

urine. Sodium lauryl sulfate is oxidized to carboxylic acid with butyric acid-4-sulfate as the major metabolite (Ref. 314).

2. *Acute toxicity.* Sodium lauryl sulfate has an LD₅₀ in rats ranging from 0.9 to 1.6 g/kg with a mean of around 1.3 g/kg (Refs. 315 and 316). Studies (Ref. 308) indicated that sodium lauryl sulfate is slightly toxic. Signs of toxicity included diuresis, diarrhea, lacrimation, salivation, tremors, convulsions, sedation, anaesthesia, and death.

Intraperitoneal administration of sodium lauryl sulfate (25 or 50 mg/kg body weight per day for 3 days) decreased the level of some cytochrome P450 species (Ref. 317), stimulated haem-oxygenase activity (Ref. 318), and affected serum lipids (Ref. 317). The concentrations of sodium lauryl sulfate and the routes of administration in these studies were specifically designed to induce toxic effects, including death, and have little in common with human exposure to this ingredient with normal use of mouthrinses and dentifrices.

3. *Chronic toxicity studies.* Rats fed a diet containing up to 2.25 percent sodium lauryl sulfate for 13 weeks demonstrated enlarged liver cells and increased liver weight, as well as elevated levels of alkaline phosphatase and glutamic pyruvic transaminase. These changes were considered to represent accommodations to the increased work load required for the metabolism of sodium lauryl sulfate. Other changes noted included nonspecific enlargement of the kidneys, increased water consumption, and enlarged intestinal lymphatics. The sodium lauryl sulfate level below which no changes could be detected was 0.14 percent of the dietary intake, or 116 mg/kg body weight (Ref. 319). Another study found the "no change" level to be 0.1 percent (Ref. 316).

In a 16-week feeding study in rats, daily doses of different percents of sodium lauryl sulfate in the diet had different results: 8 percent resulted in death, 4 percent in significant growth retardation, and 2 percent in some growth retardation that was not statistically significant (Ref. 320). In a 1-year study in dogs, a 2-percent dietary intake of sodium lauryl sulfate caused some weight loss. The "no change" level was 1 percent (Ref. 308).

The toxicology of alkyl sulfates has been extensively reviewed (Refs. 321 and 322). The Subcommittee notes several hypothetical examples (Ref. 313) that place the above findings in the context of human subject users. In the unlikely event of a 20-kg child ingesting 10 mL of a mouthrinse containing 0.3 percent sodium lauryl sulfate daily, over

a 13-week period, the daily dose ingested would be 1.5 mg/kg body weight. Based on a "no change" level of 116 mg/kg in the rat feeding study, the safety factor is 77-fold (Ref. 319). The safety factor in a 50-kg adult ingesting 1 mL of the mouthwash daily would be over 1,900. Based on the 1-year study in dogs (Ref. 308), the safety factors for the child and adult would be greater than 500 and 13,000, respectively.

4. *Reproduction toxicity.* Teratogenic studies in rats (Refs. 323 through 326) revealed no evidence of teratogenicity. Some embryotoxicity was noted at high doses that were severely toxic to the dams.

5. *Mutagenic potential.* Neither in vivo (Refs. 327 and 328) nor in vitro (Refs. 329 and 330) assays resulted in any increase in chromosome aberrations. There is no evidence that sodium lauryl sulfate incorporated in oral health care products is a teratogenic or mutagenic risk in humans.

6. *Skin irritation.* At concentrations of 2, 10, and 20 percent, sodium lauryl sulfate produces a Draize skin irritancy test score compatible with that of a primary skin irritant (Ref. 308). The 1 to 6 percent concentrations of sodium lauryl sulfate applied to human skin under an occlusive patch for 21 days were irritating to the skin. However, no irritancy potential could be detected in the absence of the occlusive patch (Ref. 331). Therefore, open application of sodium lauryl sulfate produces little, if any, irritation at these concentrations.

7. *Ocular irritation.* The 10 percent sodium lauryl sulfate applied to the rabbit eye caused corneal damage if washing was delayed or withheld. A 1-percent sodium lauryl sulfate application caused little irritation and no corneal damage (Refs. 309, 321, and 322).

8. *Oral irritation potential.* Sodium lauryl sulfate solutions in concentrations of 0.1 to 1 percent in 12 percent ethanol were swabbed for 30 seconds 4 times daily for 4 days on the oral mucosa of rats. Only mild cheilitis (inflammation of the lips) and sloughing were observed (Ref. 332). A single application of 0.2 percent sodium lauryl sulfate to the oral mucosa of rats did not produce any detectable changes, whereas increased cellularity was observed with a 2-percent application in half of the animals. After 3 weekly applications, the cellular reaction decreased (Ref. 333).

The Subcommittee concludes that, based upon the results of the extensive toxicity tests (only some of which are referenced above), sodium lauryl sulfate does not constitute a risk to consumers in the concentrations found in oral

health care products. The widespread use of sodium lauryl sulfate in numerous oral health care products, as well as in foods and other personal products, without any reported side effects attributable to normal use, further supports the safety of this ingredient.

ii. *Effectiveness.* The Subcommittee concludes that there are insufficient data available to permit final classification of the effectiveness of sodium lauryl sulfate as an antigingivitis/antiplaque agent.

Sodium lauryl sulfate is used in oral health care products because of certain desirable properties, which include: (1) Decreasing surface tension (Refs. 334 and 335), (2) affinity for enamel surfaces, leading to masking of receptor sites for bacterial proteins (Ref. 336), (3) emulsification of food and bacterial components (Refs. 334 and 337), (4) inhibition of selective enzymes that help form dental plaque (Refs. 337, 338, and 339), (5) affinity for bacterial proteins and ability to denature them (Ref. 337), (6) disruption of cell membranes (Ref. 340), (7) inhibition of plaque formation through decreased surface tension and competition with negatively charged bacterial cells for binding sites on the tooth surface (Ref. 341), and (8) optimization of antibacterial properties of certain zinc salts (Ref. 340).

These properties of sodium lauryl sulfate contribute to its usefulness to loosen and remove food particles (Refs. 342 through 349). Some of these properties also allow sodium lauryl sulfate to inhibit the formation of dental plaque (Ref. 350), exert a mild antibacterial effect (Ref. 351), and provide consumers with the feeling that tooth surfaces are smooth and clean and their breath is fresher (Ref. 352).

In examining the results of clinical trials involving sodium lauryl sulfate, the types of products containing this ingredient and the characteristics that make it desirable for a particular product should be considered. Because of differences in formulations and the presence of other ingredients, it may be difficult to determine to what extent sodium lauryl sulfate contributes to some of the beneficial effects claimed for marketed products. For example, a major objective for mouthrinse users is to reduce oral malodor. However, it is difficult to compare the effect of rinses containing sodium lauryl sulfate to those that do not, since flavoring agents are obvious confounding factors (Refs. 352 through 357). The most common oral health care products that contain sodium lauryl sulfate include