-Chen-Hao-Tang	Inactivation of virus particles, against HSV-1 and HSV-2	Cheng et al., 2008
	Hippomanin A from *Phyllanthus urinaria*	Active against HSV-2	Lin et al., 2014
	Geraniin and 1,3, 4,6-tetra -*O*-galloyl-ß-D-glucose derived from *Phyllanthus urinaria*	against HSV-1 and HSV-2	Lin et al., 2014
	Excoecarianin from *Phyllanthus urinaria*	Inactivation of virus particles, against HSV-2	Cheng et al., 2011
	Punicalagin and chebulagic acid isolated from *Terminalia chebula*	Cell surface GAG-competitors; inhibit viral binding and fusion with host cell and post-infection cell-to-cell spread, against HSV-1	Lin et al., 2011
	Meliacine isolated from *Melia azedarach*	Induces TNF-α and IFN-γ production, against HSV-2 infection in a mouse model	Petrera & Coto, 2009
	Actinophnine from *Actinodaphnehookeri*	Active against HSV-1	Montanha et al., 1995a
	Harmaline and harminefrom*Peganum harmala*	Have antiviral effect against the DNA-containing herpes virus type 1 (HSV-1)	Rashan, 1990
	Luteolin from *Pedilanthustithymaloides*	Active against HSV-2	Ojha et al., 2015
	Ursolic acid from *Mallotuspeltatus*	Active against HSV-1 and HSV-2	Bag et al., 2012
	Oleanolic acid from *Achyranthes aspera*	Active against HSV	Mukherjee et al. (2013)
	Chebulagic acid and punicalagin from *Terminalia chebula*	Active against HSV-1	Lin et al. (2011)
	Oxyresveratrol from *Artocarpus lakoocha*	Inhibit viral replication	Chuanasa et al. (2008)

Dengue virus	Baicalein from *Scutellariabaicalensis*against DENV-2	Virucidal activity against extracellular virus; impedes viral adsorption onto the host cell; inhibits viral replication post entry	Zandi et al., 2012
	Quercetin against DENV-2	Inhibits viral replication; do not affect viral attachment and entry	Lin et al., 2014
	Narasin against DENV-2	Disrupts viral protein synthesis without affecting viral RNA replication	Lin et al., 2014
	Marine seaweed extracts against DENV serotypes 1–4; *Canistrocarpuscervicornis*, *Padina gymnospora*, *Palisada perforate*, and *Caulerpa racemosa* are most effective	Act at the early stage of viral infection	Koishi et al., 2012
	Chebulagic acid and punicalagin isolated from *Terminalia chebula* against DENV-2	Inactivate free virus particles by preventing early viral entry as well as attachment andpenetration; not affective in viral cell-to-celltransmission	Lin et al., 2014
	Honokiol from *Magnolia grandiflora*	Inhibits dengue virus type 2 infection	Fang et al., 2015
Measles virus	Herbal prescription Sheng-Ma-Ge-Gen-Tang	Antiviral effect may be modulated by TNF-a stimulation	Huang et al., 1997
	Cherokee remedy spicebush	Unclear	Lin et al., 2014
	Biflavonoids from *Rhus succedanea* and *Garcinia multiflora*, as well as their methyl ethers and acetates	Unclear	Lin et al., 2014
	Calcium spirulan from the blue-green alga *Spirulina platensis*	Unclear	Lin et al., 2014
	Crotolusduris-susterrificus- snake venom	Probably virucidal or targets viral entry	Petricevich& Mendonca, 2003
	Extracts of *Zanthoxylum chalybeum* and *Warburgiaugandensis*	Unclear	Lin et al., 2014
	Oliniarochetiana(Olkirenyi) and *Warburgiaugandensis* (Osokonoi)	Neutralize virus particles	Parker et al., 2007
	Stem and root extract of *Cajanus cajan*	Unclear	Lin et al., 2014

	Punicalagin and chebulagic acid isolated from *Terminalia chebula*	Inactivate free virus particles by interfering in viral binding, fusion, and post-infection cell-to-cell spread	Lin et al., 2014
Enterovirus 71	Aqueous and ethanolic extracts of *Ocimum basilicum* along with its constituent compounds ursolic acid, linalool and apigenin	Ursolic acid prevents viral replication and infection	Chiang et al., 2005
	Raoulic acid from *Raoulia australis*	Unclear	Lin et al., 2014
	Gallic acid from *Woodfordiafruticosa* flowers	Unclear	Lin et al., 2014
	Epigallocatechin gallate from green tea	Interferes with viral replication by means of modulation of the cellular redox environment	Ho et al., 2009
Coxsackievirus	Aqueous and ethanolic extracts of *Ocimum basilicum* along with its constituent compounds ursolic acid, linalool and apigenin against CVB	Ursolic acid interferes with viral infection and replication	Chiang et al., 2005
	Raoulic acid isolated from *Raoulia australis* against CVB	Unclear	Lin et al., 2014
	Herbal prescription Xiao-Chai-Hu-Tang against CVB	Induction of type I interferon response	Cheng et al., 2006
	Bupleurum kaoi against CVB	Induce type I interferon response	Cheng et al., 2007
Respiratory syncytial virus	Punicalagin and chebulagic acid isolated from *Terminalia chebula*	Inactivate free virus particles by preventing early viral entry as well as attachment and penetration; not affective in viral cell-to-cell transmission	Lin et al., 2014
	Dicaffeoylquinic acids from *Schefflera heptaphylla*	Inhibit viralfusion in the early stage and prevent cell-to-cell fusion at the end of replication cycle	Li et al., 2005a, b
	Uncinoside A and B from *Selaginella uncinate*	Unclear	Lin et al., 2014

	Genkwanol B, C, and stelleranol extracted from *Radix Wikstroemiae*	Unclear	Lin et al., 2014
	Flavones from the leaves of *Lophatherum gracile*	Unclear	Lin et al., 2014
	Herbal prescription Sheng-Ma-Ge-Gen-Tang	Inhibits viral attachment and internalization by stimulating IFN-ß secretion	Lin et al., 2014
	Tangeretin and nobiletin from *Citrus reticulata*	Affected the intracellular replication of RSV. Tangeretin down regulated the expression of RSV phosphoprotein (P protein)	Xu et al., 2014
	Carnosic acid from *Rosmarinus officinalis*	Inhibit replication of RSV	Shin et al., 2013
	Cimicifugin from *Cimicifuga foetida* L.	Inhibit viral attachment and internalization	Lin et al., 2014
	Resveratrol against RSV-induced inflammation	Reduces virus-induced airway inflammation via down-regulation of IFN-γ levels during RSV infection	Lin et al., 2014
Vesicular stomatitis virus (VSV)	1-Cinnamoyl-3,11dihydroxymeliacarpin (CDM) from *Melia azedarach* L.	Blocks viral entry and the intracellular transport of VSV-G protein, confined it only to the Golgi apparatus	Barquero et al., 2006
	Glycyrrhizin from *Glycyrrhiza glabra*	Inhibits phosphorylating enzymes and latency phase of the virus	Fiore et al., 2008
	Oleanolic acid from *Calendula arvensis*	Inhibit VSV multiplication	De Tommasi et al., 1991
Polio virus (PV)	Apigenin from *Baccharis gaudichaudiana*	Anti-PV type 2	Visintini et al., 2013
	Chrysophanic acid from *Dianella longifolia*	Inhibit PV 2 and PV 3 replication	Semple et al., 2001
	Chrysosplenol C from *Pterocaulons phacelatum*	Inhibit PV	Semple et al., 1999
Ebola virus	Silvestrol from *Aglaia foveolata*	Active against Ebola virus	Biedenkopf et al., 2016
	Curcumin from *Curcuma longa*	Active against Ebola virus	Mathew and Hsu, 2018
Epstein–Barr virus (EBV)	Glycyrrhizic acid from *Glycyrrhiza radix*	Interferes with an early step of EBV replication cycle	Lin, 2003
	Manassantin B from *Saururus chinensis*	Inhibitory effects toward EBV lytic replication	Cui et al., 2014

Traditional Anti-Viral Herbal Medicines

There are a significant number of medicinal plants from Ayurveda and the traditional Chinese system of medicine that serve as potential remedies to decrease the severity of infections caused by viruses. In Ayurveda, *Panchakarma* (five proceces of purification), *Rasayana Chikitsa* (immune-modulators therapy) and *Sadvritta* are leading treatments for any epidemic condition (Niraj & Varsha, 2020).There are several compounds and drugs possess the *Rasayana* effects that are supposed to improve defense mechanism (Niraj & Varsha, 2020). Till date, there are many *Rasayana dravyas*that are well known for their immunomodulatory effects via histamine release, immunoglobulin secretion, modulation of cytokine secretion, lymphocyte secretion and phagocytosis and so on (Kumar et al., 1999). The mechanism of these Ayurvedic plant extracts and compounds are listed at Table 3. Some well-known plants in Ayurveda that are used for dealing with infectious viral diseases include:

Ashwagandha (Withania Somnifera)

Ashwagandha is one of the most widely used herbs in Ayurveda, commonly known as Indian Winter Cherry and Indian Ginseng. It may combat against infections, reduce anxiety, stress as well aslower cholesterol and triglycerides. Ashwagandha helps to improve immunity by enhancing the nitric oxide synthetase activity of the macrophages (Tiwari et al., 2014).

Guduchi (Tinospora Cordifolia)

In Rasayana, Guduchi is well known as “Amrita”, as it has the capability to rejuvenate dead cells and immune-modulatory effects that enhances immunity against viral infection, including COVID-19 (Niraj & Varsha, 2020).

Amalaki (Phyllanthus Emblica)

Amalaki is the richest source of vitamin C (Repine et al., 1997). Acharya Charaka, the ancient ‘Father of Ayurveda’ described Amalaki as the best rejuvenating herb that is used in cough and skin diseases (Sharma & Chaudhary, 2015).

Mulethi (Glycyrrhiza Glabra)

Mulethi, also called Yasthimadhu, has proven antiviral activity against Human immunodeficiency virus (HIV). It bears potent immunomodulatory and antioxidant activity (Akamatsu et al., 1991).

Shatavari (Asparagus Racemosus)

Sahatavari play a major role as Ayurvedic rejuvenating tonic for the female. Shatavari shows its activity as altering the function of macrophages by potent immunomodulatory property (Dahanukar et al., 1986).

Kalmegha (Andrographis Paniculata)

Kalmegha is also an important *Rasayana* herb which can enhance immune responses. It has the capacity to treat viral respiratory infections (Niraj & Varsha, 2020).

Tulsi (Ocimum Sanctum)

Tulsi is widely regarded as the mother medicine of nature. It has the capability to shorten the course of all illness.Tulsi leaves are beneficial for the treatment of certain respiratory disorders like bronchitis, influenza, asthma, cough and cold (Pattanayak et al., 2010). Beside this, it also has anti-bacterial, anti-viral and anti-fungal activities (Cohen, 2014).

