CHAPTER 7

CAPRIC ACID AND SOME CAPRATES

SECTION 1

CAPRIC ACID

§ 1. COMPOSITION

426. When capric acid was analyzed in the form of dry lead caprate, this gave:

	BY WEIGHT	BY VOLUME
Oxygen…………………………..	16.25	1.00
Carbon……………………………	74.00	5.95
Hydrogen………………………...	9.75	9.63

427. Assuming that 100 parts of acid neutralize an amount of base that contains one third of the amount of oxygen, and that the 'dry' acid consists of (by volume):

Oxygen…………………………………………………..	1.00
Carbon…………………………………..………………	6.00
Hydrogen………………………………………………..	9.63

the acid itself will be composed of:

	ATOMS[1]	BY WEIGHT	
Oxygen………………………	3	300.00	16.142
Carbon……………………..	18	1377.54	74.121
Hydrogen……………………	29	180.96	9.737
TOTAL………………………		1858.50	100.000

According to this hypothesis, 100 parts of acid should neutralize 5.38 parts of oxygen in the bases. However, instead of this amount, I found an amount of 5.89 parts for barium caprate; when multiplied by 3, this gives 17.67, which is quite different from the ratio of the elements in the acid as determined by experiment. I would have liked to repeat my analysis but this was impossible because I had only 2 grams of capric acid at my disposal for all the experiments I carried out on it.

Composition of free capric acid with a density of 0.9103 (g/mL)

428. When an amount of 550 mg of free capric acid was mixed with 5 g of lead oxide, they reacted rapidly and heat was evolved. Heating the reaction mixture caused an amount of 38 mg of water to evaporate. This water was neither odoriferous nor acid; therefore:

Capric acid anhydride.	0.512[2]	100
Water……………………..	0.038	7.4, containing 6.596 oxygen

This is the composition of the acid whose properties I went on to examine. If I had submitted it to the same treatments as the free isovaleric, butyric and caproic acids, there is no doubt that I would have obtained a hydrate in which the oxygen content of the water would have been a third of that in the 'dry' acid[3].

§ 2. PHYSICAL PROPERTIES

429. When free capric acid was sealed in a small, stoppered flask which it filled completely at a temperature of 23°C, it remained liquid at 11.5°C. But after the flask had been opened and the acid had been stirred, it solidified immediately into small needles that are totally colorless. At 16.5°C they were still solid but at 18°C they were completely liquefied[4].

430. At a temperature of 18°C, the free capric acid had a density of 0.9103 (g/mL) since a flask that can contain 647 mg of water contained 589 mg of capric acid.

431. Capric acid smells like caproic acid with a slight odor of billy goat. It has an acid, burning taste with a light goaty flavor. It is this last property that distinguishes its flavor from that of caproic acid.

§ 3. CHEMICAL PROPERTIES

432. It is very poorly soluble in water at a temperature of 20°C. 10 g of this liquid dissolved only 1 mg of the free acid. A further 5 mg were added but the dissolution was still not complete after a month. It thus follows that 100 parts of water cannot completely dissolve 0.15 parts of capric acid.

433. It is completely miscible with alcohol.

§ 4. PREPARATION

434. (See Book III, Chapter 1.)

§ 5. NOMENCLATURE

435. *Capric* comes from *capra* or “goat”.

§ 6. OCCURRENCE

436. It is present in soap made from cow’s milk butter.

§ 7. HISTORY

437. I discovered it in 1818.

SECTION 2

CAPRATES

ARTICLE 1

BARIUM CAPRATE

Preparation

438. It is prepared by neutralizing an aqueous solution of barium hydroxide with capric acid.

Composition

439. When 100 parts of crystalline barium caprate were exposed to a dry vacuum for 96 hours, they lost 2.2 parts but the crystals kept their luster. When the salt was then pulverized and exposed to a dry vacuum for 96 hours, there was no further weight loss.

440. When 100 mg of dry barium caprate was heated in a platinum crucible, it softened and at the same time released a fatty and empyreumatic odor mixed with that of billy goat. Soon after the salt had melted, it discolored and released an aromatic smell of basil oil. The basic carbonate left behind yielded 55 mg of sulfate, corresponding to 36.08 mg of barium oxide; thus:

Capric acid anhydride..	63.92^{5}	100
Barium oxide…………	36.08	56.45, containing 5.89 oxygen

441. When barium caprate is crystallized rapidly by cooling a previously concentrated solution, it forms thin, shiny flakes that are very light and have a greasy appearance.

442. Barium caprate that has crystallized slowly by spontaneous evaporation is in the form of globules the size of a hempseed. By examining these crystals under a magnifying glass, it is possible to observe the facets, some of which look triangular whereas others look like a square or parallelogram; from certain angles, they reflect light very strongly, unlike the crystal itself, which is rather dull.

Odor and taste

443. Its aroma is not at all like that of butyric acid but is reminiscent of caproic acid with a touch of billy goat; it becomes most noticeable when the salt is pressed between the fingers and is lightly moistened.

