SOME INTERRELATIONS BETWEEN SEBUM, SWEAT AND THE SKIN SURFACE

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The recent work of Kligman and Shelley (1) does much to advance our concepts of the physiology of sebaceous secretion. This paper presents several experimental observations that intend to further modify these concepts.

The composition of sebum has been thoroughly explored. From an examination of its approximate composition, one would expect sebum to emulsify water as the internal phase of a water-in-oil emulsion, but would not expect it to disperse spontaneously in a large volume of water.

Sebum, with some admixed cellular debris, may be collected in relatively large amounts during the warm months by drawing a pharmaceutical spatula across the forehead and flush area, applying light pressure. Under average summer conditions (80° F., relative humidity 50%), the collected sebum shows no dispersed water droplets, provided the subject has not been sweating within the previous few minutes.

If several drops of freshly collected sebum are touched to a water surface of limited area, e.g., that enclosed by a 150 ml. beaker, the material instantly breaks up and spreads rapidly as a series of globular lenses separated, presumably, by an invisible monolayer. This occurs when the water surface is insufficient to permit all of the sebum to spread entirely as a monolayer. The "spreaders" of this monolayer consist of long chain acids and alcohols, cholesterol, and mono- and diesters of glycerol. The film may contain dissolved triglycerides, fatty esters and hydrocarbons.

This phenomenon may best be observed when the water temperature is 38° C., since the lenses remain liquid and globular. At 30° C. they begin to solidify and become irregular. At neither temperature, observed for periods up to three days, does any of this surface film disperse in water. Neither does this film inhibit the evaporation of water. This may be confirmed at either temperature by comparing the rate of evaporation from the sebum-containing beaker to that of a control beaker, both held thermostatically at a desired temperature. This indicates that the monolayer is normally in a highly expanded, easily compressible state. This characteristic has been used to advantage in the interesting work done on sebaceous secretion quantitatively determined by measurement of the area covered by a compressed sebum monolayer (2, 3).

To confirm previous findings (4) a small mound of sebum was stained with Sudan IV, a drop of water placed adjacent to it, and the whole incubated for a short while at 38° C. and 100% humidity. In confirmation of the above, the sebum showed a considerable dispersion of water as the internal phase. It is doubtful, however, that this occurs to any great extent on the skin surface, where sweat evaporates rapidly.

In contradiction of previous interpretations, the water droplet itself appeared to be covered by a surface film of minute stained lenses, there being no dispersion in the body of the droplet. To test this under physiological conditions, a large drop of water was then placed on the forehead of one subject. After thirty seconds it was removed by touching with a glass slide, being careful not to touch the skin itself. Many minute glistening globules were seen, barely visible to the naked eye. Microscopically, all the globules appeared to be in the same plane of focus, indicating that all the lipid is on one surface of the droplet. This finding may be duplicated with thermogenic sweat, although it is difficult to be certain the skin surface is not touched while sampling small droplets.

It is apparent that, although sebum of sebaceous gland origin does not disperse in water, considerable amounts of sebum may spread rapidly over a wet surface as a lens-monolayer system. Although it has been demonstrated previously that sweating does not increase the total amount of lipid extractable from a given area, sweating apparently affects the distribution of lipid within a given area. This has been demonstrated experimentally by Herrmann and his group, who noted the difference in darkening by osmic acid between an atropinized and control

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site after sweating. The most likely explanation at present is that lipid in the follicles spreads on the surface of sweat droplets and is deposited on the skin surface after evaporation.

Sebum exists on dry skin as multimolecular layer. Because of the phenomena of increased sebum yield with increased frequency of collection, Shelley and Kligman postulate the cornified epithelium acts as a "wick", drawing up oil from the follicular reservoir by capillary attraction.

Cornified epithelium softens in water, but not in sebum, and it would be surprising if hydrated cornified epithelium could take up any significant amount of water-immiscible sebaceous lipid. Indeed, if cornified tissue had a high affinity for sebum, the skin would be quite brittle. Calluses immersed in sebum stained with Sudan IV show no staining of the interior after incubation at 38 C. for 24 hours. If a callus, surrounded by a thick film of stained sebum, is then incubated at 38° centrigrade and 100% humidity, it still shows no staining of the interior after softening of the callus. To test this hypothesis literally, a wick of callus tissue was suspended vertically with one end immersed in a pool of stained sebum. After incubation at 38° C. and 100% humidity for 24 hours, no rise was found on examination of the dermal (cut) surface of the callus. On the external surface, a 1–2 mm. rise was observed in the sulci only.

Although a slight capillary attraction may be exerted by the skin sulci, other explanations may be found to explain increased lipid recovery with increased frequency of collection. Increased total contact time between skin and collecting agent (solvent or absorbent paper) may in itself be partly responsible for the increased yield. Shelly and Kligman show that when total contact time is the same, using absorbent paper, equal amounts are collected, even though one side is changed more frequently. There may also be a simple physical mechanism at work whereby lowering the sebum level on the skin surface causes an increased flow from the follicular reservoir. In any event, the concept of cornified epithelium as an oil-soaked wick does not appear to be valid.

SUMMARY

(1) Sebaceous lipid does not disperse in water, but spreads over a restricted water surface as a lens-monolayer system. Considerable amounts of lipid may be redistributed by this mechanism.

(2) Sebum exists as a multi-molecular surface layer on dry skin, and does not penetrate cornified epithelium to any extent.

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