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# OVERVIEW OF GLOBALLY ACCEPTED SAFE AND EFFECTIVE VACCINES AGAINST COVID-19

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**Abstract:** The ongoing COVID-19 disease has been control by the help of several vaccines that developed in various countries such as India, United States, China, Russia, United Kingdom etc. Vaccine gives the protection against the COVID-19 and also vaccine generates immunity. The developed countries have completed their vaccination but some countries in the globe have been arranging the program of a vaccination to deliver the approved vaccines to people. Vaccine blocks the spreading of infection and improves local immune response. The main purpose for writing this review is to provide the information about which type of safe and effective vaccines are available to the people against SARS-CoV-2 globally.

**Keywords:**
COVID-19, SARS-CoV-2, Vaccine, Immune response

## List of Abbreviations:

| Sr. No. | Abbreviated form | Full form |
|---|---|---|
| 1 | BARDA | Biomedical Advanced Research and Development Authority |
| 2 | CDC | Centers for Disease Control and Prevention. |
| 3 | CDSCO | Central Drug Standard Control Organization |
| 4 | CMR | Indian Council of Medical Research |
| 5 | DCGI | Drugs Controller General of India |
| 6 | EDTA | Ethylenediamine tetraacetic acid |
| 7 | EMA | European Medicines Agency |
| 8 | EUA | Emergency Use Authorization |

| | | |
|---|---|---|
| 9 | FDA | Food and Drug Administration |
| 10 | ID | Intradermal Route |
| 11 | IM | Intramuscular Route |
| 12 | NAS | Intranasal Route |
| 13 | NIV | National Institute of Virology |
| 14 | NTAGI | National Technical Advisory Group on Immunization |
| 15 | QC | Quality Control |
| 16 | RUZF | Russian Direct Investment Fund |
| 17 | SARS-CoV-2 | Severe Acute Respiratory Syndrome Coronavirus 2 |
| 18 | SC | Subcutaneous Route |
| 19 | SEC | Subject Expert Committee |
| 20 | SII | Serum Institute of India |

## 1. INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) producing the disease that name is COVID-19 and that coronavirus started in the city of Wuhan, China, in the December 2019. Coronavirus is an infectious disease and it can be spread from an infected person to the other person by cough, breath, sneeze, speak or sing. Infected people with the COVID-19 virus get the experience of mild to moderate respiratory illness**.** COVID-19 has a various types of symptoms and these symptoms may be seen 2-14 days after showing to the virus. COVID-19 can be prevented by the use of alcohol based sanitizer, avoid touching nose, mouth, and eyes, always wear a face mask etc. The main function of vaccine to prevent or avoid the Coronavirus and improve immune response against virus.[1]

A vaccine is a biotic composition and that gives a active acquired immunity against a certain infectious disease. A vaccine dose contains active ingredients, adjuvants, preservatives and excipients that boost or generate the immune response. But sometimes they can cause an allergic reaction to hypersensitive people. Most of vaccines are generally administered by parenteral route of administration but sometimes they are given by orally or nasally. After stimulated by vaccine it provides antibodies that are prepared from the human donor or an animal.[2]

## 2. TYPES OF VACCINES

There are various types of vaccines to overcome the risk of illness and to produce immune response against disease. Namely these are:[3]

1) Attenuated Vaccine
2) Inactivated Vaccine
3) Toxoid Vaccine
4) Subunit Vaccine
5) Conjugate Vaccine
6) Genetic Vaccine
   i) Viral Vector Vaccine
   ii) mRNA Vaccine
   iii) DNA Vaccine

## 3. PREPARATION OF VACCINE

According to the CDC there are six stages of vaccine production. [4]


**Figure 1** Schematic presentation of stages of vaccine production

## 4. ROUTE OF ADMINISTRATION

Each and every vaccine has a particular route of administration and site. The vaccines are administered by following routes:

- Oral Route
- Intradermal Route (ID)
- Intramuscular Route (IM)
- Subcutaneous Route (SC)
- Intranasal Route (NAS)

## 5. SAFE AND EFFECTIVE VACCINES AGAINST COVID-19

For the use, India has approved some vaccines against COVID-19 and these are as follows:[5]

1) **Covaxin vaccine**
2) **Covishield vaccine**
3) **COVOVAX vaccine**
4) **Sputnik V vaccine**
5) **Sputnik Light vaccine**
6) **Corbevax vaccine**
7) **ZyCoV-D vaccine**
8) **Spikevax vaccine**
9) **Johnson & Johnson vaccine**

### 5.1 Covaxin vaccine

Covaxin is developed by Bharat Biotech in partnership with the Indian Council of Medical Research (ICMR) - National Institute of Virology (NIV).