Punarnava (Boerhaaviadiffusa)

Punarnava shows immunomodulatory effects as it has immunosuppressive and immunostimulatory activity (Mungantiwar et al., 1999).

Table 3: Ayurvedic plant extracts and their action mechanism against viral infections.

Plant	Plant extract and compounds	Antiviral Agent Against	Mode of action	References
Ashwaga-ndha	*Withaniasomni fera*glycopropein (WSG)	Coronavirus	Modulation of host Th-1/Th-2 immunity. Increasement of Interferongamma (IFN gamma) decreases the quantity of Interleukin -1, Interleukin -6 and Tumor necrosis factor which are the main factors related to COVID-19.	Gautam et al., 2004
	Ashwagandha extract with DPT vaccine	Diphtheria, Pertusis and Tetanus	Competent protective immune responses when added with DPT vaccine against fatal outcome of	Gautam et al., 2004

			diphtheria and pertussis toxins.	
Guduchi	Tinosporin (diterpenoid)	Retroviruses	Unknown	(Niraj & Varsha, 2020)
Amalaki	Norsesquiterpenoid glycosides	Coxsackie virus B3 (CVB3)	Exhibited strong anti-CVB3 activity.	(Niraj & Varsha, 2020)
Mulethi	Glycyrrhizin	SARS-associated virus	Inhibition of replication	(Niraj & Varsha, 2020)
	Extract	Herpes simplex virus type 1 (HSV-1)	Type I and II interferons (IFN) and Th2 cytokines secretion.	(Niraj & Varsha, 2020)
		HIV	Unknown	(Niraj & Varsha, 2020)
Shatavari	Shatavari extract with DPT vaccine	Diphtheria, Pertusis and Tetanus	Significant upregulation of Th-1,Th-2 and cytokines and immunostimulant property by significant increase of CD4/ CD8 along with T cell activation	Gautam et al., 2004
Kalmegha	Kalmegha extract	Herpes simplex virus 1 (HSV-1) and HIV	Significant rise in the mean CD4+ lymphocyte level.	(Niraj & Varsha, 2020)
Tulsi	Essential oils like Eugenol	Polio virus type 3, Herpes virus (HSV) and Hepatitis B virus	Unknown	(Niraj & Varsha, 2020)
	Ethanolic extract of Tulsi leaves in a range of 22.5 mg/ml concentration.	Polio type 3 virus	Inhibition of replication	(Niraj & Varsha, 2020)
	Extracted components of like linalool and ursolic acid	Adenovirus	Unknown	(Niraj & Varsha, 2020)
Punar nava	Punarnava root extract	RNA bacteriophages	Cell lysis	(Niraj & Varsha, 2020)

Besides these mostly used Ayurvedic herbs, there are also numerous medicinal plants those have active compounds showing affectivity in the treatment of several viral infections (Table 4).

Table 4: Plants and their products' antiviral mechanism against selected viruses.

Sl. No.	Plant Family	Plant	Antiviral Plant Compounds	Anti viral Agai nst	Type of Study	Model Used	Major Findings	References
1.	Anacar diaceae	*Rhus chinensis* & *R.javanica*	Gallic acid, Moronic acid & Plant extract	HSV	*in-vitro* &*in-vivo*	U937 cell line, Mice & Guinea pigs	Gallic acid induces apoptosis Moronic acid exhibits anti-HSV activity Suppresses HSV infection	Mishra et al., 2013
2.	Aristol ochiace	*Aristolochia indica*	Plant extracts	HIV	*in-vivo*	Human subjects	• Marked increase in $CD4^+$ T cell population in 7 out of 10 individuals observed	Cunningham et al., 2010
3.	Calophy llaceae	*Calophyllu mlanigerum*	Calanolide A	HIV	*in-vitro, invivo*	Human subjects	Calanolide A interacts with HIV reverse transcriptase and inhibits it	Mishra et al., 2013
		Calophyllum spp.	Inophyllum calanolide A coumarins	HIV	*in-vitro*	*Enzyme Assay*	• Inhibitory effects on HIV reverse transcriptase enzyme	Mishra et al., 2013
4.	Cucurb itaceae	*Trichosanthes Kirilowii*	Ribosome Inactivating proteins (RIPs) e.g.Trich obitacin	HIV	*in-vitro*	H9, C8166, H9/ HIV-1 III_B cell lines	Depurination of rRNA, leading to inhibition of protein synthesis Reduction in HIV-1 p24 antigen	Mishra et al., 2013
5.	Euphor biaceae	*Phyllanth usniruriP. amarus*	Lignans, alkaloids & flavonoids	HBV	*in-vivo* &*in-vitro*	Human subjects Mice, Vero cell line	Effective clearance of HbsAg by *P.urinaria, P.niruri*, &*P.amarus* HBV elimination by *P.niruri*	Mishra et al., 2013
		Phyllanth usniruri	Alkaloid extract	HIV	*in-vitro*	MT-4 cells	• *P.niruri* decreased cytopatho genicity caused by HIV infection	Weiss RA, 1993
		Phyllanthus niruri	Plant extracts	HIV	*in-vivo*	Human subjects	• Marked increase in $CD4^+$ T cell population in 7 out of 10 individuals observed	Cunningham et al., 2010

6.	Fabaceae	*Glycyrrhiza glabra*	Glycyrrhizin, SNMC	HCV HIV	*in-vivo*	Rat Human subjects	SNMC found to be effective for a short term 66.7% efficacy of glycyrrhizin, in reducing Symptoms • Glycyrrhizin inhibits HIV-1 and reduces symptoms	Mishra et al., 2013
		Glycyrrhiza glabra	Licorice roots	HSV	Topical treatment	Human subjects	Licorice based cream resolves HSV infection symptoms	Taylor et al., 2002
		Sophora spp.	Plant extract	Coxsackie B virus	*in-vivo*	Human subjects	• Relief from symptoms and antiviral activity	Zhang et al., 2001
		Cassia occidentalis,	Plant extracts	HIV	*in-vivo*	Human subjects	• Marked increase in $CD4^+$ T cell population in 7 out of 10 individuals observed	Cunningham et al., 2010
7.	Menispermaceae	*Tinospora cordifolia*	Plant extracts	HIV	*in-vivo*	Human subjects	• Marked increase in $CD4^+$ T cell population in 7 out of 10 individuals observed	Cunningham et al., 2010
8.	Phytolaccaceae	*Phytolacca americana*	Pokeweed antiviral protein (PAP I,II & III)	HIV	*in-vitro*&*in-vivo*	Biochemical Assay & human trial	Antiviral property of PAP: Depurination of genomic HIV-1 RNA HIV inactivation	Mishra et al., 2013
9.	Phyllanthaceae	*Phyllanthus emblica*	nor-sesquiterpenoid glycosides and ellagitannins	Coxsackie B virus	*in-vitro*	Cell lines	• Phyllaemblicin exhibits anti-Coxsackie B virus activity	Bhattacharya et al., 1999

Ingestion Methods

Herbal antiviral drugs can be consumed in a variety of ways. For example, ginseng can be found as capsules, tablets, dried ginseng root, liquid extract of ginseng, ginseng gum and possibly even ginseng cigarettes also. Making a tea from the dried roots, leaves, or flowers of the herb is another popular way of taking herbal drugs. Following are some common ways of preparation and ingestion of herbal medicines: Decoction is a dring made from the roots, bark, or other body parts of the plant boiling in water. Infusion is a tea made by pouring water over the dried leaves, fruit or flower of the herb and allowing them to steep into water. Generally, the used water

should boil, but there are some infusions that use cold water.

Tincture is an extract of specific herbs made by soaking them in alcohol, vinegar or glycerin for few weeks. The liquid is strained from the plant and can be used therapeutically by addition of hot water or other beverages. Like other medicines, tincture can also be taken by spoonful. Linimentis is the extract of a particular herb added to vinegar, alcohol or either. It can be applied to the skin (Sandberg et al., 2005). Poulticeis is a moist, soft mass of plant derived substances, often bruised or crushed, and has to be wrapped in a fine woven cloth. It can be applied to wounds, burns, rashes or other skin damage and diseases (Adetutu et al., 2011).

Conclusion

In developed world, herbal drugs are in huge demand for health care as they are efficient, safe and have comperatively slighter side effects. The herbal formulations are proven effectiveandv safe. More than 80%of the population uses herbals and folk remedies worldwide. In developing countries, where many people do not have access to modern health care, traditional herbal medicines are the only option. Besides therapeutic use, herbal drugs are also disease preventors and used as cosmetics, dietary supplements for reducing obesity (Kapoor, 2005; Breemen et al., 2008). There is a necessity to improve technology for the rapid isolation of bioactive compounds of herbal plants in large extents. This is important for evaluation with the specific collection of plant material and maintenance of biodiversity.The availability of highly advanced throughout screening for discovery of target-based drug is also essential. The required maintainance approaches may include profiling kits for drug toxicity study-libraries which contain a large number of laboratory animal models imitating human diseases, highly pure phytochemicals, and bioinformatics database for long-term safety prediction. Considering the enormous number and amazing structural diversity of the currently available antimicrobial and antiviral plant constituents, one might hope that promising systematic and locally acting anti-infecting agents might be discovered in the plant kingdom.

