

BOOK IV

COMPARATIVE STUDY OF VARIOUS KINDS OF FATS AND OF FAT FROM CADAVERS

CHAPTER 1

§ 1. VARIOUS PROPERTIES THAT CAN BE DISTINGUISHED IN FATS WITHOUT DECOMPOSING THEM

725. The fat extracted from the kidneys of a man who had been tortured to death was colored yellow; it had no odor. At 40°C, it was perfectly fluid and remained so until 25°C, when it began to become cloudy. At 23°C it was semi-opaque and at 17°C it had set into a solid mass in which a white solid and a yellow liquid could be distinguished.

Human fat

726. Fat that was extracted from the thighs of a man who had died from an acute illness had a similar color and was also odorless. At 15°C it was perfectly fluid. After having been kept at that temperature for several days in a closed flask, a solid precipitate could be observed but after a fortnight, it still had not set into one solid mass. A yellow oil floated on the part that had solidified.

727. After examining these two fats, it is clear that the fluidity of human fat can vary¹. These variations stem from the different proportions of stearin and olein, since the solid part of the fat is a combination of olein with an excess of stearin and the fluid part is a combination of stearin with an excess of olein.

728. It is white and it has only a faint odor when solid. When brought into contact with boiling water, it gives off a very unpleasant, sickly smell.

Lard

729. When melted at 50°C and a thermometer is inserted, it can be seen that the mercury drops to 25.93°C where it remains for a time as the fat congeals. If the fat is agitated with the thermometer before it has completely solidified, the mercury rises² to 27°C.

* When a solution of lard in ether is distilled, the odorous principle distils with the ether.

730. There are samples in which the thermometer reading goes down to 29°C and then rises to 31°C.

Jaguar fat

731. The sample I investigated came from an animal that had died after a long illness. It had an orangey yellow color and a peculiar, very unpleasant smell.

732. The thermometer that I inserted in the fat after having melted it at 40°C went down to 29°C and then rose to 29.5°C when the fat solidified. But I must point out that there remained a certain amount of fat that did not congeal.

Goose fat

733. It had a very slight yellow color and an agreeable smell. It seemed to me to solidify at 27°C.

Mutton tallow

734. It is white and sometimes has a bluish or greenish tinge. When fresh, it has hardly any smell; it is only after contact with the air that it acquires a slight candle-like odor.

735. If mutton tallow samples originating from different animals are melted separately, in some of them the temperature reading drops to 37°C and then rises to 39°C, while in others it drops to 40°C and rises to 41°C.

Beef tallow

736. The sample I examined was pale yellow and had a very slight odor. When a thermometer was immersed, the reading dropped to 37°C and then rose to 39°C.

737. 100 parts of boiling alcohol with a density of 0.821 (g/mL) dissolved:

Human fat.....	2.48
Jaguar fat.....	2.18
Mutton tallow.....	2.26
Beef tallow.....	2.52

738. 100 parts of boiling alcohol with a density of 0.816³ (g/mL) dissolved:

Lard.....	2.80
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739. None of the fats discussed so far was shown to be acid, either when spread on litmus paper or when an alcoholic solution was mixed with an aqueous extract of this coloring principle (litmus).

§ 2. CHANGES IN THE NATURE OF THE FATS
WHEN THEY REACT WITH POTASSIUM HYDROXIDE

740. 100 parts of each kind of fat were saponified by potash that had been causticized with lime⁴. The soap was acidulated with tartaric acid which split it into *constituent fatty acids*⁵ and an aqueous liquid containing potassium bitartrate⁶, glycerin and in some cases an *odorous principle*. The aqueous liquid was added to the water with which the acidified fat was washed and this mixture was distilled. The distillate was neutralized with baryta water when it was found to be acid and the resulting salt was dried and weighed. Glycerin was separated from the distillation residue by means of concentrated alcohol. After evaporating the latter, the glycerin became syrupy and it was then weighed. The potassium tartrate that had been dissolved by the alcohol was taken into account*.