**Figure 2** Covaxin vaccine

Covaxin is developed by Bharat Biotech in partnership with the Indian Council of Medical Research (ICMR) - National Institute of Virology (NIV). Covaxin is also known as vaccine adjuvants because it is added in the vaccine preparation for the use of to increase or boost the vaccine immunogenicity. For phase I and Phase II Human Clinical Trials Bharat Biotech accepted a DCGI approval in July, 2020. Now covaxin has been approved for the use of emergency cases in 13 countries from 31 January 2020.[6]

**Table 1** Profile of Covaxin vaccine

| | |
|---|---|
| Research Name | BBV152 |
| Type of vaccine | Inactivated Vaccine |
| Route of administration | Intramuscular (IM) Route |
| Pharmaceutical form | Suspension for injection |
| Dose of vaccination | 2 dose (0.5ml) |
| time interval between two doses | 4 to 6 weeks |
| Storage temperature | 2° to 8°C |

### 5.1.1 Composition of Covaxin

- Whole virion inactivated SARS-CoV-2 antigen (strain: NIV-2020-770)
- Aluminum hydroxide gel
- 2- phenoxyethanol
- TLR ⅞ agonist (imidazoquinolinone)
- Phospate ® buffer saline

### 5.1.2 Contraindications for covaxin

- Allergies
- **A**cute infection in the last 3 months
- HIV infection
- Chronic infection
- Pregnant or breastfeeding women

### 5.1.3 Side effects of Covaxin

- Headache
- Fever
- Body ache
- Injection site pain
- Vomiting
- Nausea

## 5.2 Covishield Vaccine

Covishield vaccine is also known as Oxford, AstraZeneca vaccine. Covishield vaccine is manufactured by the Serum Institute of India Pvt Ltd. and it is co-developed by AstraZeneca and the university of Oxford.


**Figure 3** Covishield Vaccine

India Union Health Ministry declared that the pregnant women also get covishield vaccine against corona virus disease. Covishield vaccine has accepted an emergency use against corona virus disease illness. Covishield dosage is to invent a protective antibodies in the body for preventing infection.Covaxin.[8] The covishield vaccine has the CDSCO authority for vaccination and this vaccine is approved in 47 countries.

**Table 2** Profile of Covishield Vaccine.

| | |
|---|---|
| Research Name | AZD1222(ChAdOx1) |
| Type of vaccine | Non-replicating Viral Vector |
| Route of administration | Intramuscular injection |
| Pharmaceutical form | Solution for injection |
| Dose of vaccination | 2 doses (0.5ml) |
| time interval between two doses | 12 to 16 weeks |
| Storage temperature | 2° to 8°C |

### 5.2.1 Composition of covishield [9]

- L-Histidine
- L- Histidine hydrochloride monohydrate
- Magnesium chloride hexahydrate
- Polysorbate 80
- Ethanol
- Sucrose
- Sodium chloride
- Disodium Edetate Dihydrate (EDTA)
- Water for Injection

### 5.2.2 Contraindications for covishield [10]

- Hypersensitivity of active composition
- Patients who have Major blood clotting
- Server allergic reaction
- Low platelet count

### 5.2.3 Side effects of Covishield

- Injection site pain, swelling & redness
- Pain in the arms and legs i.e. joint pain
- Tiredness
- Flu like symptoms (fever, chills and body pain)
- Nausea
- Headache
- Lost appetite

### 5.3 COVOVAX

Covovax vaccine is also known as Novavax vaccine. Covovax vaccine is manufactured by Novavax Inc.