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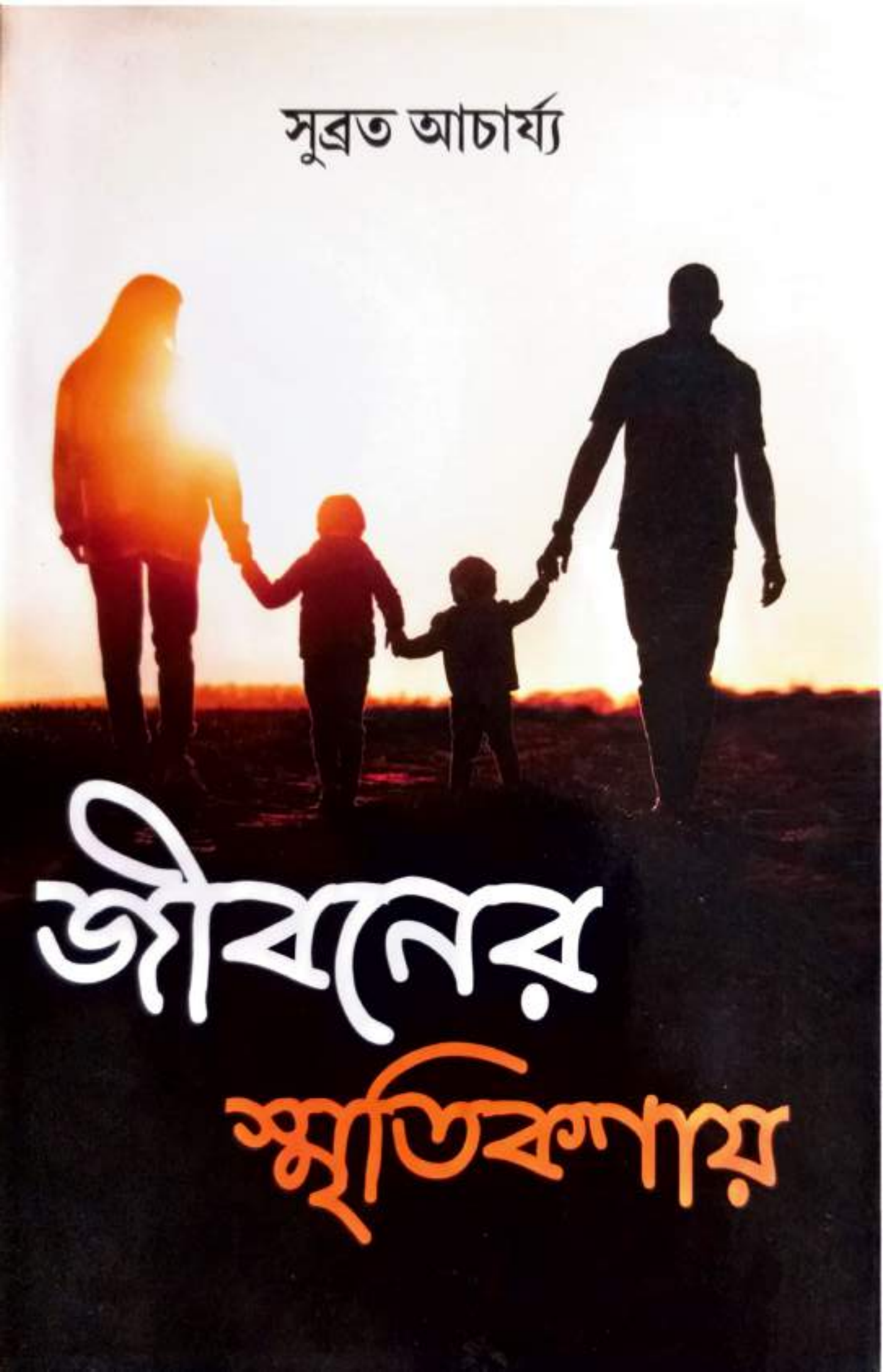
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সুব্রত আচার্য্য



জীবনের স্মৃতিকথায়

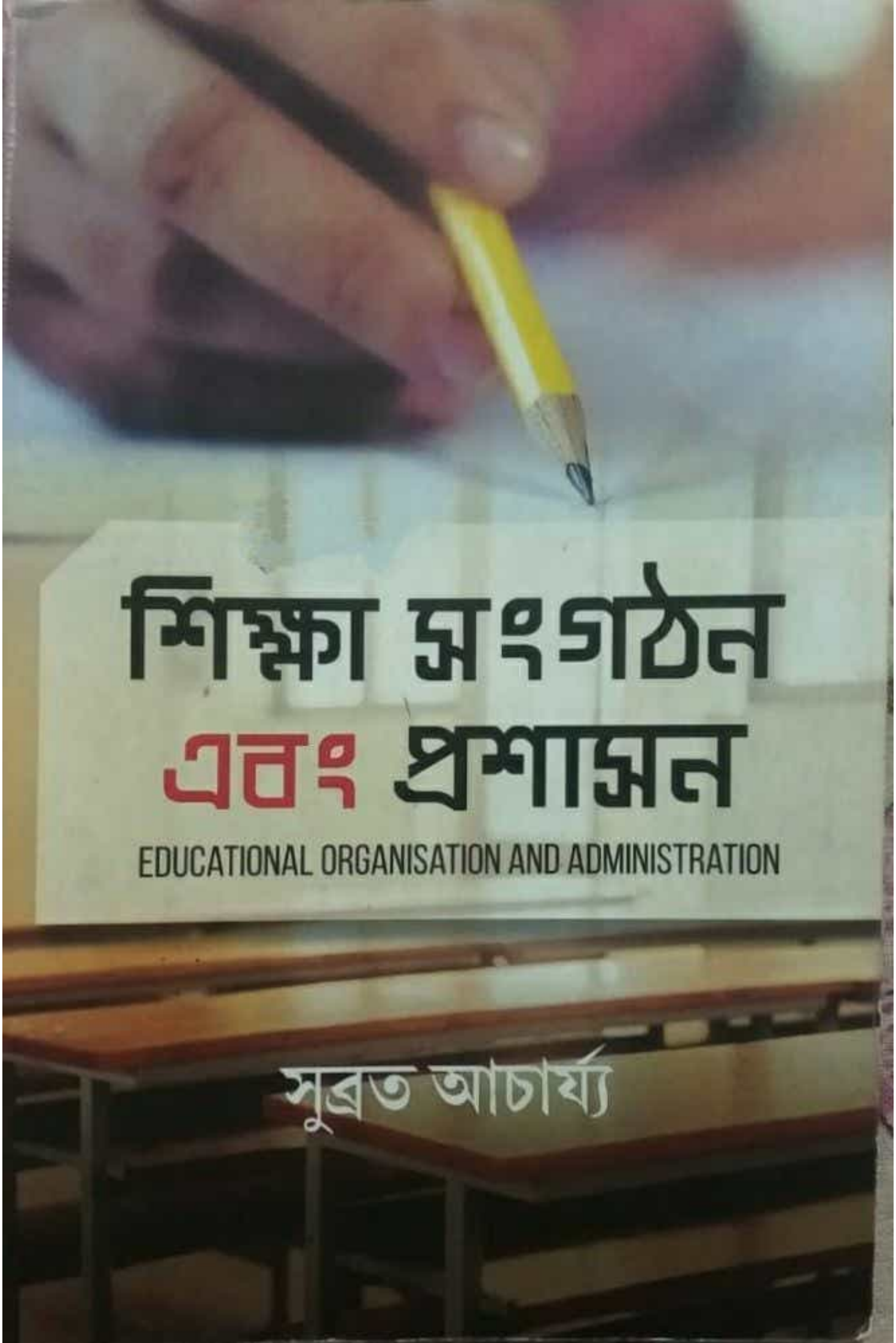
জীবনের স্মৃতিকণায়

সুব্রত আচার্য্য

আলপনা

সূচিপত্র

প্রকৃত দান ৯
তৃষ্ণার্ত ১০
অব্যক্ত যন্ত্রণা ১১
আঁধারে মনুষ্যত্ব ১২
বাংলা ভাষা ১৩
শিক্ষক ১৫
ক্ষত ১৬
মৃত্যু ১৭
মা ১৮
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অদৃশ্য ২২
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নিমগ্ন দহন ২৪
প্রশ্ন ২৫
দারিদ্রতা ২৬
নির্বাসনে মনুষ্যত্ব ২৮
অপ্রমাণিত ২৯
ওরা কারা ৩০
মুখোশ ৩১
স্ত্রী ৩২
অব্যক্ত কথা ৩৩
উপলব্ধি ৩৪



শিক্ষা সংগঠন এবং প্রশাসন

EDUCATIONAL ORGANISATION AND ADMINISTRATION

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Calcutta University Semister-III (Hons. & Gen), Kalyani University Semister-V (Hons. & Gen), West Bengal State University Semister-IV (Hons. & Gen), Bankura University Semister-V (Hons. & Gen), Burdwan University Semister-V (Hons. & Gen), Vidyasagar University Semister-III (Hons. & Gen), North Bengal University Semister-IV (Hons. & Gen), Sidhu Kanu Birsha University Semister-V (Hons. & Gen).

শিক্ষা সংগঠন এবং প্রশাসন

(Educational Organisation and Administration)

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রামানন্দ কলেজ, বাঁকুড়া

ALPANA
enterprise

সূচিপত্র

প্রথম অধ্যায়

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❖ বিদ্যালয়ের সময়তালিকার প্রয়োজনীয়তা ৭৬
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Ms. Sonam Jalan

AMITAV GHOSH

A Writer with a Difference



Editor

INDIRA NITYANANDAM

Ecological Refugees: Climate Change and the Unthinkable in Amitav Ghosh's Gun Island

Sonam Jalan

Abstract

"We do not inherit the earth from our ancestors; we borrow it from our children" - Wendell Berry

Environmental destruction is a harsh reality of our times which we cannot escape. Climate change, deforestation, threats to biodiversity, land, water and air pollution and all forms of ecological crisis have affected not only people's lives but also the environmental sustainability. Irony lies in the fact that the most affected and grieved in these environmental deteriorations are the poor and vulnerable people from the poor countries whose access to survival is often denied. Such global injustices need to be addressed in a world that is gradually more selfish, ignorant and dehumanized. Fiction and literature can play a major role in helping us consider the world in a new way. Amitav Ghosh in his book-length essay, *The Great Derangement: Climate Change and the Unthinkable*, laments the absence of such a crucial phenomenon in fictional writing causing humanity's derangement. He talks about an urgency for a new literature of climate change that would represent the vague, omnipresent threat hovering over the survival of humanity. My paper will fall back on the world of Amitav Ghosh's latest fiction *Gun Island* which is a sort of fulfillment to his own demands of a "serious fiction" that deals with a global view of environmental vulnerability. This book

Prof. Somnath Basu

The Unspoken Words

A Study of T.S. Eliot's Critical Writings

Editors

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The Unspoken Words
A Study of T.S. Eliot's Critical Writings

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Dr. Baibaswata Bhattacharjee

A Design of Frequency Encoded Dibit-based Comparator Using Reflective Semiconductor Optical Amplifier with Simulative Verification

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***Abstract*—In this modern era, optical computing increases the chance of ultra-high-speed information processing. All-optical comparator is one of the necessary components of the optical computing systems. Here we have designed a low power frequency encoded comparator using reflective semiconductor optical amplifier. This proposed comparator can compare a single bit signal. This work is based on dibit concept which improves the bit error problems. The proposed comparator is realized by simulation in MATLAB Simulink (R2018a) software. The devised design with the integrating ability is very purposeful in optical communication and computation.**

***Index Terms*—Optical Communication, Dibit-based logic system, Frequency encoding, Reflective semiconductor optical amplifier, Comparator.**

I. Introduction

In this modern world, the photon is a very good choice for information transmission. Photon has super fast speed but no rest mass comparison to the electron. So photon is very preferable to the researcher rather than the electron. For long-range transmission of the data signal, an encoding technique is must be used. Among all the encoding techniques [1]–[4], the frequency encoding technique is preferable due to its unaltered characteristics in reflection, refraction, polarization, absorption, etc. In optical information processing, the optical comparator is essential for decision-making circuits, arithmetic, and logic units. It is also needed for optical data processors. Here the comparator compares the magnitude of the input signals which are encoded by two different frequencies ν_1 and ν_2, where these two represent the digital logic state '0' and '1' respectively. In recent years, significant research works have been carried out for comparator. Some of these are discussed below.