444. It has a faint taste that is slightly alkaline, bitter and reminiscent of barium salts, and the specific taste of the acid it contains.

Density

445. It has a higher density than water. When barium caprate is added to water, if any remains on the surface of the liquid, this is caused by a layer of air attached to the salt.

446. A saturated aqueous solution of barium sulfate at 20°C consists of:

Water	100
Salt	0.5

447. This solution is alkaline; carbon dioxide causes it to deposit a trace of basic barium carbonate.

Spontaneous decomposition of barium caprate dissolved in water

448. When a diluted solution of caprate is kept in a stoppered flask that is filled to about one sixth of its capacity, it gradually decomposes. Basic barium carbonate colored yellow by an organic material is deposited together with light, white flakes. At the same time, it gives off an aroma identical to that of Roquefort cheese. This smell dissipates when the solution of altered caprate is boiled. Under the same circumstances, barium isovalerate gives the same results.

Effect of heating

449. When 300 mg of dry barium caprate are distilled in a tube that is filled with mercury, this gives:

(a) *A residue* of barium carbonate mixed with 2 mg of carbon;

(b) *A reddish yellow liquid* that has a strong odor of basil oil mixed with an empyreumatic odor. It solidifies partially; it is neutral to litmus and with time, the aroma of basil oil wears off;

(c) *A gaseous product* consisting of 0.4 mL of carbon dioxide and 20 mL of olefiant gas[6].

ARTICLE 2

STRONTIUM CAPRATE

Preparation

450. It is prepared by neutralizing of an aqueous solution of strontium hydroxide with capric acid and leaving the solution exposed to air.

451. When 100 mg of strontium caprate were heated in a crucible, they melted, darkened and liberated an odor that is slightly aromatic and mixed with the odor of an empyreumatic oil. The residue yielded 49 mg of strontium sulfate[7], which corresponds to 27.62 mg of base; thus:

Acid anhydride	72.38	100
Strontium oxide	27.62	38, containing 5.77 oxygen

Effect of water

452. At a temperature of 18°C, 100 parts of water dissolved 0.5 parts of strontium caprate.

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[1] The molecular formula of capric acid is $CH_3(CH_2)_8COOH$, so the 'dry' acid will be $(C_9H_{19}CO)_2O$ or $C_{20}H_{38}O_3$ rather than the $C_{18}H_{29}O_3$ listed in the table. The hydrogen content has been vastly underestimated and the carbon content is also on the low side.

[2] This amount of water can be used to calculate the relative molecular mass of the capric acid anhydride according to: 18 x 512 : 38 = 242.5 as opposed to the theoretical value of 326.

[3] Given the relative molecular mass of capric acid of 172, an amount of 550 mg of capric acid should have yielded (550 : 172) x (18 : 2) = 28.78 rather than 38 mg of water.

[4] According to *The Lipid Handbook*, 2nd edition, 1994, the melting point of capric acid is 31.6°C which is quite a bit higher than the < 18°C reported by the author. In the table below various properties of caprylic acid (C8:0) and capric acid (C10:0) as listed in (H.A. Boekenoogen, *De Scheikunde der Oliën en Vetten,* 1948) are compared with the values given by the author for capric acid.

Property	Caprylic acid	Capric acid	This chapter
Melting point (°C)	16.5	31.6	< 18
Density	0.9105	0.8858	0.9103
Solubility in water (g/100 mL)	0.1	0.015	> 0.1
Solubility in alcohol	miscible	good	miscible

Given the values above and taking the anomalies mentioned in the above endnotes into account (underestimation of carbon content; more water being formed with lead oxide than corresponds to theory), this raises the question of whether the acid studied by the author actually was what is now called capric acid, or in fact what is now called caprylic acid. Since the answer to this question is speculative and not to confuse matters even further, "l'acid caprique" will continue to be translated as "capric acid"; there will be no name shift and it will not be translated as caprylic acid, as 'acid margarique' was translated with 'palmitic acid'. See also A.J. Dijkstra, Which goat is which? *Inform*, volume 19, issue 4, pages 207-208.

[5] This allows the relative molecular mass of the capric acid anhydride to be calculated according to: (63.92 : 36.08) x (137.3 + 16) = 271.6 as opposed to the theoretical value of 326. This provides further support for the likelihood that what the author called 'capric' acid' is what we call today 'caprylic acid'.

[6] Olefiant gas (ethylene) was prepared in 1794 by J.R. Deiman, A. Paets van Troostwyk, N. Bondt and A. Lauwerenburgh. They also added chlorine to this compound and produced what became known as the "oil of the Dutch chemists" (ethylene dichloride, $C_2H_4Cl_2$). Because the raw material for this oil was a gas, it was called 'oil-making' (olefiant) gas.

[7] The data on strontium oxide also allow the relative molecular mass of the caprate moiety to be calculated according to: (72.38 : 27.62) x (87.6 + 16) = 271.5. This figure, which is close to the one arrived at in the previous endnote, again supports the possibility that the author actually studied caprylic acid, the anhydride of which has a relative molecular mass of 270.