The Role of Sebaceous Gland Activity and Scalp Microfloral Metabolism in the Etiology of Seborrheic Dermatitis and Dandruff

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Most common scalp flaking disorders show a strong correlation with sebaceous gland (SG) activity. Early SG activity in the neonate results in microfloral colonization and cradle cap. After maternal hormonal control subsides, there is little SG activity until puberty, when the SG turns on under sex hormone control. When the SG activity increases, the present but low *Malassezia* population has a new food source and proliferates, resulting in the scalp itching and flaking common to greater than 50% of adults. Dry scalp flaking, dandruff, and seborrheic dermatitis are chronic scalp manifestations of similar etiology differing only in severity. The common etiology is a convergence of three factors: (1) SG secretions, (2) microfloral metabolism, and (3) individual susceptibility. Dandruff and seborrheic dermatitis (D/SD) are more than superficial stratum corneum disorders, including alteration of the epidermis with hyperproliferation, excess lipids, interdigitation of the corneal envelope, and parakeratosis. The pathogenic role of *Malassezia* in D/SD has recently been elucidated, and is focused on their lipid metabolism. *Malassezia restricta* and *M. globosa* require lipids. They degrade sebum, free fatty acids from triglycerides, consume specific saturated fatty acids, and leave behind the unsaturates. Penetration of the modified sebaceous secretions results in inflammation, irritation, and scalp flaking.

Key words: dandruff/microflora/sebaceous gland/seborrheic dermatitis/sebum
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Sebaceous Gland (SG) Activity

Human SG are found over the entire skin surface (except the palms of the hands and soles of the feet), but sebum secretion is highest on the scalp, face, chest, and back (Strauss and Pochi, 1968a). Sebum is produced under hormonal control, with SG active at birth under the control of maternal androgens. They quickly reduce in size and sebum production until the onset of puberty. As puberty begins the SG again activate, this time under the control of circulating androgens. The sebum secretion rate increases throughout the teens, remains steady through the 20s and 30s, then lessens with age (Strauss *et al*, 1983; Dawber, 1997). Throughout the active period of sebum secretion, the secretion rate is higher in males than in females. In males, the rate remains higher longer, into the 50s and 60s, but in females, the secretion rate drops quickly after menopause (Strauss and Pochi, 1968b). Common scalp flaking disorders all show a strong temporal correlation with sebaceous activity, following the pattern of early cradle cap, low incidence until puberty, increasing incidence through the teens, second and third decades, then declining (Dawber, 1997; Gupta *et al*, 2003, 2004a, b).

The primary functions of sebum have historically been controversial, but are recently being elucidated. Sebum is involved in development of epidermal structure and maintenance of the epidermal permeability barrier (Pilgram *et al*, 2001), carrying anti-oxidants to the skin surface (Theile *et al*, 1999), protection from microbial colonization, generation of body odor, and pheromone generation (Kligman, 1963). It has also recently come to light that sebum is directly involved in skin-specific hormonal signaling, epidermal differentiation, and protection of the skin from ultraviolet irradiation (Thiboutot *et al*, 2003; Zouboulis, 2003).

Abbreviations: D/SD, dandruff and seborrheic dermatitis; SG, sebaceous gland

Composition of Human Sebum

When secreted human sebum is a complex mixture of triglycerides, fatty acids, wax esters, sterol esters, cholesterol, cholesterol esters, and squalene (Fig 1) (Strauss *et al*, 1983). As the sebum is secreted, it consists primarily of triglycerides and esters, which are broken down by commensal microbes into diglycerides, monoglycerides, and the constituent free fatty acids. Human sebum contains both saturated and unsaturated fatty acids, with a preponderance of unsaturates. The fatty acid chain lengths of human sebum vary considerably, but are predominantly 16 and 18 carbons (stearic, C18:0, oleic, C18:1Δ9, linoleic, C18:2Δ9Δ12, palmitic, 16:0, sapienic, 16:1Δ6, and palmitoleic, C16:1Δ9, Fig 1). The role of specific fatty acids of human sebum becomes apparent when we examine the metabolism of *Malassezia*.

