SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 6 | Issue: 6 | June 2021 - Peer Reviewed Journal

AVILABLE COVID-19 VACCINES FOR PUBLIC AND THEIR CHARACTERISTICS: A CASE STUDY

Balwant Singh[1], Sakshi Tripathi[2], Shivangi Tripathi[3]

[1]*Research Scholar, Department of Botany, Dr. Ram Manohar Lohiya Avadh University Ayodhya, Uttar Pradesh India*

[2]*Post Graduate Student, Department of Zoology, B. P. P.G. College Narayanpur Maskanwa Gonda, Uttar Pradesh, India*

[3]*Junior Research Fellow, Department of Microbiology, King Georg Medical University Lucknow, Uttar Pradesh, India*

ABSTRACT

Covid-19 is an infectious disease that caused by newly evolved zoonotic corona virus (SARS CoV-2). It becomes largest pandemic disease since 1965 were corona virus firstly identified. Covid-19 spread more than 200 countries and affected approximate 30 million positive cases with about 1 million deaths globally till May 2021. Only vaccine to be supposed as blocks the Covid-19 outbreak. More than 200 vaccine candidates for covid-19 being developed in which, about 12 vaccines are approved to peoples. These vaccines have different working mechanism based on its type. In this article we are expressed the knowledge about vaccine type and their characteristics, efficacy, and their advantages for general awareness to the peoples with also the level of academician and researchers.

KEY WORDS: *Covid-19, SARS CoV-2, Corona Virus, Vaccine.*

INTRODUCTION

First Corona virus appearance was reported in 1965 as human common cold virus [(1)]. Since 1965, a number of zoonotic viruses with the same crown like morphology evolved and some of these become pandemic time to time [(2)]. Corona virus pandemic was outbreak before the evaluation of SARS CoV-2 which is becomes 3rd pandemic of human. Before the SARS CoV-2, two HCoV pandemic SARS-CoV and MERS-CoV were reported from China and UAE during year 2002 and 2012 respectively. SARS CoV-2 cause respiratory illness and named Covid-19 which also originated from Hubai Province of China at the end of year 2019. From 2020, Covid-19 becomes a challenging outbreak infectious viral disease and thousands of researchers working for the cure of this pandemic [(1)(2)]. Since December 2020, over than 200 vaccine candidates for Covid-19 (SARS CoV-2) being developed, of these, at least 52 candidates vaccine are in Human trail. The trail of vaccine running under three phases Phase-I, Phase-II and Phase-III. Typically, many vaccine candidates will be evaluated before any are found to be both safe and effective and also having lots of different vaccines in development increases the chances that there will be one or more successful vaccines that will be shown to be safe and efficacious for the intended prioritized populations. Of the vaccines that do make it to clinical trial, just one in five is successful [(3)]. In this article we are express knowledge about the vaccine development globally and its type with different characteristics that become useful for researchers as well as society.

TYPE OF VACCINES

There are three main approaches to be designing by the researchers for vaccine. Their differences lie in whether they use a whole virus or bacterium, just the parts of the germ that triggers the immune system or just the genetic material that provides the instructions for making specific proteins

SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 6 | Issue: 6 | June 2021 - Peer Reviewed Journal

and not the whole virus. By these approaches following types of vaccines are evaluated by researchers. The functional advantages of different type of vaccines are also displayed below (Table 1).

Inactivated vaccines: They are produced by growing SARS-CoV-2 in cell culture, usually on Vero cells, with the chemical inactivation of the virus. Because the whole virus is presented to the immune system, immune responses are likely to target not only the spike protein of SARS-CoV-2 but also the matrix, envelope and nucleoprotein [(4)(5)(6)(7)].

Live attenuated vaccines: They are produced by generating a genetically weakened version of the virus that replicates to a limited extent, causing no disease but inducing immune responses that are similar to that induced by natural infection. Attenuation can be achieved by adapting the virus to unfavorable conditions (for example, growth at lower temperature, growth in non-human cells) or by rational modification of the virus [(4)(5)(6)(7)].