Chattapadhyay [5] proposed a method for 1-bit comparator using Terahertz Optical Asymmetric Demultiplexer (TOAD) and also developed an n-bit comparator by the use of cascading technique. Ghosh et al. [6] proposed a design of all-optical wavelength encoded 1-bit comparator in which the non-linear property like four-wave mixing of semiconductor optical amplifier (SOA) is used. Mukherjee et al. [7] proposed a design of n-bit comparator using the concept of 3rd order nonlinearity like four-wave mixing (FWM) of semiconductor optical amplifier. Kaur et al. [8] introduced a comparator based on Mach-Zehnder Interferometer and verified by simulation in Opt Sim 4.7.1. A digital comparator has been reported by Singh et al. [9] using cross-phase modulation (XPM) and cross gain modulation (XGM) of SOA. Yang et al. [10] demonstrated a digital comparator using two micro-ring resonator (MRR). Two binary numbers are represented by two electrical signals which are modulated in two MRRs. For verification of their proposed model, a thermo-optic effect-based comparator is fabricated. Law et al. [11] proposed a digital 1-bit magnitude comparator using five silicon micro-ring resonator (MRR) and results are verified by time-varying simulation. Tian et al. [12] proposed 2-bit digital comparator using micro-ring resonator (MRR) with U-shaped wave-guides. By using complementary metal-oxide-semiconductor-fabrication, this comparator is fabricated on silicon-on-insulator substrate. To the best of our knowledge, no comparator based on the co-propagation scheme of reflective semiconductor optical amplifier (RSOA) has been proposed. Therefore, we design the frequency encoded dibit-based comparator using RSOA add/drop multiplexer (ADM). The proposed design is simulated in MATLAB Simulink (R2018a) software and the simulation results are satisfied with the desired outputs of the proposed design.

II. Working Principle of RSOA and ADM

One strong pump beam and a weak probe beam are used as input signals of SOA but in output, the weak probe beam is obtained with a higher power. That extra power comes from the strong pump beam. This SOA is called reflective semiconductor optical amplifier (RSOA) [3]. A high reflective (HR) coating is on the one facet of RSOA and an anti-reflective (AR) coating is on the other facet of RSOA. It has a very versatile high gain medium. Fig. 1 shows the block diagram of RSOA. In this paper, the input weak probe signal is in the C-band (1536-1570nm) and the saturation power may be used in the range of 5-20 dBm [4].

An optical add/drop multiplexer is a device that works as a frequency selector. ν_1 and ν_2 are the frequencies of the

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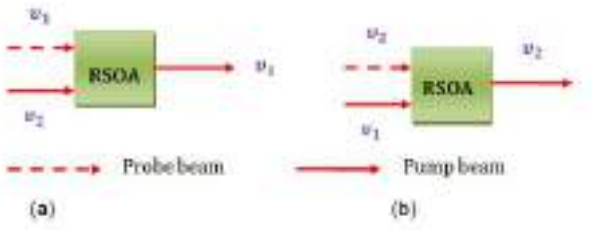


Fig. 1. The working function of RSOA. (a) The probe beam and pump beam frequencies are ν_1 and ν_2 respectively but output gives ν_1. (b) The probe beam and pump beam frequencies are ν_2 and ν_1 respectively but output gives ν_2.

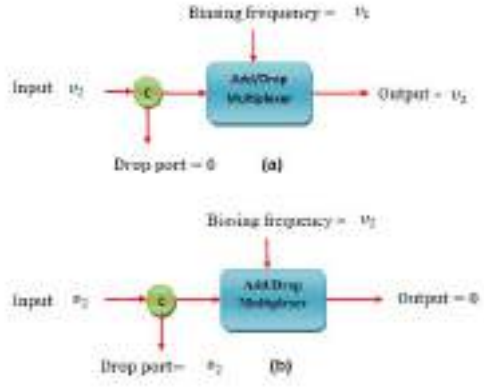


Fig. 2. The working function of ADM. (a) When biasing frequency and input frequency are different then ADM passes the input frequency at the output port whereas drop port gives '0'. (b) When biasing frequency and input frequency are the same then output gives '0' and ADM reflected the input frequency at the drop port by the use of circulator 'C'.

input control signals. ADM can send ν_1 and ν_2 frequencies in two different paths but it can separate a particular frequency without interfering between the two different frequencies in the adjacent channel [3]. Without dropping any other frequency except the same biasing frequency, the rest of the frequency passes through the ADM. In Fig. 2, if the ADM is biased with frequency ν_2 then ADM selects frequency ν_1 and reflects frequency ν_2.

III. Realization of Proposed Comparator

In this communication, frequency encoding with two different frequencies represent the two different digital logic states. Here ν_1 and ν_2 use to represent '0' and '1' digital logic state respectively. In dibit-based representation technique [13], two consecutive bit positions use to represent a digital logic state. In dibit logic $\langle 0\rangle\langle 1\rangle$ represents the digital logic state '0' whereas $\langle 1\rangle\langle 0\rangle$ represents the digital logic state '1'. The two frequencies ν_1 and ν_2 when placed side by side as $\langle \nu_1\rangle\langle \nu_2\rangle$ indicates the digital logic state '0' and for $\langle \nu_2\rangle\langle \nu_1\rangle$ indicates the logic state '1'.

a) Case-1: In Fig. 3, when inputs A (A', A'') and B (B', B'') are equal i.e. A $(A' = \nu_1, A'' = \nu_2)$, B $(B' = \nu_1, B'' = \nu_2)$ or A $(A' = \nu_2, A'' = \nu_1)$, B $(B' = \nu_2, B'' = \nu_1)$ are applied to the input terminals of comparator. Both the ADM-1 and ADM-2 get ν_1 as biasing frequency and ν_2 as input frequency. Since input and biasing both the frequencies are different so input frequency ν_2 is selected by the ADM-1 and ADM-2. These ν_2 frequencies are working as pump beams of RSOA-1 and RSOA-2. Frequencies ν_1 are also working as probe beams of both the RSOAs. The output of RSOA-1 is ν_1, injected into the input and biasing frequency of ADM-3 and ADM-7 respectively. The output of RSOA-2 is ν_1, injected into the input and biasing frequency of ADM-7 and ADM-3 respectively. Since biasing and input frequency of ADM-3 and ADM-7 are the same then ν_1 frequencies are reflected by the ADM-3 and ADM-7 at the drop ports. These ν_1 frequencies are worked as pump beams of RSOA-3 and RSOA-8. The output of RSOA-3 is the frequency ν_1 which reaches the output G'. In this way output of RSOA-8 is the frequency ν_1 which reaches the output L'. Another part of the output of RSOA-3 and RSOA-8 are injected into the input and bias part of ADM-5. Since both the frequencies are the same i.e. ν_1. So, ν_1 is obtained at the drop port of ADM-5. The drop port frequency ν_1 is injected into RSOA-6 and here ν_2 works as probe beam. Therefore, ν_2 is obtained at the output port of RSOA-6 whereas RSOA-9 is not working due to the absence of pump beam. The output of RSOA-6 is the frequency ν_2 which reaches the output E'. The output of RSOA-6 is also injected into the input of ADM-6 and a fixed frequency ν_2 is applied to the biasing part of ADM-6. Therefore, the frequency ν_2 is obtained at the drop port. This ν_2 works as a pump beam of RSOA-10 and a fixed frequency ν_1 works as the probe beam of RSOA-10. The output of RSOA-10 i.e. ν_1 frequency is obtained at the output E''. The output of RSOA-8 is also injected into the input of ADM-8 and a fixed frequency ν_2 is already injected into the bias port of ADM-8. Since the input and biasing frequencies are different then the frequency ν_1 is selected by the ADM-8 and ν_1 obtains at the output port. This ν_1 frequency works as pump beam of RSOA-11. A fixed beam with frequency ν_2 works as the probe beam of RSOA-11. Therefore, frequency ν_2 is obtained at the output L'' and also we get the final output. This result shows that when input A $(A' = \nu_1, A'' = \nu_2)$ and B $(A' = \nu_1, A'' = \nu_2)$ are the same then G $(G' = \nu_1, G'' = \nu_2)$, E $(E' = \nu_2, E'' = \nu_1)$ and L $(L' = \nu_1, L'' = \nu_2)$ are obtained at the outputs of the comparator.

b) Case-2: When inputs A (A', A'') and B (B', B'') are different i.e. A $(A' = \nu_2, A'' = \nu_1)$, and B $(B' = \nu_1, B'' = \nu_2)$ are applied to the input terminals of comparator. The ADM-1 gets ν_2, ν_1 as biasing frequency and input frequency respectively. ADM-2 gets ν_1 as biasing frequency and ν_2 as input frequency. Since input and biasing both the frequencies are different so input frequency ν_1 and ν_2 are selected by the ADM-1 and ADM-2 respectively. These ν_1 and ν_2 frequencies are working as pump beams of RSOA-1 and RSOA-2 respectively. Frequencies ν_2 and ν_1 are also working as probe beams of the RSOA-1 and RSOA-2 respectively. The output of RSOA-1 is ν_2, injected into the input and biasing frequency of ADM-3 and ADM-7 respectively. The output of RSOA-2 is ν_1, injected into the input and biasing frequency of ADM-7 and

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TABLE I
TRUTH TABLE OF FREQUENCY ENCODED DIBIT-BASED COMPARATOR

Dibit Input A'	**Dibit Input** A''	**Digital logic state (A)**	**Dibit Input** B'	**Dibit Input** B''	**Digital logic state (B)**	**Dibit Output** G'	**Dibit Output** G''	**Digital logic state (G)**	**Dibit Output** E'	**Dibit Output** E''	**Digital logic state (E)**	**Dibit Output** L'	**Dibit Output** L''	**Digital logic state (L)**
ν_1 [0]	ν_2 [1]	0	ν_1 [0]	ν_2 [1]	0	ν_1 [0]	ν_2 [1]	0	ν_2 [1]	ν_1 [0]	1	ν_1 [0]	ν_2 [1]	0
ν_1 [0]	ν_2 [1]	0	ν_2 [1]	ν_1 [0]	1	ν_1 [0]	ν_2 [1]	0	ν_1 [0]	ν_2 [1]	0	ν_2 [1]	ν_1 [0]	1
ν_2 [1]	ν_1 [0]	1	ν_1 [0]	ν_2 [1]	0	ν_2 [1]	ν_1 [0]	1	ν_1 [0]	ν_2 [1]	0	ν_1 [0]	ν_2 [1]	0
ν_2 [1]	ν_1 [0]	1	ν_2 [1]	ν_1 [0]	1	ν_1 [0]	ν_2 [1]	0	ν_2 [1]	ν_1 [0]	1	ν_1 [0]	ν_2 [1]	0