**Figure 4** Covovax vaccine

Covovax vaccine has approved by DCGI. Covovax vaccine is used for in emergency cases of covid 19 on 17 December 2021. In Europe, the covovax vaccine will be developed under the trade name of Nuvaxovid and that approved by European Medicines Agency. The covovax vaccine has been approved in 3 countries

India, Philippines and Indonesia. Covovax vaccine has been restricted use in emergency cases and it has approved by Central Drug Standard Control Organization (CDSCO).[11]

**Table 3** Profile of Covovax vaccine

| | |
|---|---|
| Research Name | NVX-CoV2373 |
| Type of vaccine | Protein Subunit |
| Route of administration | Intramuscular injection |
| Pharmaceutical form | Suspension for injection |
| Dose of vaccination | 2 doses (0.5ml) |
| time interval between two doses | 3 to 4 weeks |
| Storage temperature | 2° to 8°C |

### 5.3.1 Composition of Covovax [12]

- SARS-CoV-2 spike protein that derived from Spodoptera frugiperda species.
- Adjuvanted Matrix-M1 containing Fraction-A (42.5 micrograms) and Fraction-C (7.5 micrograms) of Quillaja Saponaria Molina extract.
- Some Excipients

### 5.3.2 Contraindications for Covovax

- Anaphylaxis to any composition of Covovax.
- Person who have developed anaphylaxis after 1st dose and that person not give 2nd dose .
- Pregnant women

### 5.3.3 Side effects of Covovax

- Injection site pain
- Tenderness
- Fatigue
- Headache
- Muscle pain

### 5.4 Sputnik V

Russian state institute of Gamaleya National Research centre of Epidemiology and Microbiology developed Sputnik Vector ( Sputnik V) vaccine on May 2020.


**Figure 5 Sputnik V vaccine**

Sputnik V vaccine used a weekend virus to provide small part of pathogen and stimulate the immune response against SARS-CoV-2 coronavirus. Sputnik V vaccine has approved for Emergency Use Authorization (EUA) by the DCGI. At first Sputnik V vaccine was approved in Russia and then this vaccine is registered in 71 countries. A deal between Russia and India, the Russia would send 850 million doses of Sputnik V vaccine to the India and effectiveness rate of this vaccine has 91.6%. [13]

**Table 4** Profile of Sputnik V vaccine

| | |
|---|---|
| Research Name | Gam-COVID-Vac |
| Type of vaccine | Non-replicating Viral Vector |
| Route of administration | Intramuscular injection |
| Pharmaceutical form | Solution for injection |
| Dose of vaccination | 2 dose (0.5ml) |
| time interval between two doses | 21 days |
| Storage temperature | 2° to 8°C |

### 5.4.1 Composition of Sputnik V[14]

- Tris-( hydroxy methyl) - amino methane
- Sodium chloride
- Sucrose
- Magnesium chloride hexahydrate
- Disodium EDTA Dihydrate
- Polysorbate 80
- Ethanol
- Water

### 5.4.2 Contraindications for Sputnik V

- Pregnant women
- Coagulation disorder
- Thrombocytopenia
- Person on anticoagulation therapy

### 5.4.3 Side effects of Sputnik V

- Injection site reaction
- Flu-like illness
- Fatigue
- Headache

## 5.5 Sputnik Light

Sputnik Light vaccine is the first component of Sputnik V and it is developed by Gamaleya Research centre, Russia.


**Figure 6** Sputnik Light vaccine

The Russian Direct Investment Fund (RUZF) has announced that Russian one-shot Sputnik Light vaccine against COVID-19 and it has been authorised by DCGI. Sputnik Light vaccine has been certified as universal booster shot in more than 30 countries with total population of across 2.5 billion people. Sputnik Light vaccine has proved 80% effective rate again SARS-CoV-2 coronavirus. Sputnik Light vaccine has been best booster shot for people who have previously infected with Coronavirus . India's drug regulator has to give the grant of Emergency Use Authorization (EUA ) to ses single dose of Sputnik Light vaccine. Sputnik Light vaccine is not effective against COVID-19 but also it is effective against Omicron. Sputnik Light vaccine is also used as third dose as booster shot for who completed their 2 dose of Sputnik V vaccine at least 6 months before this Sputnik Light vaccine.[15]