Recombinant protein vaccines: They can be divided into recombinant spike-protein-based vaccines; recombinant RBD-based vaccines and virus-like particle (VLP) based vaccines. These recombinant proteins can be expressed in different expression systems including insect cells, mammalian cells, yeast and plants; it is likely that RBD-based vaccines could also be expressed in *Escherichia coli* [(4)(5)(6)(7)(8)].

Replication-incompetent vectors: They represent a large group of vaccines in development. Such vaccines are typically based on another virus that has been engineered to express the spike protein and has been disabled from replication in vivo by the deletion of parts of its genome [(5)(9)].

Replication-competent vectors: They are typically derived from attenuated or vaccine strains of viruses that have been engineered to express a transgene, in this case the spike protein. In some cases, animal viruses that do not replicate efficiently and cause no disease in humans are used as well. This approach can result in a more robust induction of immunity, because the vector is propagating to some extent in the vaccinated individual and often also triggers a strong innate immune response [(4)(5)].

Inactivated virus vectors: Some SARS-CoV-2 vaccine candidates that are currently under development rely on viral vectors that display the spike protein on their surface but are then inactivated before use32. The advantage of this approach is that the inactivation process renders the vectors safer because they cannot replicate, even in an immune-compromised host [(4)(5)(6)(7)].

VLPs (Virus-Like Particles): Vaccine development based on the recombinant proteins and VLPs is a more innovative approach. Antiviral vaccines are usually developed on the basis of surface proteins that form VLPs. Production of VLPs in the cells with further reconstruction into the stable and immunogenic forms is a multi-stage process [(4)(6)].

DNA vaccines: They are based on plasmid DNA that can be produced at large scale in bacteria. Typically, these plasmids contain mammalian expression promoters and the gene that encodes the spike protein, which is expressed in the vaccinated individual upon delivery. The great advantage of these technologies is the possibility of large-scale production in *E. coli*, as well as the high stability of plasmid DNA [(4)(5)(6)(7)].

RNA vaccines: They are a relatively recent development. Similar to DNA vaccines, the genetic information for the antigen is delivered instead of the antigen itself, and the antigen is then expressed in the cells of the vaccinated individual. Either mRNA or a self-replicating RNA can be used. Higher doses are required for mRNA than for self-replicating RNA, which amplifies itself, and the RNA is usually delivered via lipid nano-particles (LNPs) [(4)(5)(6)(7)(10)].

Table 1: Functional Advantages of Type of Covid-19 Vaccines [(9)(11)].

S.N.	Vaccine Type	Advantages
1	Live-attenuated	✓ Strong and long-lasting immune response ✓ Broad antigenic profile
2	Inactivated	✓ Broad antigenic profile
3	Protein subunit	✓ Noninfectious ✓ Targeting key antigens
4	VLP	✓ Noninfectious ✓ Broad antigenic profile
5	Non-replicating viral vector	✓ Fast to produce ✓ Reusable platform ✓ Strong in both cell- and antibody-mediated immune responses
6	Replicating viral vector	✓ Fast to produce ✓ Lower doses/single dose

SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 6 | Issue: 6 | June 2021 - Peer Reviewed Journal

		✓ Reusable platform ✓ Strong in both cell- and antibody-mediated immune response ✓ Less infectious
7	DNA	✓ Fast to produce ✓ Scalable ✓ Noninfectious ✓ Reusable platform ✓ Stable at room temperature
8	RNA	✓ Fast to produce ✓ Noninfectious ✓ No genome integration risk ✓ Reusable platform ✓ Stimulates strong T cell response ✓ Simple formulations