A COMPARISON OF THE WEIGHTS OF THE SAPONIFICATION
PRODUCTS WITH THOSE OF THE NATURAL PRODUCTS

741. Saponification of 100 parts of four types of fat yielded⁷ the following:

	Fat source			
	Human	Lard	Mutton	Beef
	---	---	---	---
Constituent fatty acids ⁸ ...	95.24	95.00	96.54	96.00
Glycerin.....	10.00	8.40	8.00	8.60
Barium salts.....	trace	trace	0.30	trace

742. We concluded that the saponified fats were converted entirely into acids since no non-acid material was extracted after we had allowed them to react with baryta water and the salts formed had been treated with alcohol. As one would expect, the saponified fats turned litmus strongly red.

743. They had a higher melting point⁹ than the fats from which they had been derived because the constituent fatty acids were largely congealed at 35°C. When a thermometer was immersed in the constituent fatty acids from lard, its reading dropped to 39°C, then rose to 40.5°C. In the case of mutton tallow, it dropped to 48°C and then rose to 50°C. In the case of beef tallow it stayed at 48°C and in that of jaguar fat at 36°C.

* In Book IV, Chapter 2, Section 1, § 2, a more accurate method to determine the weight of the glycerin will be given.

744. The constituent fatty acids had a greater tendency to crystallize as needles than the natural fats.

745. They were miscible in all proportions with boiling alcohol with a density of 0.821¹⁰ (g/mL). Up to a point, this solvent could be used to fractionate them into *stearic* and *palmitic acid* on the one hand and *oleic acid* on the other. The experiment I carried out with the constituent fatty acids of lard was as follows: 1 part of these acids was dissolved in its own weight of boiling alcohol. On cooling, the material became a solid mass that was repeatedly macerated in cold alcohol¹¹. This yielded a first alcoholic liquor containing a combination of fatty acids in solution with a melting point of 25°C; a second alcoholic liquor with fatty acids melting at 27°C and finally a third alcoholic liquor with fatty acids melting at 32°C. The residue that did not dissolve in the alcohol was white, pearly and glossy and had a melting point of 51.5°C. No further experiments were carried out to find out if it was possible to isolate stearic and palmitic acid from the oleic acid.

746. The constituent fatty acids of lard, mutton and beef tallow had more or less the same solubility in aqueous potash and soda ash in that 100 parts of constituent fatty acids dissolved in:

	Lard	Mutton	Beef
Potassium oxide ¹²	15.40	15.41	15.42
Sodium oxide.....	10.29	10.27	10.24

747. The glycerins were slightly colored. They had an agreeable smell with the exception of the glycerin derived from jaguar fat.

748. The aqueous liquid originating from the acidulation of a soap made from human kidney fat (725) and that originating from a soap prepared from the fat from a woman's breast gave off a pronounced aroma of butter but I have every reason to think that this aroma stems from the acid that is produced when nitrogenous tissue putrefies and not from butyric acid. None of the other human fats contained this odoriferous principle; the fat I described in sub-section (726) contained none at all, nor did the fat of a woman's breast, the elementary composition of which I determined in Book VI, Chapter 2.

749. The aqueous liquid from the soap made from mutton tallow contained hircic¹³ acid.

750. Although only a very small amount of acid is collected when distilling the aqueous liquid from beef tallow soap, it is nevertheless slightly acid and has the same odor as that exhaled by steers that are hot after a long race.

751. The odoriferous principle is much more pronounced in saponified jaguar fat than in the unsaponified fat. This odor, which I cannot define, reminded me of the smell that sometimes hangs over a menagerie of wild animals.

752. I would have liked to investigate the odoriferous principles in the soap made from beef tallow and jaguar fat and compare them with the odoriferous acids described in Book II. Unfortunately, I obtained such small amounts that it was impossible to study them.

§ 3. COMPARATIVE STUDY OF THE SOLID FATTY ACIDS OF VARIOUS KINDS OF FATS

753. The constituent fatty acids of human fat, lard, jaguar and goose fat and beef and mutton tallow were allowed to react with caustic potash and the resulting soaps were split into a *pearly material* and *oleates**.