**Table 5** Profile of Sputnik Light vaccine

| | |
|---|---|
| Research Name | Sputnik Light |
| Type of vaccine | Non-replicating Viral Vector |
| Route of administration | Intramuscular injection |
| Pharmaceutical form | Solution for injection |
| Dose of vaccination | 1 dose (0.5ml) |
| Storage temperature | 2° to 8°C |

### 5.5.1 Composition of Sputnik Light [16]

- Recombinant Human Adenovirus Serotype number 26(rAd26)
- Adenovirus Ad5
- Excipients

### 5.5.2 Side effects of Sputnik Light

- Mild pain at the injection site
- Fatigue
- Muscle aches
- Headache
- Fever

## 5.6 Corbevax

Corbevax vaccine has developed by Biological E. Limited ( BioE) in partnership with US based Dynavax, California and Baylor College of medicine, Houston.


**Figure 7** Corbevax vaccine

Corbevax vaccine has approved for children with authority of Indian Drug Regulator's nod and it has granted an Emergency Use Authorization (EUA) by DCGI. At present, India has not started vaccinating Children below 15 years old and BioE also started clinical trials on 5- 18 year age group in October,2021. The DCGI has approved after the Subject Expert Committee (SEC) on covid 19 of CDSCO has granted restricted EUA to Corbevax vaccine. The National Technical Advisory Group on Immunization (NTAGI) has approved Corbevax vaccine for pregnant women and lactation women.[17]

**Table 6** Profile of Corbevax vaccine

| | |
|---|---|
| Research Name | BECOV2D |
| Type of vaccine | Protein Subunit |
| Route of administration | Intramuscular injection |
| Pharmaceutical form | Suspension for injection |
| Dose of vaccination | 2 dose(0.5ml) |
| time interval between two doses | 28 days |
| Storage temperature | 2° to 8°C |

### 5.6.1 Composition of Corbevax[18]

- Aluminium hydroxide gel
- CpG 1018
- Buffe
- Tris and sodium chloride
- Water

### 5.6.2 Side effects of Corbevax

- Pain or swelling at the injection site
- Mild headache
- Mild fever
- Irritability
- Sweating
- Body ache

## 5.7 ZyCoV-D vaccine

The Indian pharmaceutical company of Zydus Cadila has manufactured ZyCoV-D vaccine, Zydus Cadila vaccine against corona virus from June,2021.


**Figure 8** ZyCoV-D vaccine

The ZyCoV-D vaccine is painless and needle free because it is injected into dermis. In August 20, 2021 the ZyCoV-D vaccine has approved the Emergency Use Authorization (EUA) by DCGI. ZyCoV-D vaccine has been started over 3.5 crore teens in 15-18 years age group had vaccinated 1st dose under the Union Health Minister Mansukh Mandaviya since January 3. The cost of ZyCoV-D vaccine is Rs. 265 per dose and for applicator the cost of this vaccine is Rs. 93 per dose excluding GST. The ZyCoV-D vaccine has efficacy of 66.6% against corona virus infection according to Central Drug Standard Control Organization (CDSCO).[19]

**Table 7** Profile of ZyCoV-D vaccine

| | |
|---|---|
| Research Name | Zydus Cadila |
| Type of vaccine | DNA based vaccine |
| Route of administration | Intradermal injection |
| Dose of vaccination | 3 doses |
| time interval between two doses | 0 - 28 - 56 days |
| Storage temperature | 2° to 8°C |

### 5.7.1 Side effects of ZyCoV-D vaccine

- Redness or soreness at site of vaccination
- Low grade fever
- Fatigue within 24 to 48 hours

## 5.8 Spikevax vaccine

The Spikevax vaccine is manufactured by American company Moderna, the United States National Institute of Allergy and Infectious Disease (NIAID) and the Biomedical Advanced Research and Development Authority (BARDA).


