|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type of vesicles | Preparation technique | Composition | Results | Reference |
| Microparticles | spray drying | Plasmid DNA/HBsAg/albumin microparticles | When comparing the oral vaccination with interleukins cohort to the subcutaneous class, oral immunization with pDNA to HBsAg microparticles resulted in dramatically greater titer levels of both sIgA and IgG at weeks 9 and 34. | [125] |
| Nanoparticles | ionic gelation | trimethyl chitosan (TMC)/ hydroxypropyl methylcellulose phthalate (HPMCP)/ HBsAg nanoparticles | Both prior and after stacking, the antigen demonstrated remarkable activity. The findings indicate that TMC/HPMCP nanoparticles could be employed to administer the HBsAg vaccination orally. | [126] |
| Liposomes | - | dissolving microneedle array (DMA)-associated transcutaneous immunization (TCI) system packed with cationic liposomes/ hepatitis B DNA vaccine/CpG ODN | Finally, it was revealed that the innovative approach might successfully deliver the hepatitis B DNA vaccine into the skin, eliciting a robust immune response and changing the immune type using adjuvant CpG ODN. | [127] |
| Microparticles | ionotropic gelation | Chitosan microparticles/recombinant hepatitis B vaccine and coated with poly(vinyl alcohol) | Oral vaccination of rats with a designed system's vaccine elicited a seroprotective immune response that was analogous to current intramuscular vaccination practices. The findings showed that the device might be employed as an oral vaccine delivery method for the hepatitis B vaccine and that it could be a viable substitute for needle-based immunization. | [128] |
| Microparticles | - | Covalently modified albumin (BSA) microparticles/ maleic anhydride (MA) and crosslinked with N′, N′-dimethyl acrylamide (DMAAm) | The novel particle architecture manifested a vast amount of capability as a mucosal vaccination for hepatitis B. | [129] |
| Nanoparticles | - | SiO2@ layered double hydroxides (LDH) nanoparticles/ HBVsAg DNA vaccine | The caveolae-mediated absorption of the material by macrophages was shown to activate macrophages through the NF-kB signaling cascade. The findings suggest that SiO2@LDH nanoparticles might be implemented as a non-viral gene delivering strategy. | [130] |
| Nanoparticles | Coacervation/precipitation technique | Human serum albumin (HSA)-chitosan NP/DNA (CH NP/DNA) (HSA-CH NP/DNA) | HBV-specific IgA was identified in vaginal and nasal fluids after intranasal immunization with the formulated complexes; no mucosal or systemic reactions were observed after immunization with DNA alone. Overall, the device evoked both mucosal and humoral immune responses, making it a promising gene delivery approach for HBV nasal vaccination. | [131] |
| Nanoparticles | Double emulsion solvent evaporation | HBsAg/PLGA NPs | The nanoparticles served as an effective carrier system for immunization, resulting in higher antibody titers and increased immunological capacity. The findings showed that intramuscular administration of the nano-vaccine contributed to superior cellular and humoral responses, along with putative vehicles for antigen delivery, compared to single-dose intramuscular treatment for Hepatitis B. | [132] |
| Nanoparticles | - | HBsAg-Alum/selenium NPs (SeNPs) (HBsAg-Alum/SeNPs) | The application of the HBsAg vaccination in combination with SeNPs influenced lymphocyte proliferation; additionally, total antibody responses elevated IFN-levels and caused a Th1 response. | [133] |
| Liposomes | emulsification–lyophilization | mannose-PEG-cholesterol/lipid A-liposomes (MLLs) encapsulated with HBsAg, later filled into microneedle reverse mold’s microholes (proHMAs) | It was revealed that the system might be quickly vaccinated by oral mucosal way to establish multiple immune responses against HBV incursion, and it might be a durable HBV vaccine that can be distributed widely in a regulated temperature loop. | [134] |

**Supplementary Table II** Latestnovel vaccine formulations including nanotechnology based vaccine formulations for Hepatitis B [125-134].