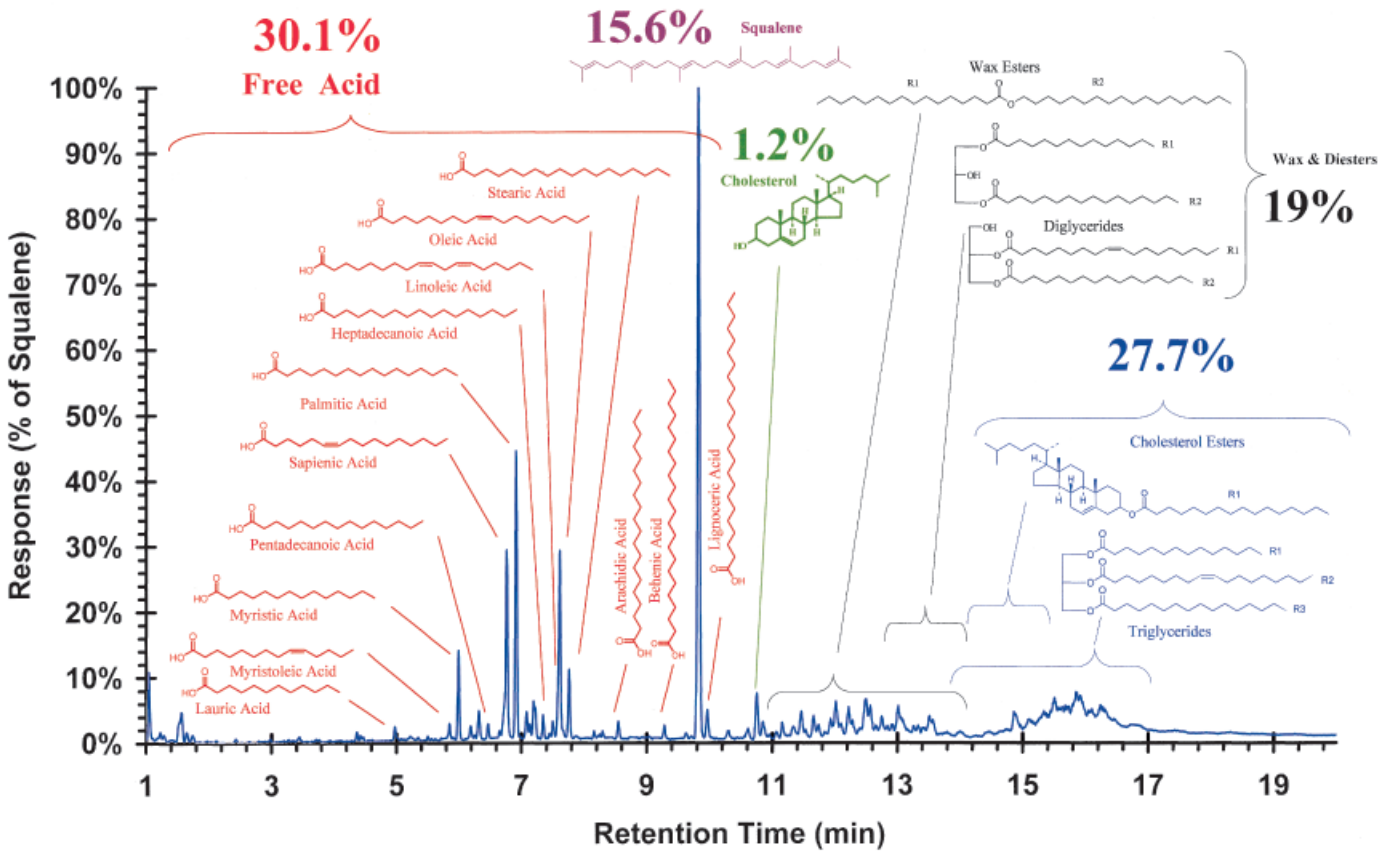

Figure 1
Relative composition of human sebum. Samples of human sebum were collected and analyzed by gas chromatography. Peaks were identified by comparison to known standards. Identifications confirmed by GC-mass spectrometry.

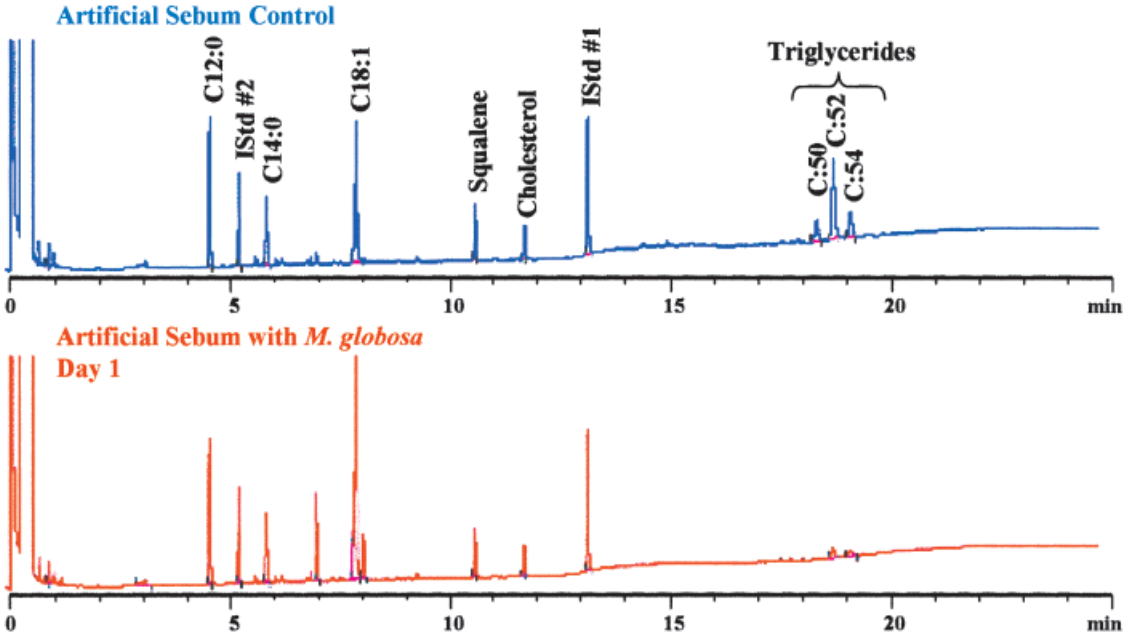

Figure 2
Triglyceride degradation and increased free fatty acids after incubation of artificial sebum by *Malassezia globosa*. Lipid composition analyzed as in Fig. 1, but following incubation of *M. globosa* for 24 hours with defined lipid matrix.