Chapter 33

Insoluble Metallic Soaps

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Bossert (1950) lists twenty-eight metallic ions from eight periodic groups as forming the chief metallic soaps from nine fatty acids.

From the cosmetic viewpoint, only the soaps of Al, Ca, Li, Mg and Zn derived from the C_{14}-C_{22} saturated aliphatic fatty acids are of any commercial importance. The C_8, C_{10}, C_{11}, oleic, ricinoleic, montanic and hydroxystearic acid soaps have specialty and limited application. Their commercial production and use are discussed elsewhere. (Elliot 1946)

Methods of Manufacture

Two processes are used in making metallic soaps. The procedure most used in making solid metallic soap is the well-known double decomposition and precipitation technique. A soluble soap is treated with a solution of the desired metal salt. The resulting precipitate is washed, dried and powdered.

In the second process, usually reserved for use with liquid fatty acids, the metal (cation) oxide, hydroxide or carbonate is directly saponified by the fatty acid in question. (Davis 1960) Some higher-melting metallic soaps such as zinc stearate may also be made this way. It is said that products made by this process are darker in color, have more odor, have higher free fatty acid content and contain unreacted metal oxide or other starting compound.

The most important insoluble metallic soaps appear to be the metallic stearates. Their properties vary considerably as does their chemical analysis (see Table 1).

Table 1. Principal Metal Soaps

Metal	Fatty Acid	Metal Soap
Ti	Behenic	Behenate
Al	Lauric	Laurate
Zn	Linoleic	Linoleate
Ca	Myristic	Myristate
Hg	Naphthenic	Naphthenate
Li	Oleic	Oleate
Mg	Palmitic	Palmitate
Sr	Stearic	Stearate
Ag	Rosin	Abietate
Bi	Ricinoleic	Ricinoleate
Ce	Tall oil	Tallate

Stumpf (1953) has determined the effect of free fatty acids on the melting point of the metal soap. These data are found in Table 2.

Table 2. Influence of Percentage Free Fatty Acid on the Melting Points of Metallic Stearates

Metallic Salt of 98%	% Free Fatty Acid	Softening Point, °C	Melting Point, °C
Aluminum	9.32	131-140	146-149
di-Aluminum	6.02	142-150	156-159
Aluminum	12.30	120-131	136-140
Tri-Aluminum	27.80	101-104	106-110
Calcium	0.41	140-145	155-160
Lithium	0.20	195-199	210-218
Magnesium	0.25	130-135	142-148
Zinc	0.10	113-117	123-130
Zirconium	0.34	69-75	86-97

Effect of Fatty Acid Grade

The process used determines quality, as do the type and grade of fatty acid used. Stumpf also studied the effect of single-, double- and triple-pressed stearic acids as starting materials in the preparation of metallic stearates by the precipitation process. Table 3 shows the variation in these properties. Today, when it is possible to get commercial fatty

Table 3. Influence of Pressing Stearic Acids Upon the Melting Points of Metallic Stearates

Metallic Salt of Single Pressed Stearic Acid *	% Free Fatty Acid	Softening Point, °C	Melting Point, °C
Aluminum	5.06	134-139	147-150
di-Aluminum	10.10	121-128	132-137
Calcium	0.71	128-135	141-148
Lithium	0.35	181-188	190-194
	4.79	171-176	181-185
Magnesium	0.48	121-124	127-130
	5.76	118-120	122-125
Zinc	0.56	100-107	110-116
	5.88	92-97	102-109

Metallic Salt of Double-Pressed Stearic Acid

Metallic Salt of Single Pressed Stearic Acid *	% Free Fatty Acid	Softening Point, °C	Melting Point, °C
Aluminum	6.10	141-143	149-151
di-Aluminum	9.38	129-132	136-140
Calcium	0.47	134-140	146-153
	6.10	120-123	131-138
Lithium	0.34	190-192	195-198
	5.71	173-178	186-190
Magnesium	0.28	125-127	131-136
	5.43	119-121	125-128
Zinc	0.15	105-109	115-119
	5.18	94-99	104-109

Metallic Salt of Triple-Pressed Stearic Acid

Metallic Salt of Single Pressed Stearic Acid *	% Free Fatty Acid	Softening Point, °C	Melting Point, °C
Aluminum	5.81	144-147	152-153
di-Aluminum	10.73	133-135	141-144
Calcium	0.34	137-141	148-154
	6.10	121-123	1332-139
Lithium	0.36	191-194	200-207
	6.34	174-178	187-193
Magnesium	0.42	126-129	134-140
	5.71	120-121	131-140
Zinc	0.32	107-110	117-120
	4.93	97-101	106-110

*The stearic acids used had the following melting points:
Single press 53.3°C
Double press 54.3°C
Triple press 55.3°C