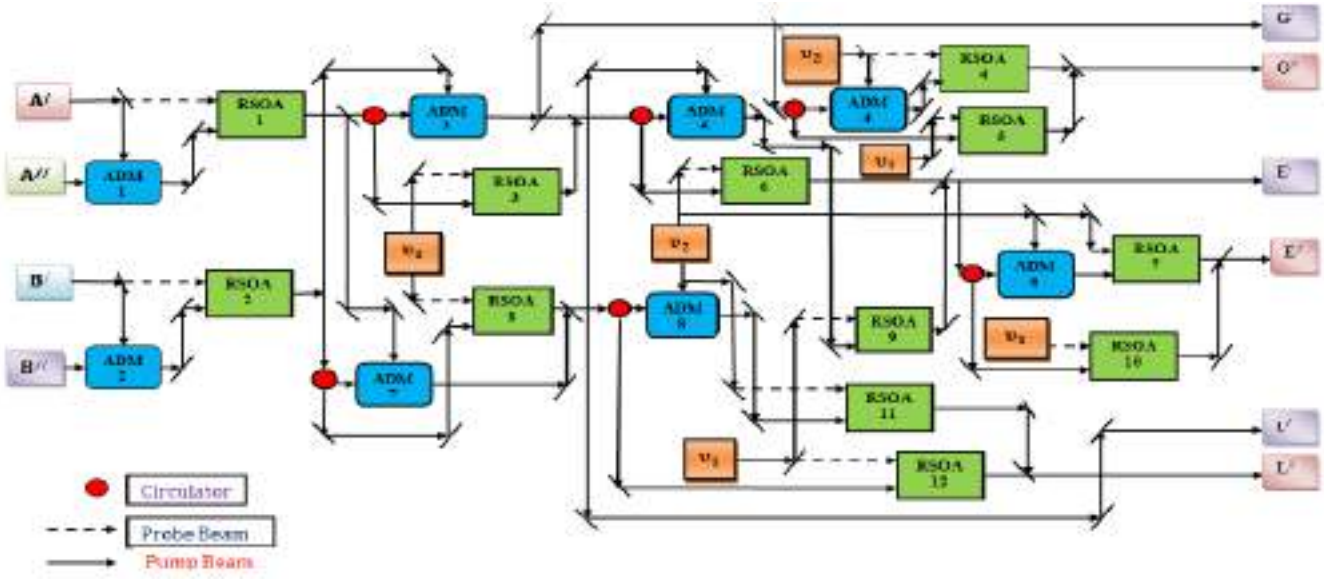


Fig. 3. Schematic diagram of proposed dibit-based comparator.

ADM-3 respectively. Since biasing and the input frequency of ADM-3 and ADM-7 are different then ν_2 frequency is selected by the ADM-3 and ν_1 frequency is selected by the ADM-7 at the output ports. RSOA-3 and RSOA-8 are not working due to the absence of the pump beams. The output of ADM-3 is the frequency ν_2 which reaches the output G'. The output of ADM-7 is the frequency ν_1 which reaches the output L'. Another part of output of ADM-3 is injected into the inputs of ADM-4 and ADM-5. Since both the frequencies of ADM-4 is same i.e. ν_2. So, ν_2 is obtained at the drop port of ADM-4. The drop port frequency ν_2 is injected into RSOA-5 and here ν_1 works as probe beam. Therefore, output of RSOA-5 is the frequency ν_1 which reaches the output G''. The RSOA-4 and RSOA-6 are not working due to the absence of pump beams. The output of RSOA-5 is the frequency ν_1 which reaches the output G'' to the input of ADM-6 and a fixed frequency ν_2 is applied to the biasing part of ADM-6. Therefore, the frequency ν_2 is obtained at the drop port. This ν_2 works as a pump beam of RSOA-10 and a fixed frequency ν_1 works as probe beam of RSOA-10. The output of RSOA-10 i.e.ν_1 frequency is obtained at the output E''. The output of RSOA-8 is also injected into the input of ADM-8 and a fixed frequency ν_2 is already injected into the bias port of ADM-8. Since the input and biasing frequencies are different then the frequency ν_1 is selected by the ADM-8 and ν_1 obtains at the output port. This ν_1 frequency works as pump beam of RSOA-11. A fixed beam with frequency ν_2 works as the probe beam of RSOA-11. Therefore, frequency ν_2 is obtained at the output L''. We get the final output. This result shows that when input A $(A' = \nu_1, A'' = \nu_2)$ and B $(A' = \nu_1, A'' = \nu_2)$ are same then G $(G' = \nu_1, G'' = \nu_2)$, E $(E' = \nu_2, E'' = \nu_1)$ and L $(L' = \nu_1, L'' = \nu_2)$ are obtained at the outputs of the comparator.

IV. SIMULATION OF PROPOSED COMPARATOR

The proposed comparator is verified by simulation with the MATLAB Simulink (R2018a) software. As shown in Fig. 4 dibit signal A and B are applied to the inputs of the comparator. RSOA and ADM blocks are programmed by MATLAB language to get the output. If the probe signal and pump signal are considered as say ν_1=193.5 THz (digital logic state '0') and ν_2=193.9 THz (digital logic state '1') respectively then at the output end of RSOA gives 193.5 THz that represents '0' digital logic state. Similarly, if the probe signal and pump signal are considered as say ν_2=193.9 THz and ν_1=193.5 THz respectively then at the output end of RSOA gives 193.9 THz. ADM block is programmed as such a way that ADM selects all other frequencies at the output

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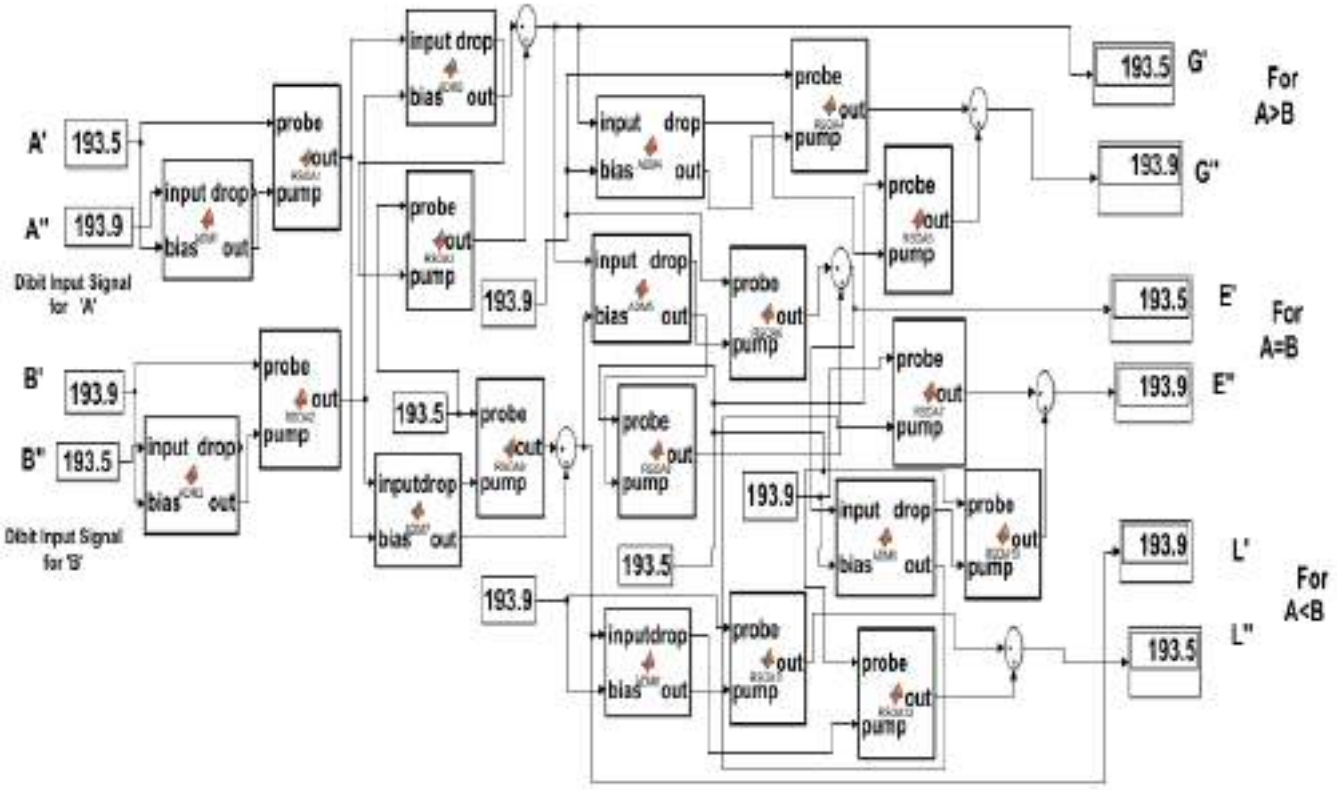


Fig. 4. Simulation model, when A'=193.5 THz, A''=193.9 THz and B' =193.9 THz, B''= 193.5 THz are applied to the input port.

except the biasing frequency which reflects at the drop port. If biasing frequency and the input frequency are considered as say ν_1=193.5 THz and ν_2=193.9 THz respectively then ADM gives at the output ν_2= 193.9 THz and at the drop port gives zero. But when the input and biasing frequency are considered as the same then output of ADM gives zero and the drop port gives the input frequency. In Fig. 4, when both the inputs are the same i.e., $\langle 193.5\rangle\langle 193.9\rangle$ and $\langle 193.5\rangle\langle 193.9\rangle$ represent the '0' and '0' digital logic states, and these are applied to the dibit inputs (A) and (B) terminal. After the simulation, the equal (E', E'') terminal shows $\langle 193.9\rangle\langle 193.5\rangle$ and the other terminals show $\langle 193.5\rangle\langle 193.9\rangle$ because both the inputs are equal. This results are similar for $\langle 193.9\rangle\langle 193.5\rangle$ and $\langle 193.9\rangle\langle 193.5\rangle$ these represent the '1' and '1' digital logic state. When both the inputs are different i.e., $\langle 193.5\rangle\langle 193.9\rangle$ and $\langle 193.9\rangle\langle 193.5\rangle$ represent the '0' and '1' digital logic state respectively, and these are applied to the dibit inputs (A) and (B) terminal respectively. After the simulation, less than (L', L'') terminal shows $\langle 193.9\rangle\langle 193.5\rangle$ and the other terminals show $\langle 193.5\rangle\langle 193.9\rangle$ because the input (A) is less than the input (B) i.e. $A < B$.

V. Results and Discussion

In this work, 193.5 THz and 193.9 THz signals represent the frequency ν_1 and ν_2 which are applied in the time interval of 10 ps. The dibit input signals waveform are given in Fig. 5. When the proposed model is simulated with these input signals, dibit output signals waveform are obtained. The dibit output signals are given in Fig.6. The input dibit signals waveform and simulation waveform of dibit outputs are verified with the simulation results and the truth table I of the proposed design. First 10 ps, 193.5 THz in A', 193.9 THz in A'', 193.9 THz in B' and 193.5 THz in B'' are applied as inputs of the proposed model but the $\langle 193.9\rangle\langle 193.5\rangle$ is obtained at the less than (L', L'') terminal and $\langle 193.5\rangle\langle 193.9\rangle$ are obtained at the other terminals $(G', G''andE', E'')$. In the range, 10-30 ps, 193.9 THz in A', 193.5 THz in A'', 193.5 THz in B' and 193.9 THz in B'' are applied as inputs of the proposed model but the $\langle 193.9\rangle\langle 193.5\rangle$ is obtained at the greater than (G', G'') terminal and $\langle 193.5\rangle\langle 193.9\rangle$ are obtained at the other terminals $(E', E''andL', L'')$. In this way, the outputs waveform are obtained according to applied inputs waveform of A and B. After verification of above data and the simulation results, it can be concluded that the theoretical prediction of outputs of the comparator are accurately verified with the simulation output results, outputs waveform, and truth Table I.

