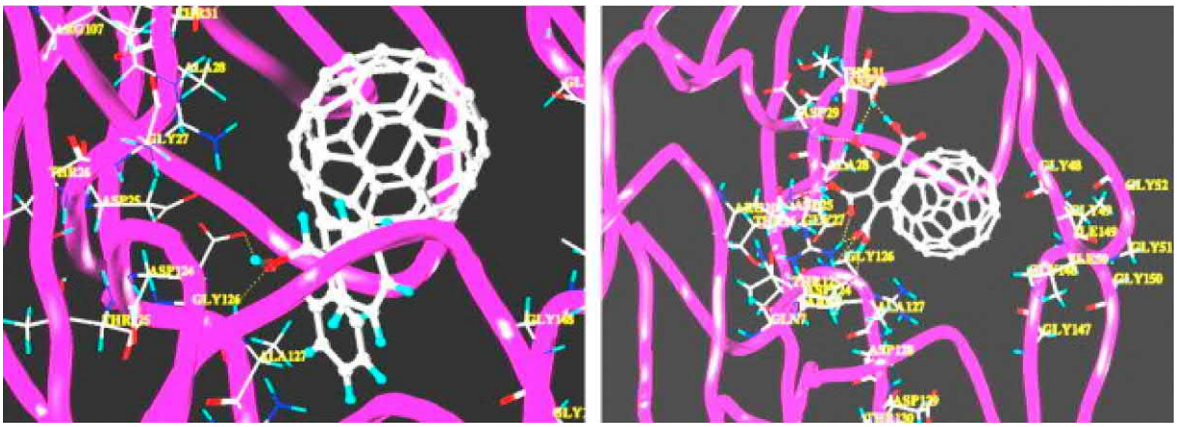

FIG. 16 The binding interactions of 1 and 23 at the active site of the HIV-1 PR [84].

significant contributed factors were hydrogen bond acceptor by 28.0%, hydrogen bond donor by 16.7%, electrostatic by 12.7%, and steric by 42.6%. The resultant contour plots were utilized to propose new inhibitor compounds of higher bioactivities and binding affinities toward the HIV-1 PR (Fig. 16).

6. DNAS AS DRUG DELIVERY SYSTEMS

DNA nanomaterials and their self-assembled forms have been emerged as effective drug carrier biomaterials with particularly interesting versatile structures and functionalities. Self-assembled DNA nanotubes (DNTs) illustrate exactly controlled biocompatible nanostructures that among the most auspicious drug carriers [85, 86]. DNTs are widely investigated in delivery of various pharmaceutics. It was revealed that folic acid labeled DNTs targeted and internalized the receptors existing on the surfaces of cancer cells [87]. Also, DNTs loaded cargos along their lengths and triggered the cargo release to respond external stimulants [88]. DNTs were used as auspicious nanocarriers that targeted macrophages of tissues [89]. The DNTs cellular uptake was examined using siRNA nanomaterials. Such results could help to recognize the DNTs capacities and benefits in delivery of medicines. However, few MD simulation studies have so far been accomplished on DNAs as DDSs [90–92].

The DNA origami technique causes folding long and single strand DNA as 3D complex arrangements in subnanometer sizes. MD simulations were done to examine microscopic mechanical and structural features of DNA origami substances [90]. MD simulations exhibited that DNTs underwent substantial nanometric structural variations. In aqueous medium the DNA origami structures leaved their perfect targets due to electrostatic, steric, and solvent-mediated interactions. Holliday junctions in DNA origami materials adopted an antiparallel left-handed conformation. Type of lattice in these substances significantly affected global mechanical characteristics like bending rigidity.

MD simulations were accomplished on self-assembled 384 base pair small origami that were created from staple single and strands of oxDNA that was a nucleotide DNA model in solution [91]. It was observed that new staple strands were attached in parallel; however, the second staple domain was bound when the neighboring bond was partially generated. The system only containing one copy of every staple strand, full assembly happened at intermediate temperatures so that complete assembly was not occurred at low temperatures upon misbonding, whereas at higher temperature extremely large free energy barriers were measured for the assembly. At high concentrations using extra staple strand, full assembly was not seen as two copies of identical staples were attached onto the scaffold and created a kinetic trap which prevented each staple from full binding. In real organizations, such staple blockage could form partially aggregated origamis that could lead to design origami structures.

To achieve targeted and smart drug nanocarriers using DNTs, their interactions with anticancer drugs were explored by MD simulations [93]. It was revealed that the DNT drug carriers highly absorbed anticancer drugs through π-π interactions particularly using high drug concentration. Consequently the drug aggregation was significantly decreased in water. Furthermore the DNTs stability was enhanced on drug absorption. This study proved that DNTs were favorable drug vehicles as they strongly absorbed anticancer drugs.