ARTICLE 1

THE PEARLY MATERIAL AND ITS ACIDS

754. The pearly materials were purified by the following procedure: while on the filter, they were washed three times with water, left to drain and then mixed with over fifteen times their weight of boiling water. After cooling, the liquid was filtered and water was poured onto the filter three times. Finally, the pearly materials were left to dry in the air and then treated with boiling alcohol. The resulting solutions were filtered. After cooling¹⁴, alcohol was poured over the filter and the pearly materials left on the filter were pressed and allowed to dry in the sun. Finally, they were analyzed with hydrochloric acid¹⁵.

	Pearly material					
	Human fat	Lard	Jaguar fat	Goose fat	Mutton tallow	Beef tallow
Acid ¹⁶	100	100	100	100	100	100
Potassium oxide ¹⁷ ...	8.83	8.8	8.6	8.78	8.68	8.78

* When the soap made from jaguar fat was diluted with water, it deposited a very shiny, pearly material that consisted of a combination of palmitic and oleic acid melting at 42.5°C and a small amount of calcium oxide bound to these soaps. When treated with alcohol, the combination of acids in the pearly material dissolved, leaving the calcium salts behind. After neutralization by caustic potash, these acids yielded a soap that was split by water into potassium hydroxide and pearly potassium bpalmitate. I had too little jaguar fat to investigate why the soap of this fat gave a deposit of *free acids* and not potassium bpalmitate after dilution with water.

755. I boiled equal amounts of water and each of these pearly materials to find out if they would behave the same way; none of them dissolved. The only differences I have noticed are in the degree of semi-transparency of the liquids and later, some oily-looking globules that appeared on the surface of the water in which the pearly material from mutton tallow had been boiled. The pearly material from beef tallow is less opaque than that from mutton tallow and the latter less so than the pearly material from lard.

756. Boiling alcohol with a density of 0.832¹⁸ (g/mL) dissolved the pearly material in all proportions since 20 g of alcohol dissolved 50 g of pearly material at 60°C, and when the alcohol was concentrated until the ratio of alcohol to pearly material was 1 : 6, there was still no precipitate.

757. Let us now compare the acids from the various pearly materials. They were all shiny white, tasteless, almost odorless, insoluble in water and miscible with boiling alcohol in all proportions. When combined with potassium to saturation, they were soluble in boiling water and on cooling, they split into potassium hydroxide and pearly material. The differences they presented were in their melting point, in the arrangement and size of the flakes formed when the acid was allowed to cool on the surface of the water. These differences can be assessed by means of the following descriptions.

Acid from the
pearly material
of human fat

758. I obtained these acids in the form of:

1. Very fine, elongated needles, arranged in flat stars and melting at 55 to 56°C.

2. Very fine, very short needles that form wavy patterns similar to those of crystals of palmitic acid derived from human adipocere¹⁹.

3. Flat, shiny crystals, intertwined or arranged in a star-shaped configuration like the crystals of the pearly material from lard; they melted at 56.5 to 56.8°C.

Acid from the
pearly material
of lard

759. Flat, shiny crystals, intertwined or arranged in a star-shaped and melting at 56.5°C are almost always obtained.

Acid from the
pearly material
of goose fat

760. Similar in appearance to the previous one; melting point 55°C.

Acid from the
pearly material
of jaguar fat

761. Small radiating needles, melting at 55.5°C.

Acid from the
pearly material
of mutton tallow

762. Fine radiating needles, melting at 63°C.

763. Small radiating needles that are quite similar to the previous ones, though the groups of needles are rather more marked; they melt at 60°C.

Acid from the
pearly material
of beef tallow

764. When subjecting the acid part of the pearly material of human fat, lard, beef and mutton tallow to further treatments as described in Book III, Chapter 1, Section 3, § 1, I observed:

1. That *the pearly material from human fat* consisted of palmitic acid melting at 60°C, palmitic acid melting at 56°C and oleic acid. The latter was present in only a very small amount.

2. That *the pearly material from lard* consisted of stearic acid melting at 70°C, palmitic acid and a small amount of oleic acid.

3. That *the pearly material from beef tallow* had the same composition except that it contained more stearic acid with melting point 70°C than palmitic acid, and less oleic acid.