**Figure 9** Spikevax vaccine

Spikevax vaccine is not approved for the use in children below 6 year old however it had approved in people aged 6 years and older. For adult and adolescents above the age 12 years have been give 100 micrograms per dose and for children aged 6 to 11 years have been give 50 micrograms per dose. Booster shot may be provided to adults at least 3 months after vaccination with another mRNA vaccine or adenoviral vector vaccine. Spikevax vaccine can be administered during pregnancy and it is also administered during breast feeding women because there is no risk of adverse effects. [20]

**Table 8** Profile of Spikevax vaccine

| | |
|---|---|
| Research Name | mRNA - 1273 |
| Type of vaccine | RNA |
| Route of administration | Intramuscular injection |
| Pharmaceutical form | Dispersion for injection |
| Dose of vaccination | 2 doses (0.5ml) |
| time interval between two doses | 28 days |
| Storage temperature | 2° to 8°C |

### 5.8.1 Composition of Spikevax [21]

- mRNA
- Trimethamine
- Trimethamine hydrochloride
- Sodium acetate
- Sucrose
- Cholesterol
- Polyethylene glycol (PEG) 2000 - dimyristoyl glycerol ( DMG)
- Acetic acid
- Lipid SM - 102
- 1,2- Disteroyl- SN- glycol- 3- phosphocholine
- Water

### 5.8.2 Contraindications for Spikevax

- Hypersensitivity and anaphylaxis
- Myocarditis and pericarditis
- Anxiety related reactions
- Concurrent illness
- Thrombocytopenia and coagulation disorder

### 5.8.3 Side effects of Spikevax

- Redness, soreness, swelling at the injection site
- Chills
- Fatigue
- Joint pain
- Headache
- Mild fever
- Muscle aches

## 5.9 Johnson & Johnson vaccine

Johnson & Johnson vaccine is developed by Janssen Pharmaceutical company and it has been approved an Emergency Use Authorization (EUA)by the US Food and Drug Administration ( FDA) and conditional marketing authorization by the European Medicines Agency (EMA) and the UK Medicines and Healthcare Products Regulatory Agency.


**Figure 10** Johnson & Johnson vaccine

Johnson & Johnson vaccine has been approved in 107 countries. Johnson & Johnson vaccine has been approved in persons aged 18 years and older. Johnson & Johnson vaccine is effective in people who knows the medical conditions with increased risk of Severe disease like hypertension, chronic lung disease, obesity and diabetes. A single booster dose of Johnson & Johnson vaccine may be administered to 18 years age and older who have completed their primary vaccination.[22]

**Table 9** Profile of Johnson & Johnson vaccine

| | |
|---|---|
| Research Name | JNJ-78436735 ( Ad26.COV2.S) |
| Type of vaccine | Non-replicating Viral Vector |
| Route of administration | Intramuscular injection |
| Pharmaceutical form | Suspension for injection |
| Dose of vaccination | 1 dose (0.5ml) |
| Storage temperature | 2° to 8°C |

### 5.9.1 Composition of Johnson & Johnson [23]

- Polysorbate-80
- 2- hydroxy propyl-beta - cyclodextrin
- Trisodium citrate Dihydrate
- Sodium chloride
- Citric acid monohydrate
- Ethanol

### 5.9.2 Contraindications for Johnson & Johnson

- Server allergic reaction
- Anaphylaxis
- Thrombosis with thrombocytopenia syndrome

### 5.9.3 Side effects of Johnson & Johnson

- Pain at injection site
- Muscle aches
- Headache
- Fatigue
- Nausea
- Fever
- Tiredness

## 6. CONCLUSION

Quick development of vaccine technology has been manufactured several vaccines against COVID-19 virus. According to World Health Organization, the vaccines provide good immune response and also prevent infection against corona virus. In India, most commonly used Covaxin, covishield and Sputnik vaccine. All safe and effective vaccines are stored in 2°-8°C temperature in condition. After vaccinated by vaccine it produces some common side effects like injection site pain, headache, muscle ache. Sputnik Light vaccine and Johnson & Johnson vaccine has only 1 dose of vaccine for vaccination and other vaccines required 2 dose for vaccination.

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