DISCUSSION

Covid-19 becomes a global problem which can be spread more than 200 countries as pandemic cause of human infection. The invention and production of a corona virus vaccine is a critical issue, but it is likely to take many months to resolve. Although many companies have announced that the corona virus vaccine will be ready soon, this will be sophisticated to do in reality [(3)(4)]. Rapid production of a vaccine to prevent Covid-19 is a global imperative, and defining the stakes and potential hurdles is critical because regulatory and medical decisions are based on benefit and risk [(4)]. Different types of vaccine are evolved in different country with their specific characteristics, type and efficacy (Table 2). In all, Most of vaccines has same administrative mode remaining few of them. These different candidate vaccines can be grouped based on the technological platform exploited to elicit a protective immune response. However, almost every vaccine project has its peculiarities that make it unique and which could have significant consequences regarding the efficacy or duration of the induced protection or the safety of the vaccine. The present article is most useful for general awareness to academician as well as researchers.

Table 2: Type of Vaccines and their characteristics with global scenario.

Vaccine Name	Vaccine Type	Trade Name	Other Name	Developer	Country
Pfizer	mRNA	Comirnaty	BNT162b2	Pfizer BioNTech	Canada
Pfizer	mRNA	Fosun		Fosun BioNTech	China
Moderna	mRNA	Moderna	TAK-919, CX-024414	NIAID + BARDA	USA
Astra Zeneca	Viral Vector	Vaxzevria	AZD-1222, ChAdOx1-S	Oxford	UK/USA
Astra Zeneca	Viral Vector	CoviShield		SII	India
Covaxin	Inactivated	Covaxin	BBV-1252	BB + ICMR	India
Sputnik	Viral Vector	Sputnik-V	Gam-COVID-Vac	GRIEM	Russia
Janssen	Viral Vector	Janssen	Ad26.COV2.S, JNJ-78436735	J P + J & J	Netherland
Novavax	Subunit	Novavax	NVX-CoV2373, SARS-CoV-2-rS	Novavax + CEPI	UK
Novavax	Subunit	Covovax	TAK-019	Novavax + SII	India
Corona VaC	Inactivated	CoronaVac	SinoVaC	Sinovac Biotech	China
AD5-nCOV	Viral Vector	Convidecia	CanSino	CanSino Biologics	China
BBIBP-CorV	Inactivated	BBIBP-CorV	Sinopharm	SBIBP	China
Inovio	DNA	INO-4800		I F	South Korea
CoVLP	VLP	CoVLP	Medicago	Medicago + GSK	Canada/US
VAT00002	Subunit	Sanofi-GSK	VAT00008	SP + GSK	USA
MRT-5500	mRNA			SP + TranslateBio	USA

SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 6 | Issue: 6 | June 2021 - Peer Reviewed Journal

Table 2: Continue…

Efficacy	Administration	Dose Quantity	Requirement	Minimum Interval	References
95-98%	Intramuscular	0.3 ml./ Dose	Dual Dose	21 Days	(12)(13)(14)(15)(16)
95-98%	Intramuscular	0.3 ml./ Dose	Dual Dose	21 Days	(12)(13)(14)(15)
94-97%	Intramuscular	0.5 ml./Dose	Dual Dose	28 Days	(12)(16)(17)(18)
76-81%	Intramuscular	0.5 ml./Dose	Dual Dose	28 Days	(12)(16)(19)(20)
76-81%	Intramuscular	0.5 ml./Dose	Dual Dose	28 Days	(12)(13)(14)(16)(21)
78-88%	Intramuscular	0.5 ml./Dose	Dual Dose	28 Days	(12)(13)(21)(22)
92-95%	Intramuscular	0.5 ml./Dose	Dual Dose	21 Days	(23)(24)
72-82%	Intramuscular	0.5 ml./Dose	Dual Dose	28 Days	(16)(25)
89-95%	Intramuscular	0.5 ml./Dose	Dual Dose	28 Days	(12)(26)
89-95%	Intramuscular	0.5 ml./Dose	Dual Dose	28 Days	(9)
51%	Intramuscular	0.5 ml./Dose	Dual Dose	21 Days	(16)(27)(28)(29)
66%	Intramuscular and Intranasal	0.5 ml./Dose	Single Dose		(30)(31)
78-86%	Intramuscular	0.3 ml./Dose	Dual Dose	21 Days	(12)(16)
	Intramuscular	0.5 ml./Dose	Dual Dose	28 Days	(12)(32)
	Intramuscular		Dual Dose	21 Days	(33)
	Intramuscular		Dual Dose	28 Days	(12)(14)(34)
	Intramuscular		Dual Dose or Single Dose	21 Days	(9)