4. That *the pearly material from mutton tallow* differed from the previous one in that it had a higher content of stearic acid melting at 70°C and it contained less oleic acid than palmitic acid.

ARTICLE 2

OLEIC ACID

765. All the samples of oleic acid I have investigated had the same properties²⁰, except for their odor; when an odoriferous principle is formed during the saponification of a fat, some traces will almost always remain in the oleic acid prepared from that fat.

766. I examined barium oleate, strontium oleate and basic lead oleate prepared with oleic acid made from human fat, lard, goose fat and mutton and beef tallow and I found near enough the same properties and the same proportions of base to acid for each species of oleate, regardless of the origin of the acid used to prepare it.

§ 4. COMPARATIVE STUDY OF THE STEARIN AND THE OLEIN OF VARIOUS FATS

ARTICLE 1

STEARINS

767. They were all beautifully white, odorless or almost so, tasteless and had no effect on litmus.

- Human fat stearin 768. When a thermometer was inserted into the molten fat, the temperature was shown to drop to 41°C and then to rise to 49°C. On cooling, the stearin crystallized in very fine needles with a flat surface. This stearin has been described in Book II, Chapter 13.
- Lard stearin 769. It gave off a slight odor of lard when molten. The reading of a thermometer dropped to 38°C and then rose to 43°C. On cooling, it set into a mass with a very uneven surface that seemed to consist of small needles. On shock cooling, the parts that touched the wall of the vessel had the semi-transparency of the white of a boiled egg.
- Goose fat stearin 770. The thermometer reading went down to 40°C and then rose to 43°C. It set as a flat mass.
- Mutton tallow stearin 771. The thermometer reading went down to 40°C and then rose to 44°C. It set as a flat mass the center of which, having cooled down more slowly than the outside, revealed small, fine needles arranged in star-shaped configurations. This stearin has been described in Book II, Chapter 12.
- Beef tallow stearin 772. The thermometer reading went down to 39.5°C and rose to 44°C. It set as a mass with a flat surface sprinkled with microscopic stars. It had a slight semi-transparency.
- Solubility in alcohol 773. 100 parts alcohol with a density of 0.795²¹ (g/mL) dissolved:
- | | | | |
|--------------|---|----------------------------------|-------|
| Stearin from | { | Human fat..... | 21.50 |
| | | Lard..... | 18.25 |
| | | Goose fat..... | 36.00 |
| | | Mutton tallow [†] | 16.07 |
| | | Beef tallow..... | 15.48 |

SAPONIFICATION BY POTASSIUM HYDROXIDE

774. When 100 parts *human fat stearin* were saponified, they yielded:

Glycerin.....	8.6 ²²
Constituent fatty acids ²³	94.9

The free fatty acids had a melting point of 51°C and crystallized in small needles which together formed a crater.

775. 100 parts of *lard stearin* gave:

* In another experiment, a value of 17.65 was found

† In another experiment, a value of 15.04 was found.

Glycerin.....	9.00
Constituent fatty acids.....	94.65

The fatty acids started to solidify at 54°C but the thermometer reading remained constant at 52°C. They crystallized in small needles that clumped together in flattened globules.

776. 100 parts of *goose fat stearin* gave:

Glycerin.....	8.20
Constituent fatty acids.....	94.40

The fatty acids solidified at 48.5°C and crystallized into needles forming a crater.

777. 100 parts of *mutton tallow stearin* gave:

Glycerin.....	8.0
Constituent fatty acids.....	94.6

The fatty acids started to get cloudy at 54°C and the thermometer reading remained constant at 53°C. They crystallized into fine, radiating needles.

The aqueous liquid yielded a little hircic acid and less than 0.3 parts of barium hirciate.

778. 100 parts of *beef tallow stearin* gave:

Glycerin.....	9.8
Constituent fatty acids.....	95.1

The free fatty acids started to congeal at 54°C but solidification was not complete until 52°C. They crystallized into small needles that were clumped together in flattened globules.

