UNIVERSITI TEKNOLOGI MARA

USE OF MICROWAVE TECHNOLOGY IN TRANSDERMAL DRUG DELIVERY

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ABSTRACT

The project focused on the use of microwave in controlling drug release from film matrix and modifying skin barrier for transdermal drug delivery. With reference to controlled-release application, the effects of microwave on drug release properties of pectin films carrying sulfanilamide (P-SN), sulfathiazole (P-ST) and sulfamerazine (P-SM) of high to low aqueous solubilities were investigated. These films were prepared by solvent-evaporation technique and treated by microwave at 80 W for 5 to 40 min. Their profiles of drug dissolution, drug content, matrix interaction and matrix crystallinity were determined by drug dissolution testing, drug content assay, differential scanning calorimetry, X-ray diffractometry and scanning electron microscopy techniques. Microwave was found to be able to increase the matrix amorphousness. However, the strength of matrix interaction was accordingly increased thereby lowering the drug release propensity with a greater retardation extent in P-SN films. A gain in amorphous structure did not necessarily increase the drug release of film. Microwave can possibly retard drug release of pectin film carrying water-soluble drug through modulating its state of matrix interaction. In the case of skin barrier modification by microwave, the mechanism of microwave enhancing transdermal permeation of drug from film through its action on skin was investigated. The transdermal drug delivery profiles of pectin film was evaluated against pectin gel with reference to the influences of microwave, as well as chemical permeation enhancer namely oleic acid on skin. Hydrophilic P-SN films and gels, with or without oleic acid (OA), were prepared and subjected to drug release and skin permeation studies. The skins were untreated or microwave treated, and characterized by infrared spectroscopy, raman spectroscopy, thermal, electron microscopy and histology techniques. Skin treatment by microwave at 2450 MHz for 5 min promoted drug permeation from OA-free film without incurring skin damage. Skin treatment by microwave followed by film loaded with drug and OA resulted in permeation of all drug molecules that were released from film. Microwave exerted spacing of lipid architecture of stratum corneum into structureless domains which was unattainable by OA. It allowed OA to permeate stratum corneum and accumulate in dermis at a greater ease, and synergistically inducing lipid/keratin fluidization at hydrophobic C-H and hydrophilic O-H, N-H, C-O, C=O, C-N regimes of skin, and promoting drug permeation. Unlike solid film, skin treatment by microwave at 2450 MHz for 5 min demoted drug permeation from pectin gel. Formulation of gel with OA as penetration enhancer resulted in a greater reduction extent in drug permeation. Both OA and microwave exerted lipid/keratin fluidization at hydrophobic and hydrophilic regimes of skin. Using gel with freely soluble pectin molecules instead of solid film with entangled chains, these polymer molecules could interact with epidermis and dermis via hydrogen bonding to retard drug permeation. In comparison to microwave which fluidized stratum corneum into structureless domains, OA could extract endogenous lipid fraction and form separate phases within intercellular lipid lamellae. It provided a more extensive intercellular space for binding of pectin with skin, thereby remarkably decreasing drug permeation. The physical forms of a delivery system can exert opposite influences on transdermal drug permeation modulated by microwave or OA.

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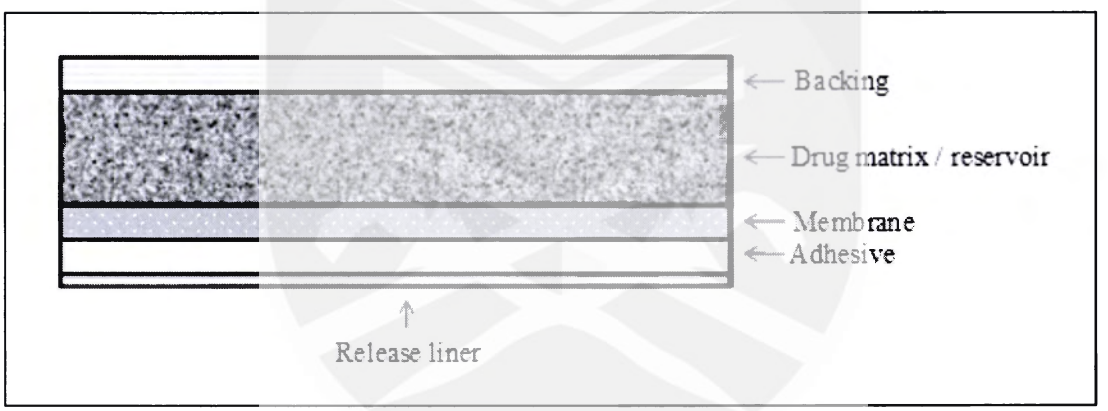
1.1.1 Transdermal Drug Delivery System

The basic components of a transdermal drug delivery system (TDDS) consist of drug(s) dissolved or dispersed in an inert polymer film, outer backing film of paper, plastic or foil, and a pressure-sensitive adhesive that anchors these films to the skin (Figure 1.1). The adhesive is covered by a release liner, which needs to be peeled off before applying the TDDS to the skin [1-2]. This type of TDDS is known as a matrix system. Another main category of TDDS is a reservoir-type patch. It holds the drug in the form of solution, suspension, gel or solid polymer matrix with drug delivery controlled by a rate-limiting membrane.

FIGURE 1.1
Schematic Diagram of a TDDS



TDDS provides a controlled continuous delivery of drug molecules from the surface of skin, through its layers, and to the circulatory system [3]. In comparison to oral dosage forms, delivery of drugs by means of transdermal route avoids harsh gastrointestinal condition which results in drug first pass metabolism and offers multi-day dosing with a single administration, thereby leading to improved patient compliance [4–6]. Development of long-acting, extended or sustained-release oral