ABBREVIATIONS

BARDA	Biomedical Advanced Research and Development Authority
BB	Bharat Biotech
CEPI	Coalition for Epidemic Preparedness Innovations
Covid-19	Corona Virus Disease 2019
GRIEM	Gamaleya Research Institute of Epidemiology and Microbiology
GSK	Glaxo Smith Kline
HCoV	Human Corona Virus
ICMR	Indian Council of Medical Research
J & J	Johnson and Johnson
JP	Janssen Pharmaceutical
MERS	Middle East Respiratory Syndrome
NIAID	National Institute of Allergy and Infectious Disease
RBD	Receptor Binding Domain
SARS	Severe Acute Respiratory Syndrome
SBIBP	Sinopharms Beijing Institute of Biological Products
SII	Serum Institute of India
SP	Sanofi Pasteur
VLP	Virus like Particle

SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 6 | Issue: 6 | June 2021 - Peer Reviewed Journal

Figures: Image of Vaccines (1.Pfizer, 2.Covishield, 3.Covaxin, 4.AstraZeneca, 5.Janssen, 6.CoronaVac, 7.SputnikV, 8.Moderna)

REFERENCES

1. *Singh B., Kumar V., Tripathi S. (2020) A Review of Covid-19 Based on Current Evidences, International Research Journal of Modernization in Engineering Technology and Science, 2(8): 1449-1459. www.irjmets.com*
2. *Singh B., Tripathi S., Tripathi S. (2020) Structural and Molecular Organization with their Functional Status of Corona Viruses: A Review, International Research Journal of Modernization in Engineering Technology and Science, 2(11): 359-372. www.irjmets.com*
3. *Evenett S.J., Hoekman B., Rocha N., Ruta M. (2021) The Covid-19 Vaccine Production Club: Will Value Chains Temper Nationalism?, Macroeconomics, Trade and Investment Global Practice: 1-4*
4. *Dwivedi S. (2021) An Overview of COVID-19 Vaccine Development Worldwide, International Journal of Drug Development and Research, 13(159): 1-4. https://www.ijddr.in/*
5. *Krammer F. (2020) SARS-CoV-2 vaccines in development, Nature, 586: 516-527. https://doi.org/10.1038/s41586-020-2798-3*
6. *Defendi H.G.T., Madeira L.D.S., Borschiver S. (2021) Analysis of the COVID‑19 Vaccine Development Process: an Exploratory Study of Accelerating Factors and Innovative Environments, Journal of Pharmaceutical Innovation, Springer. https://doi.org/10.1007/s12247-021-09535-8*
7. *Forni G., Mantovani A. (2021) COVID-19 vaccines: where we stand and challenges ahead, Cell Death & Differentiation, 28: 626–639. https://doi.org/10.1038/s41418-020-00720-9*
8. *Abdelmageed et al. (2020) Design of a Multiepitope-Based Peptide Vaccine against the E-Protein of Human COVID-19: An Immunoinformatics Approach, BioMed Research International Article ID 2683286: 1-12. https://doi.org/10.1155/2020/2683286*
9. *Kaur S.P., Gupta V. (2020) COVID-19 Vaccine: A comprehensive status report, Virus Research, 288. https://doi.org/10.1016/j.virusres.2020.198114*
10. *Kowalski P.S., Rudra A., Miao L., Anderson D.G. (2019) Delivering the Messenger: Advances in Technologies for Therapeutic mRNA Delivery, Molecular Therapy, 27(4): 710-728. https://doi.org/10.1016/j.ymthe.2019.02.012*
11. *Li Y., Tenchov R., Smoot J., Liu C., Watkins S., Zhou Q. (2021) A Comprehensive Review of the Global Efforts on COVID-19 Vaccine Development, ACS Central Science, 7: 512−533. https://doi.org/10.1021/acscentsci.1c00120*
12. *Anon, 2020. COVID-19 Treatment and Vaccine Tracker. https://airtable.com/. Milken*

SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 6 | Issue: 6 | June 2021 - Peer Reviewed Journal

Institute.https://airtable.com/shrSAi6t5WFwqo3GM/tblEzPQS5fnc0FHYR/viweyymxOAtNvo7yH?blocks=bipZFzhJ7wHPv7x9z.

13. *Anon, 2020. UW–Madison, FluGen, Bharat Biotech to develop CoroFlu, a Coronavirus vaccine.https://www.businesswire.com.[Online]April02. https://www.businesswire.com/news/home/20200402005666/en/UW%E2%80%93Madison-FluGen-Bharat-Biotech-develop-CoroFlu-coronavirus*
14. *Anon, 2020. Draft landscape of COVID-19 candidate vaccines. https://www.who.int/. [Online] June 22, 2020. [Cited: June 23, 2020.]. https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines*
15. *Anon, 2020. A Trial Investigating the Safety and Effects of Four BNT162 Vaccines Against COVID-2019 in Healthy Adults. https://clinicaltrials.gov/. [Online] May 8. https://clinicaltrials.gov/ct2/show/NCT04380701*
16. *Pandey A., Belbase P., Parajuli A. (2020) COVID-19 Vaccine Development to Vaccination, Journal of Nepal Health Research Council, 18(49): 807-809. https://doi.org/10.33314/jnhrc.v18i4.3351*
17. *Anon, 2020. Safety and Immunogenicity Study of 2019-nCoV Vaccine (mRNA-1273) for Prophylaxis of SARS-CoV-2 Infection (COVID-19). https://clinicaltrials.gov/.[Online].https://clinicaltrials.gov/ct2/show/NCT04283461?term=vaccine&cond=covid-19&draw=2*
18. *Jackson, Lisa A., Anderson, Evan, J., et al., 2020. An mRNA Vaccine against SARS-CoV-2— Preliminary Report. N Engl J Med. (July).*
19. *Anon, 2020. A Study of a Candidate COVID-19 Vaccine (COV001). https://clinicaltrials.gov.[Online].[Cited:June8,2020.].https://clinicaltrials.gov/ct2/show/NCT04324606?term=vaccine&cond=covid-19&draw=2*
20. *Folegatti, Pedro M, Ewer, Katie J, et al., 2020. Safety and immunogenicity of the ChAdOx1 nCoV-19 vaccine against SARS-CoV-2: a preliminary report of a phase 1/2, single-blind, randomised controlled trial. The Lancet (July)*
21. *Thiagarajan K. (2021) Covid-19: India is at centre of global vaccine manufacturing, but opacity threatens public trust, BMJ, 372(196): 1-3. http://dx.doi.org/10.1136/bmj.n196*
22. *Myupchar, 2020. Race for COVID-19 vaccine: Covaxin and ZyCoV-D begin human trials in India, Moderna publishes preliminary data from phase 1. https://www.firstpost.com/. [Online] July 15, 2020. [Cited: August 01, 2020.]. https://www.firstpost.com/health/race-for-covid-19-vaccine-covaxin-and-zycov-d-begin-human-trials-in-india-moderna-publishes-preliminary-data-from-phase-1-8600211.html/amp*
23. *Anon, 2020. An Open Study of the Safety, Tolerability and Immunogenicity of the Drug "Gam-COVID-Vac" Vaccine against COVID-19. https://clinicaltrials.gov/. [Online] June22,2020.[Cited:June22,2020.].NCT04436471.https://clinicaltrials.gov/ct2/show/NCT04436471?term=vaccine&cond=covid-19&draw=4*
24. *Anon, 2020. An Open Study of the Safety, Tolerability and Immunogenicity of "Gam-COVID-Vac Lyo" Vaccine Against COVID-19. https://clinicaltrials.gov/. [Online] June 22, 2020. [Cited: June 22, 2020.]. NCT04437875. https://clinicaltrials.gov/ct2/show/NCT04437875*