779. All the stearin-derived soaps were analyzed by the same methods as the soaps derived from the fats from which they were prepared. From each of these fats, a pearly material and an oleate were extracted, whereby the former was always more abundant than the latter.

780. The constituent fatty acids in the pearly material prepared from lard stearin and goose fat stearin had almost the same melting points as those in the pearly material prepared from lard and goose fat soaps.

781. The constituent fatty acids in the pearly material prepared from mutton tallow stearin had a melting point of 62.5°C, whereas those prepared from another stearin melted only at 64.8°C.

782. Finally, the constituent fatty acids in the pearly material derived from beef tallow stearin had a melting point of 62°C.

ARTICLE 2

OLEINS

783. All the oleins were liquid at 15°C. When kept for a month in a stoppered bottle, they did not precipitate or become acid.

ODOR, COLOR AND DENSITY OF THE OLEINS

Human fat olein	784. Colorless, odorless; density 0.913 (g/mL).
Lard olein	785. Colorless, almost odorless; density 0.915 (g/mL).
Jaguar fat olein	786. Citrine-colored, odorous; density 0.914 (g/mL).
Goose fat olein	787. Slight citrine color, almost odorless; density 0.929 (g/mL).
Mutton tallow olein	788. Colorless, slight smell of sheep; density 0.916 (g/mL).
Beef tallow olein	789. Colorless, almost odorless; y 0.913 (g/mL).

SOLUBILITY IN ALCOHOL WITH A DENSITY OF 0.795 (g/mL)

Human fat olein	790. 11.1 g were dissolved by 9 g of boiling alcohol. The solution started to get cloudy at 77°C.
Lard olein	791. 11.1 g were dissolved at 75°C in 9 g alcohol; the liquid got cloudy at 62°C.
Jaguar fat olein	792. 3.35 g was dissolved at 75°C in 2.71 ²⁴ g alcohol; the liquor got cloudy at 60°C.
Goose fat olein	793. 11.1 g were dissolved at 75°C in 9 g alcohol. The solution only started to get cloudy at 51°C.
Mutton tallow olein	794. 3.76 g were dissolved at 75°C in 3.05 g alcohol. The solution got cloudy at 63°C.

795. 5.8 g were dissolved at 75°C by 4.7²⁵ g alcohol. The solution got cloudy at 63°C.

Beef tallow
olein

796. The oleins prepared from lard, jaguar fat, goose fat and mutton tallow were extracted with alcohol and then saponified by caustic potash. 100 parts of these oleins yielded 89²⁶ parts of constituent fatty acids.

Saponification
by caustic
potash

797. 100 parts of beef tallow olein that had been extracted with alcohol yielded 92.6 parts of constituent fatty acids.

798. The amounts of glycerin have not been determined sufficiently accurately for me to report their weights but these amounts were relatively large in comparison with those obtained from the stearins²⁷ that had been extracted with alcohol.

799. Since the same stearins yielded less free fatty acids than their respective fats and the oleins yielded even less, this led me to conclude that the stearins and the oleins could have been slightly altered by the action of air and heat during their preparation. Accordingly, I prepared oleins from human fat and lard without using alcoholic solutions but by simply filtering these fats, only part of which was fluid.

800. 100 parts of human fat olein that was perfectly fluid at 0°C and that was only partially solidified at - 4°C gave:

Glycerin.....	9.8
Constituent fatty acids melting at 34 to 35°C.....	95

801. 100 parts of lard olein that was perfectly fluid at 20°C gave²⁸:

Glycerin.....	9
Constituent fatty acids.....	94

§ 5. CONCLUSIONS DRAWN FROM THE FACTS REPORTED IN THE PREVIOUS FOUR PARAGRAPHS

802. When fats are examined in their natural state, they can be distinguished from each other by color, odor and melting temperature.

803. The cause of their color is obviously a principle that has nothing to do with their intrinsic nature, since they can be obtained perfectly colorless.

804. Concerning their odor, this seems to reside in substances that are analogous to those we call *butyrin*, *phocenin*²⁹, and *hircin* but the fats discussed in this chapter only contain these substances in excessively small proportions.