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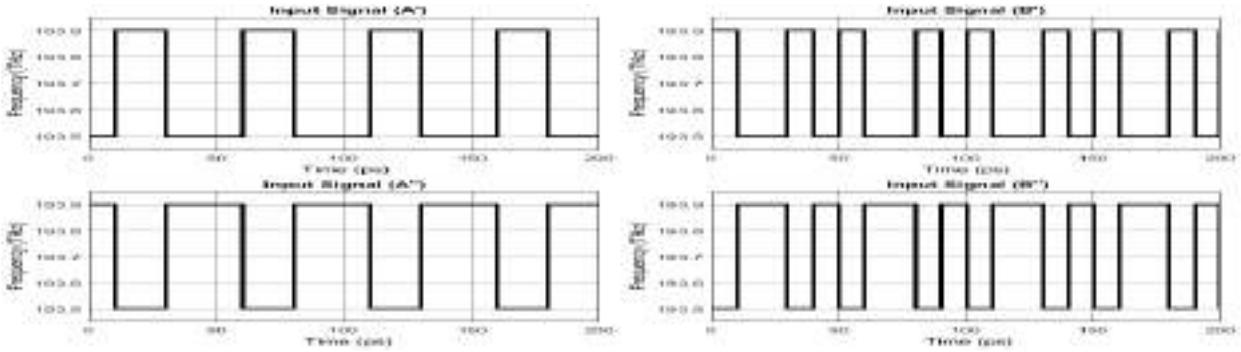


Fig. 5. The dibit input signals waveform of proposed comparator.

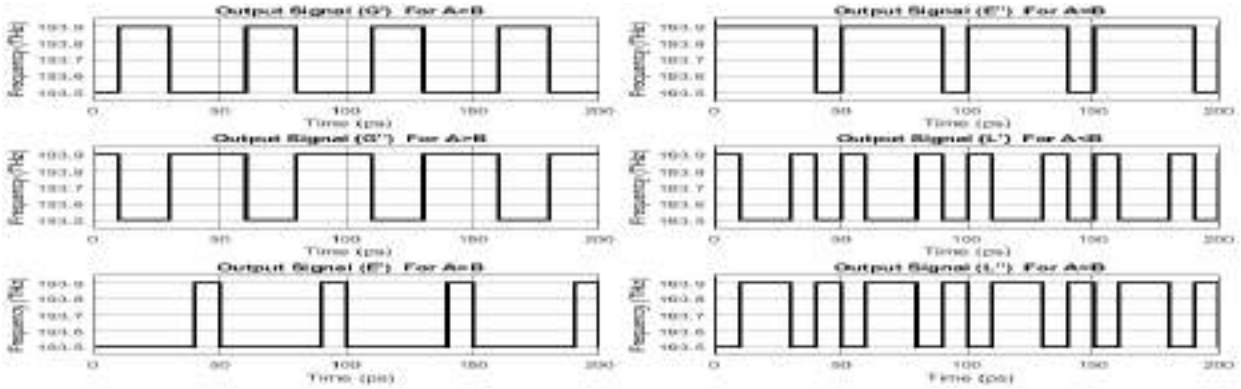


Fig. 6. The dibit output signals waveform of proposed comparator.

VI. Conclusion

The benefits of dibit representation technique and frequency encoding are established here to realize the all-optical operations. It also supports to decrease in bit error problems by increasing the high signal-to-noise ratio. Here dibit-checking unit in the input hindrances from incorrect dibit input. A high degree of parallelism can be expected with this proposed design due to dibit-based system with a very fast operational speed. The realization of these two techniques using high-speed optical switches and with the simulative verification may be used for designing other all-optical computational devices.

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All-Optical Frequency Encoded Dibit-based Half Adder using Reflective Semiconductor Optical Amplifier with Simulative Verification

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***Abstract*—In the modern era, high-speed signal communication and computation increase optical reliability. Therefore, optics is a powerful candidate for implementation in different logic gates, combinational circuits, devices, optical computers, etc. The design of all-optical frequency encoded dibit-based half adder is devised in this communication. Some papers focus on the advantage of the precision of dibit logic by carrying out logic operations on dibit representation technique. This devised dibit-based design operates with a high speed as well as it reduces the bit error problem by increasing the high signal-to-noise ratio. Frequency encoding is the most reliable encoding technique because of its unaltered nature in reflection, refraction, absorption when propagates in long-range. In this devised design reflected semiconductor optical amplifier is used to fulfill the purpose of optical switches. The operation of the devised design is verified through simulation using MATLAB Simulink (R2018a) software.**

***Index Terms*—Optical Communication, Dibit-based logic system, Frequency encoding, Reflective semiconductor optical amplifier, adder.**

I. Introduction

In this modern world, the photon is a very good choice for information transmission. Photon has super fast speed but no rest mass comparison to the electron. So photon is very preferable to the researcher rather than the electron. For long-range transmission of the data signal, an encoding technique is must be used. Among all the encoding techniques [1]–[6], the frequency encoding technique is preferable due to its unaltered characteristics in reflection, refraction, absorption, etc. In optical information processing, the optical comparator, adder, subtractor are essential for decision-making circuits, arithmetic, and logic units. It is also needed for optical data processors. Here two different frequencies ν_1 and ν_2 represent the two different digital logic states '0' and '1' respectively. In recent years, significant research works have been carried out for adder. Some of these are discussed below.

MeGeehan et al. [7] proposed a method for simultaneous half subtraction and addition which was based on semiconductor optical amplifiers (SOA) and also used the periodically poled lithium niobate (PPLN) waveguide for frequency encoding. Zhu et al. [8] proposed a method for all-optical half adder in which SOA-based four-wave-mixing (FWM) property are used. Remacle et al. [9] have introduced an all-optical full addition and subtraction by the use of three states logic. Chen [10] has introduced a novel way to design an all-optical half adder. A simultaneous optical computation device like half adder and half subtractor with the help of a single slot waveguide has been reported by Gui et al. [11]. Dong et al. [12] introduced a theoretical analysis as well as optimization for all-optical adder which is based on the SOA and optical filter. Phongsanam et al. [13] proposed a method for all-optical half adder and subtractor with the help of dark-bright soliton conversion control. Rakshit et al. [14] have introduced an all-optical adder and subtractor which is based on the micro-ring-resonator (MRR). Scaffardi et al. [15] proposed a method for all-optical full adders which is based on the SOA because it has the property of cross gain modulation and cross-polarization rotation. Terahertz optical asymmetric demultiplexer-based all-optical half adder and half subtractor has been introduced by Gayen et al. [16]. Singh et al. [17] introduced an all-optical half adder and half subtractor is designed by SOA-based logic gates. Logic implementation on the fiber-based is bulky and easily not integrable. PPLN waveguide introduces a frequency encoding technique that is temperature and polarization-sensitive.

In this paper, all-optical frequency encoded dibit-based half adder using reflective semiconductor optical amplifier (RSOA) and add/drop multiplexer (ADM) is proposed. Our contributions are a) The frequency encoded dibit-based logic design for SUM and CARRY of half adder b) Simulative verification of the proposed design. This devised design performs computation like addition at ultra-fast speed. By applying dibit-based logic, this proposed device reduces the bit error problems. This devised design is also polarization-independent.

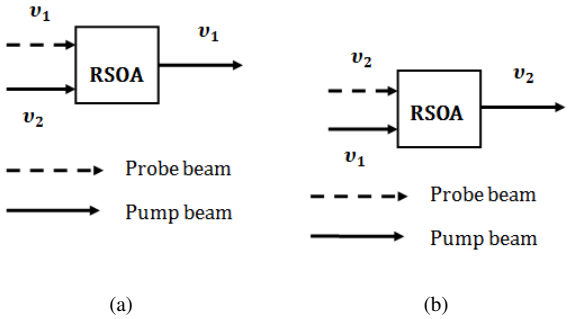
II. Working Principle of RSOA and ADM

One strong pump beam and a weak probe beam are used as input signal of SOA but the frequency of weak probe beam with a higher power is obtained at the output. That extra power comes from the strong pump beam. This SOA is called

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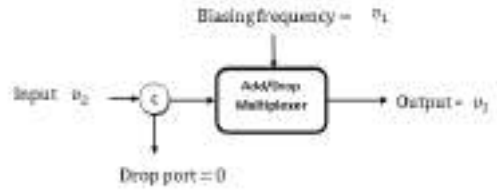
reflective semiconductor optical amplifier (RSOA) [2]. A high reflective (HR) coating is on the one facet of RSOA and an anti-reflective (AR) coating is on the other facet of RSOA. It has a very versatile high gain medium. Fig. 1 shows the block diagram of RSOA. In this paper, the input weak probe signals are in the C-band (1536-1570nm) and the saturation power may be used in the range of 5-20 dBm [5].



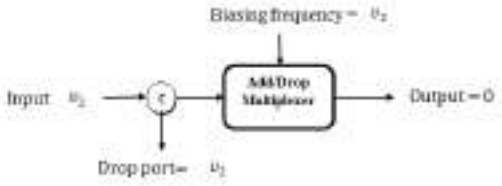
(a) (b)

Fig. 1. The working function of RSOA. (a) The probe beam and pump beam are ν_1 and ν_2 respectively but output gives ν_1. (b) The probe beam and pump beam are ν_2 and ν_1 respectively but output gives ν_2.

An optical multiplexer is a device that works as a frequency selector. ν_1 and ν_2 are the frequencies of the input control signal. ADM can send ν_1 and ν_2 frequencies in two different paths but it can separate a particular frequency without interfering between the two different frequencies in the adjacent channel [2]. Without dropping any other frequency except the same biasing frequency, the rest of the frequency passes through the ADM. In Fig. 2, if the ADM is biased with frequency ν_2 then ADM selects frequency ν_1 and reflects frequency ν_2.



(a)



(b)

Fig. 2. The working function of ADM. (a) When biasing frequency and input frequency are different then ADM passes the input frequency at the output port whereas drop port gives '0'. (b) When biasing frequency and input frequency are the same then output gives '0' and ADM reflected the input frequency at the drop port by the use of circulator 'C'.