25. *Johnson & Johnson Announces a Lead Vaccine Candidate for COVID-19, 2020. Landmark New Partnership with U.S. Department of Health & Human Services; and Commitment to Supply One Billion Vaccines Worldwide for Emergency Pandemic Use. https://www.prnewswire.com/.[Online].https://www.prnewswire.com/news-releases/johnson–johnson-announces-a-lead-vaccine-candidate-for-covid-19-landmark-new-partnership-with-us-department-of-health-human-services-and-commitment-to-supply-one-billion-vaccines-worldwide-for-emergency-pandemic-*
26. *Anon, 2020. Evaluation of the Safety and Immunogenicity of a SARS-CoV-2 rS (COVID-19) Nanoparticle Vaccine With/Without Matrix-M Adjuvant. https://clinicaltrials.gov/. [Online] May 27, 2020. [Cited: June 15, 2020.]. https://clinicaltrials.gov/ct2/show/record/NCT04368988*
27. *Anon, 2020. Sinovac gets regulatory approval to assess Covid-19 vaccine.. https:// www.clinicaltrialsarena.com.[Online]April15.https://www.clinicaltrialsarena.com/news/sinovac-covid-19-vaccine-trial-approval/*
28. *Anon, 2020. Sinovac reports positive data from Phase I/II trials of CoronaVac.. https://www.clinicaltrialsarena.com/. [Online] June 15, 2020. [Cited: June 20, 2020.]. https://www.clinicaltrialsarena.com/news/sinovac-coronavac-data/*
29. *Anon, 2020. Sinovac COVID-19 Vaccine Collaboration with Butantan Receives Approval from Brazilian Regulator for Phase III Trial. http://www.sinovac.com/.[Online]July06,2020.[Cited:August01,2020.].SinovacBiotechLimited.http://www.sinovac.com/?optionid=754&auto_id=907*
30. *Anon, 2020. Countries where COVID-19 has spread www.worldometers.info. [Online] July 30, 2020. [Cited: July 31, 2020.] https://www.worldometers.info/coronavirus/countries-where-coronavirus-has-spread/.*
31. *Zhu, Feng-Cai, Guan, Xu-Hua, et al., 2020. Immunogenicity and safety of a recombinant adenovirus type-5-vectored COVID-19 vaccine in healthy adults aged 18 years or older: a randomised, double-blind, placebo-controlled, phase 2 trial. The Lancet (July).*
32. *Anon, 2020. Safety, Tolerability and Immunogenicity of INO-4800 for COVID-19 in HealthyVolunteers.https://clinicaltrials.gov/.[Online]2020.1.https://clinicaltrials.gov/ct2/show/NCT04336410?term=inovio&cond=covid-19&draw=2&rank=1*
33. *Anon, 2020. COVID-19 Vaccine Development Program. https://www.medicago.com/.[Online]. Medigaco Inc.. https://www.medicago.com/en/covid-19-programs/*

SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 6 | Issue: 6 | June 2021 - Peer Reviewed Journal

34. *Anon, 2020. Sanofi joins forces with U.S. Department of Health and Human Services to advance a novel coronavirus vaccine. http://www.news.sanofi.us/. [Online] Sanofi U.S., February 18, 2020. http://www.news.sanofi.us/2020-02-18-Sanofi-joinsforces-with-U-S-Department-of-Health-and-Human-Services-to-advance-a-novel-coronavirus-vaccine*