and *P. aeruginosa*. The wound dressing in vivo induced a coating with significant epithelialization in the wound periphery. The upper dermal matrix displayed a well-structured granulation tissue with the absence of degeneration in the dermal matrix. The hydrocolloids restored the normal skin tissues. Hiranpattanakul et al. prepared chitin/chitosan hydrocolloid for wound dressing. The hydrocolloids water adsorption, excellent antibacterial activity, and biocompatibility make them potential wound dressings. Increasing the chitosan microbeads: chitin weight ratio reduced the water absorption. They displayed 100% antibacterial activity after 30 min exposure to *E. coli* and *S. aureus*. They were biocompatible with high water absorption and good degradability [59].

Jin et al. developed sodium alginate-based *Centella asiatica*-loaded hydrocolloid wound dressing [50]. The use of alginate to prepare the hydrocolloids enhanced their capability to retain fluid and also provide a moist environment for the wound. The hot melt pressure-sensitive adhesives and elastomers used were poly(isobutylene) and SIS which induced the chemical inertness of the dressings. Petroleum resin hydrocarbon improved the adhesive nature of the dressing together with the strength and flexibility of the dressings. Rat induced with diabetes and wounds were used for the in vivo studies. The excision wound models were evaluated for 1 month and the wound healing using the hydrocolloid was 95% when compared with the control on day 29. The wound dressings accelerated epithelialization. In infected wound models inoculated with *S. aureus* inflammation occurred. A severe form of inflammation and hemorrhage was significant in the control and a decreased wound size resulting from accelerated epithelialization was visible in the wounds in which the hydrocolloid dressing was used. In abrasion wound model, CA-loaded hydrocolloid also revealed accelerated healing when compared with the control. The moist environment around a wound makes the wound soft and induces the migration of keratinocytes and fibroblasts, cell growth factors, and cytokines thereby accelerating epithelialization and wound healing [50,51].

The reoccurrence of keloids can be prevented by combining hydrocolloids with magnets. The magnet compresses the wound thereby increasing discharge while the hydrocolloid dressings provide a moist environment for the wound. In patients with earlobe keloid who had surgical excision followed by hydrocolloid dressing combined with magnet resulted in good postoperative outcomes. No significant acute wound effects with a good long-term recurrence rate when compared with patients treated with conventional dressing methods [60]. Wound dressing composed of a layer of hydrocolloid and a layer of activated carbon was developed. The activated carbon exhibited bacteriostatic or antimicrobial activity by inhibiting the growth of bacteria and also absorbed wound fluids and unpleasant smell. The hydrocolloid layer induced wound healing by providing a moist warm environment suitable for enzymatic processes and efficient wound healing. The layer also induced debridement of dead tissue and exhibited good hemostatic activity. The combination of an activated carbon layer with a hydrocolloid layer resulted in a synergistic effect and accelerated wound healing [52].

Lee et al. developed hydrocolloid dressings loaded with silk fibroin nanoparticles for the treatment of burn wounds [61]. In vivo studies revealed the appearance of healthy tissue at 14 days without signs of edema at 21 days. A significant increase in the density of collagen fibers suggested excellent structural integrity of the tissue during wound healing. A regenerated dermis layer was visible at day 7 indicating accelerated wound healing when compared with gauze and Neoderm. The water uptake of the prepared hydrocolloid was similar to Neoderm. Increase in the content of the nanoparticles in dressing retained the shape of the dressing after the addition of water and the tensile strength also increased. The hydrocolloids were biocompatible.

3.3. Foams

Foam-based wound dressings are porous and are able to absorb fluids [62]. Their thickness varies and they can be either adhesive or nonadhesive. The contact layer of the foam on the wound area facilitates the uptake of the exudates into the foam [63]. Its adhesive nature to the surrounding skin helps in keeping the dressing in place thereby preventing excess exudates around the wound which can promote bacteria invasion (Fig. 6) [64]. However, its adhesive nature may cause skin irritation in patients with sensitive or fragile skin. The most commonly used foam is polyurethane and silicone foam is used less frequently. Silicone foams are used as a primary absorbent in wound dressings [62,63]. Foams prepared with film-backing act as a resistant barrier to water and microbial invasion. The permeability of the film-backing varies and influences the foams capacity of water evaporation and gas exchange [63]. Foam-based wound dressings offer several advantages such as good capability to maintain moisture at the wound surface; can be easily removed and protects the skin around the wound; it protects the wound against bacteria; it maintains a temperature suitable for accelerated wound healing; it provides mechanical