III. Realization of Proposed Half Adder

In this communication, frequency encoding with two different frequencies represent the two different digital logic states. Here ν_1 and ν_2 use to represent '0' and '1' digital logic state respectively. In dibit-based representation technique [18], two consecutive bit positions are used to represent a digital logic state. In dibit logic $\langle 0\rangle\langle 1\rangle$ represents the digital logic state '0' whereas $\langle 1\rangle\langle 0\rangle$ represents the digital logic state '1'. The two frequencies ν_1 and ν_2 when placed side by side as $\langle \nu_1\rangle\langle \nu_2\rangle$ indicates the digital logic state '0' and for $\langle \nu_2\rangle\langle \nu_1\rangle$ indicates the logic state '1'. Input signals are applied according to truth Table I.

For Sum (S): In this case, input signal A $(\nu_1\nu_2)$ as dibit input i.e., A'=ν_1, A''= ν_2 and also for input signal B $(\nu_1\nu_2)$ as dibit input i.e., B'=ν_1, B''=ν_2 are applied simultaneously. The real dibit input combination passes through the RSOA-1 and RSOA-2 only because ADM-1 and ADM-2 serve the purpose of dibit checking devices. RSOA-1 and RSOA-2 both give the output frequency ν_1. These ν_1 frequencies from both RSOA-1 and RSOA-2 are reached the ADM-3. They act as a biasing frequency and input frequency of ADM-3 respectively. Since biasing and input frequencies are the same, ADM-3 reflects the frequency ν_1. Therefore, the reflected frequency of ADM-3 is injected into the RSOA-4 as a pump signal. The RSOA-4 gives the ν_1 frequency at the output S' because ν_1 is the fixed probe signal of RSOA-4 whereas RSOA-3 does not work due to the absence of pump power. As a result, the output of RSOA-4 is reached the ADM-7 and selected by ADM-7 due to the biasing frequency ν_2. The selected frequency ν_1 of ADM-7 acts as a pump signal of RSOA-8 which gives ν_2 frequency at the output S'' due to a fixed probe signal ν_2 of RSOA-8 and RSOA-9 does not work due to the absence of pump power. Therefore, the output dibit SUM (S) is $< \nu_1 >< \nu_2 >$ i.e., $< 0 >< 1 >$ which represents the digital logic state '0'.

For carry (C): The output of RSOA-1 and RSOA-2 are ν_1 because the probe signals of RSOA-1 and RSOA-2 are ν_1. These ν_1 frequencies are injected into the ADM-4 and ADM-5. Since ADM-4 is biased with the frequency ν_2 then ADM-4 selects the frequency ν_1 which acts as a biasing frequency of ADM-6. The output of ADM-5 i.e., frequency ν_1 acts as an input signal of ADM-6. The output of ADM-6 acts as a probe signal of RSOA-6 which gives ν_1 frequency at the output C' whereas RSOA-5 and RSOA-7 do not work due to the absence of pump signal. The output from RSOA-6, ν_1 frequency reaches the ADM-8. The ADM-8 selects the frequency ν_1 which acts as a pump signal of RSOA-10. So at the output C'', frequency ν_2 is given by the RSOA-10 because ν_2 is the fixed probe signal of RSOA-10 whereas RSOA-11 does not work due to the absence of pump signal. Therefore, the output dibit carry (C) is $< \nu_1 >< \nu_2 >$ i.e., $< 0 >< 1 >$ which implies the '0' digital logic state. Similarly, according to truth Table I by applying the other input signals to the

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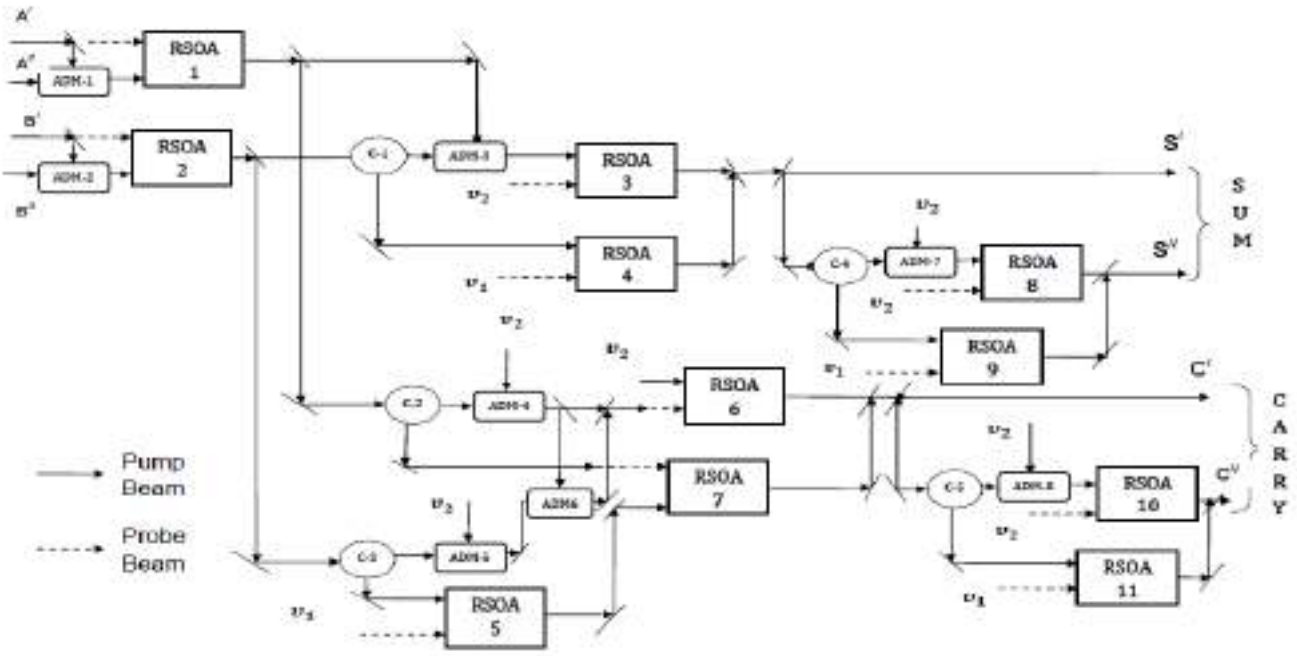


Fig. 3. Schematic diagram of proposed dibit-based half adder.

TABLE I
TRUTH TABLE OF PROPOSED FREQUENCY ENCODED DIBIT-BASED HALF ADDER

Dibit Input (A')	**Dibit Input** (A'')	**Digital logic state (A)**	**Dibit Input** (B')	**Dibit Input** (B'')	**Digital logic state (B)**	**Output Dibit Sum** (S')	**Output Dibit Sum** (S'')	**Digital logic state (S)**	**Output Dibit Carry** (C')	**Output Dibit Carry** (C'')	**Digital logic state (C)**
ν_1 [0]	ν_2 [1]	0	ν_1 [0]	ν_2 [1]	0	ν_1 [0]	ν_2 [1]	0	ν_1 [0]	ν_2 [1]	0
ν_1 [0]	ν_2 [1]	0	ν_2 [1]	ν_1 [0]	1	ν_2 [1]	ν_1 [0]	1	ν_1 [0]	ν_2 [1]	0
ν_2 [1]	ν_1 [0]	1	ν_1 [0]	ν_2 [1]	0	ν_2 [1]	ν_1 [0]	1	ν_1 [0]	ν_2 [1]	0
ν_2 [1]	ν_1 [0]	1	ν_2 [1]	ν_1 [0]	1	ν_1 [0]	ν_2 [1]	0	ν_2 [1]	ν_1 [0]	1

proposed dibit-based half adder, we obtain the desired sum and carry at the output.

IV. SIMULATION OF PROPOSED HALF ADDER

The proposed half adder is verified by simulation with the MATLAB Simulink (R2018a) software. In Fig. 4 and 5, the dibit input signals A and B are applied to the half adder. Both dibit sum (S) and carry (C) have two bits and for dibit sum (S), two bits are S' and S''.

For dibit carry (C), two bits are C' and C''. RSOA and ADM blocks are programmed by MATLAB language to get output. If the probe signal and pump signal are considered as say ν_1=193.5 THz (digital logic state '0') and ν_2=193.9 THz (digital logic state '1') respectively then at the output end of RSOA gives 193.5 THz that represents '0' digital logic state and vice-versa. To obtain the physically realizable design of half adder, we consider two frequencies as 193.5 THz and 193.9 THz because RSOA works properly in C-band (1536-1570 nm) region. ADM block is programmed in such a way that ADM selects all other frequencies at the output except the biasing frequency which reflects at the drop port. If biasing and the input frequencies are considered as say ν_1=193.5 THz and ν_2=193.9 THz respectively then ADM gives at the output ν_2=193.9 THz and gives zero at the drop port . But when the input and biasing frequency are considered as the same then the output of ADM gives zero and the drop port gives the input frequency. Here in Fig. 4 $< 193.9 >< 193.5 >$ and $< 193.5 >< 193.9 >$ represent the '1' and '0' digital logic state and these are applied to the dibit input (A) and dibit input (B) terminals respectively. After the simulation, $< 193.9 >< 193.5 >$ and $< 193.5 >< 193.9 >$ are obtained as dibit sum (S) and dibit carry (C) at the output terminal respectively. In Fig. 5, $< 193.9 >< 193.5 >$ and $< 193.9 >< 193.5 >$ are applied to the dibit input (A) and dibit input (B) terminals respectively then at the output terminal $< 193.5 >< 193.9 >$ and $< 193.9 >< 193.5 >$ are obtained as dibit sum (S) and dibit carry (C) respectively. The simulation results of the proposed model are obeyed by the truth Table I of the half adder.

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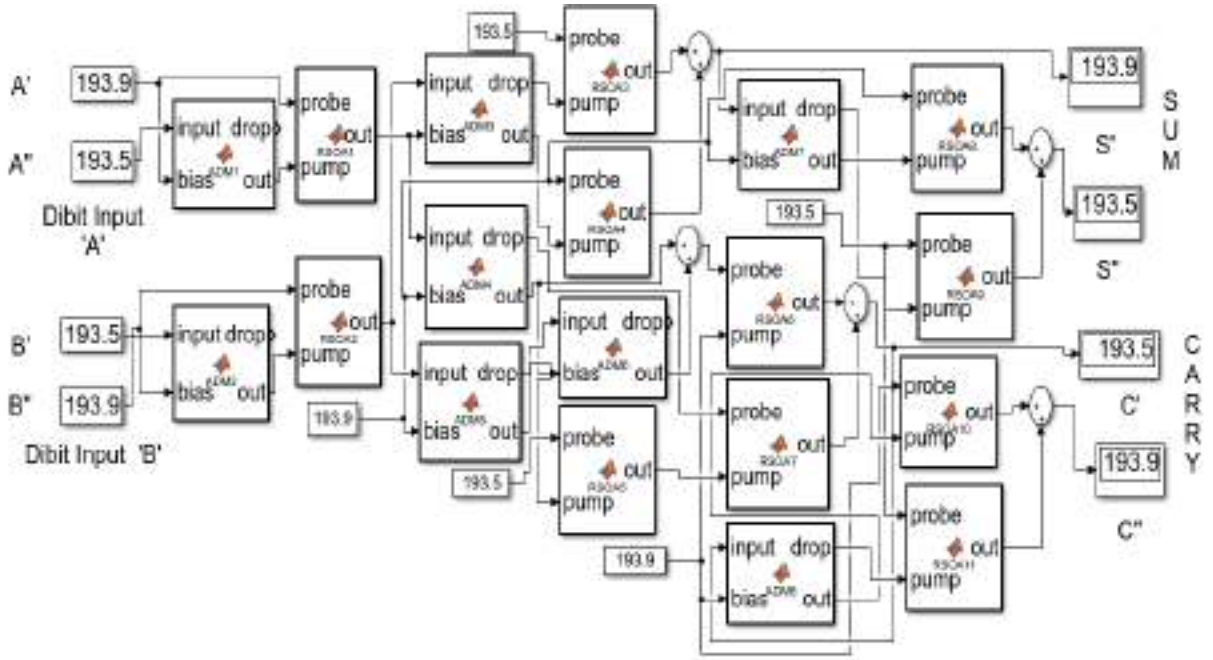


Fig. 4. Simulation model of half adder, when A'=193.9 THz, A''=193.5 THz and B' =193.5 THz, B''=193.9 THz are applied to the input port.

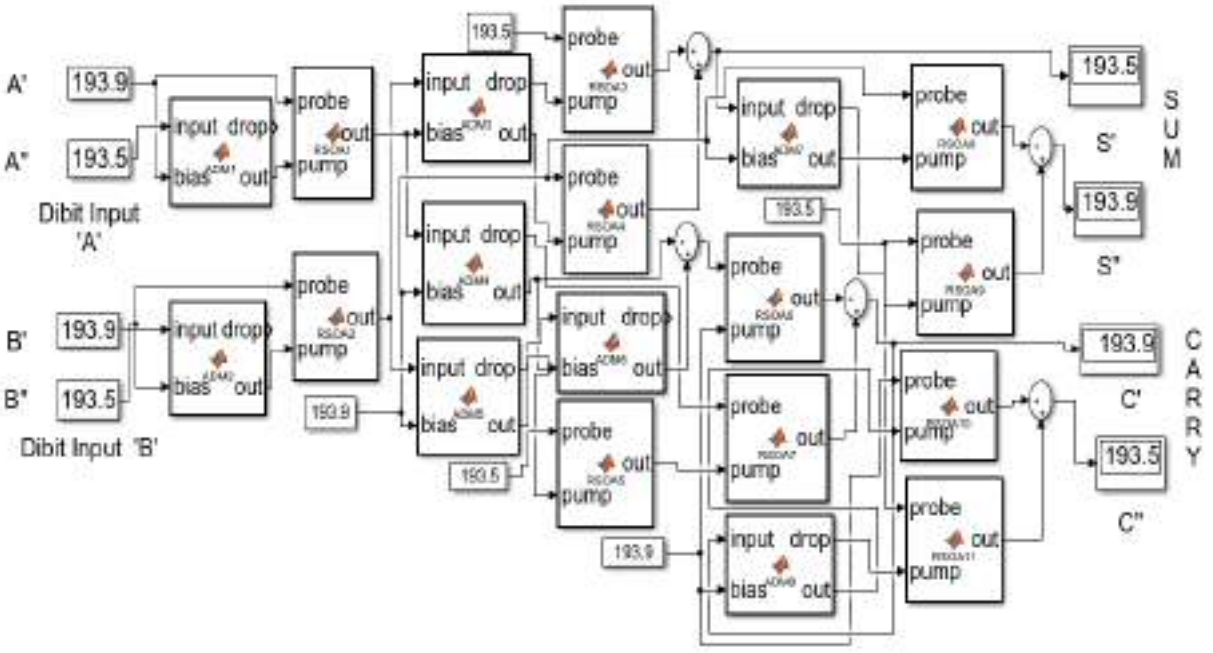


Fig. 5. Simulation model of half adder, when A'=193.9 THz, A''=193.5 THz and B' =193.9 THz, B''=193.5 THz are applied to the input port.

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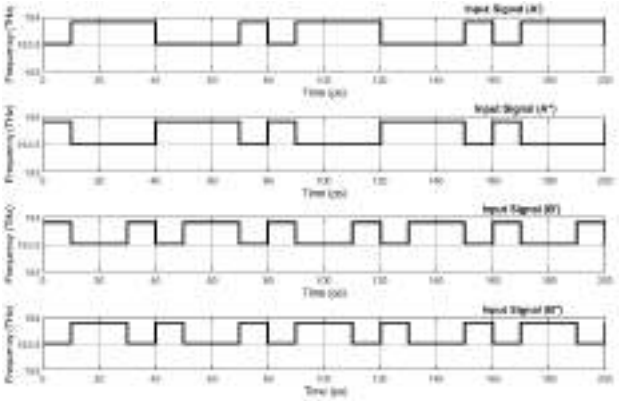


Fig. 6. Dibit input waveforms of half adder.

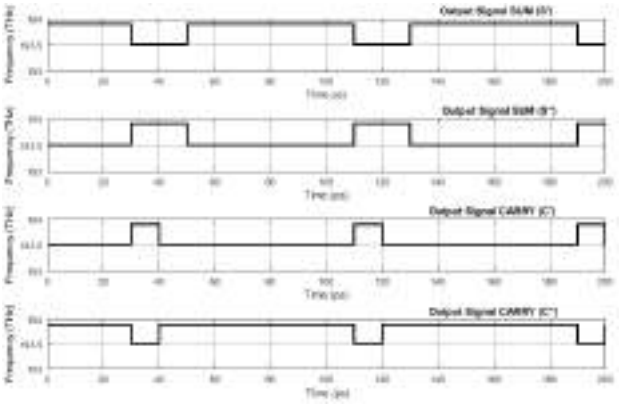


Fig. 7. Dibit output waveforms of half adder.

V. Results and Discussion

In MATLAB Simulink software, 193.5 THz and 193.9 THz frequency signals are applied in 10 ps time interval to the input of the proposed half adder model. These input signals waveform are given in Fig. 6. When the devised design is simulated with these input signals waveform then the output signals waveform are obtained in Fig. 7. After verification of the above data and the simulation results, it is concluded that theoretical prediction of outputs of half adder are accurately verified with the simulation output results, outputs waveform, and truth Table I.

VI. Conclusion

Dibit representation technique and frequency encoding give more advantages to the all-optical operation. Taking the advantage of these, we proposed all-optical frequency encoded dibit based half adder. Here dibit-checking unit in the input hindrances the incorrect dibit input. A high degree of parallelism can be expected with this proposed design due to dibit-based system with a very fast operational speed. This encourages reliable and faithful operation and also reduces the bit error problems. In the future, this design may be used for all-optical computational devices.

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A Design of Frequency Encoded Dibit-based Comparator Using Reflective Semiconductor Optical Amplifier with Simulative Verification

Surajit Bosu; Baibaswata Bhattacharjee

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2022 IEEE International Conference of Electron Devices Society Kolkata Chapter (EDKCON)

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Dr. Arpan Bhattacharya



EMERGING TRENDS IN

INDIA'S FOREIGN POLICY

DR. SHANTESH KUMAR SINGH
DR. SUDHEER SINGH VERMA

18

India's Naval Diplomacy and Great Power Competition

■■■ by *Gouri Sankar Nag & Arpan Bhattacharya*

India's unique geography, like that of a continental wedge thrust into the Indian Ocean, has given it an unparalleled dominating edge over a whole host of areas namely, the maritime trade routes, that criss-cross the expanse of the Indian Ocean. This unique feature of the Indian Ocean made the renowned historian K.M. Panikkar astutely describe it as the 'landlocked sea' in his treatise, "*India and the Indian Ocean: An Essay on the Influence of Sea Power on Indian History*". He strongly advocated India to develop into a sea power of repute, with the reasoning that it provided an overbearing advantage against 'countries whose main line of communications lie on the sea'. This vision has come to fruition with the coming of age of the Indian Navy in the late twentieth century and China has been well conscious of this. With a significant portion of China's energy requirements and trade passing close to the Indian Peninsula and onwards through the Malacca Strait, the 'Malacca dilemma' has always been 'live' for China. It is, therefore, not without reason that Beijing has always been keen to offset this disadvantage, by developing 'relations of convenience' with Indian Ocean littorals in India's sphere of influence. On the other hand, India's sui generis location within the Indian Ocean, coupled with its growing economic clout and military capabilities in the late twentieth century, has propelled the Indian Navy to swing into action for strengthening India's maritime diplomacy offering a benevolent choice for the Indian Ocean littoral nations to tie up with. This symbiotic relationship with the navies in an area, described in India's Maritime Security Strategy of 2015 as being India's 'primary areas of interest', has been nurtured in large part by the Indian Navy through its dynamic and sustained foreign cooperation initiatives, making it the 'first port of call' for many navies in the region.

Section-I

Now, considering China's latest act of perfidy in India's areas of influence, this article argues that India needs to gear up not only in the vast expanse of the IOR but also in the Bay of Bengal (in short, BoB), in the Andaman Sea and to some extent, by entering the Pacific by reaching out to not only New Zealand but also other smaller island states there. Two factors are very important here. One is strengthening the sea lanes of trade and securing the path of transportation of energy. For example, BoB as a transit region obviously stands to receive more importance in future.

Another factor is the strategic location of the BoB because although till date it remains relatively protected largely by India's overwhelming naval presence and superiority in the BoB littoral, given BoB's position as a gateway to different important sea routes both towards the IOR and towards South East Asia, towards Malacca straits, an important choke-point that even the Chinese wants to avoid, the region can easily induce extra-regional great powers. Besides, another festering issue that keeps resurfacing is related to incomplete demarcation of maritime boundary among these nations. It is important not only because it entails claims and counter-claims pertaining to sovereignty between say India and Bangladesh, but also it entails the benefits of future resource exploration which might add substantially to the coffers of the respective nations. This apart, such issues are always a matter of crucial international importance because other world powers are likely to watch keenly how the contending parties compete and cooperate for resolving such disputes, hence their methodologies become important for use in similar cases. It's here that we can mention how India's benign attitude of diplomatic engagements marks a clear departure from China's grabbing posture towards the South China Sea. That is to say, although the entire BoB is placed under India's firmly entrenched naval supremacy, India's approach to conflict resolution has never been to bully Bangladesh but to find amicable solution of the problem. For example, its maritime boundary dispute was referred by Bangladesh to the arbitral tribunal in the Hague which delivered its verdict in 2014.

This shows both a critical but agreeable bargaining approach on the part of India's smaller littoral neighbours and economic importance of the region. Needless to say that the importance of the BoB is likely to grow day by day since Nepal and Bhutan depend on their access to BoB for trade. Besides, major external powers like the US and also China always

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Emerging Trends In India's Foreign Policy
By Dr. Shantesh Kumar Singh, Dr. Sudheer Singh Verma

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