805. The fractionation of the fats into stearin and olein explains how they differ in fluidity. But should stearins and oleins originating from different fats be regarded as two genera that comprise various species, or rather as two species, each of which is exactly the same as a stearin or an olein extracted from any of the fats I have investigated³⁰?

806. If the stearins and oleins are identical, they must behave identically when investigated under the same conditions in all conceivable aspects. Accordingly, they should present the same appearance, the same solubility in alcohol, and the same decomposition by caustic potash. Therefore, the fatty acids and the glycerin they yield should be the same and in the same proportion³¹.

807. Having got this far, the question looks easy to answer: all we have to do is establish whether the stearin and the olein display identical behavior. Well, stearin samples with the same melting point do show differences. For instance, the stearins made from human fat, mutton and beef tallow and goose fat solidify into a mass with a flat surface whereas lard stearin solidifies into a mass with an irregular surface. Stearins from mutton and beef tallow and from goose fat have the same solubility in alcohol; human fat stearin is slightly more soluble and goose fat stearin is twice as soluble. The oleins from human fat, mutton and beef tallow, jaguar fat and lard all have a density of around 0.915 (g/mL) but that of goose fat is 0.929 (g/mL). The oleins from mutton and beef tallow and from lard have the same solubility in alcohol but goose fat olein is slightly more soluble. If the differences outlined above were the only ones observed, they would not be sufficient reason to regard stearins and oleins showing these differences as different species for the simple reason that if a certain stearin or olein differs from another with respect to one property which makes it more akin to a third stearin or olein, it will be found to differ from this third one with respect to another property that makes it more akin to the second one. A number of different properties are therefore not found together in one and the same stearin or olein, which could have set it apart from the other. But does it follow that we can disregard the differences they show and reach a firm conclusion as to the identity of these bodies? No, because when the saponification products of the stearins from mutton tallow and human fat are compared, it becomes evident that: 1. the mutton tallow stearin yielded *fatty acids melting at 53 to 54°C*, whereas the latter yielded *fatty acids melting at 51°C*, despite the fact that the first stearin melted at 44°C and the second at 49°C. Now, according to the hypothesis that the

stearins are identical, the human fat stearin, which melts at 49°C, should contain less olein than the mutton tallow stearin melting at 43°C³². Consequently, the mutton tallow stearin, instead of yielding fatty acids with a higher melting point than those originating from human fat stearin with a melting point of 49°C, should have yielded fatty acids with a lower melting point because on saponification, olein produces more oleic acid than stearic or palmitic acid, while the opposite is true of stearin; 2. *the pearly material prepared from mutton tallow stearin* contains a large amount of stearic acid whereas *the pearly material prepared from human fat stearin* contains none; it consists only of palmitic acid and oleic acid. Given these two arguments, the two stearins cannot be regarded as a single species. This conclusion will be even clearer after I have set out in detail the way in which the species of the immediate principles are defined (Book VI, Section 3).

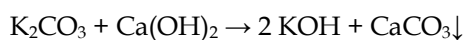
808. If human fat stearin and mutton tallow stearin really are two different species, it is highly likely that fats that contain both stearic acid and palmitic acid, contain the two species of stearin and that mutton tallow stearin also contains human fat stearin because it yields palmitic acid together with stearic acid.

¹ Human fat is strongly affected by diet. Accordingly, its properties will vary between different people, an observation the author reports himself.

² The experiment described here is a rudimentary form of the Jensen cooling curve and the Shukoff method (IUPAC standard method 2.132; IOCCC method 31-1998) used to study the crystallization behavior of confectionery fats.

³ The densities of 0.821 and 0.816 (g/mL) correspond to 90.7 and 92.5 % by weight or 93.7 and 95.0 % by volume respectively.

⁴ Before potassium hydroxide was manufactured by the electrolysis of its chloride, it was produced by causticization: by reacting its carbonate (potash) with slaked lime according to:



⁵ The original refers to *acidified fats* ('graisse acidifié') but the term *constituent fatty acids* is considered to be more precise; it will therefore be used from now onwards.

⁶ When using an excess of tartaric acid, the resulting potassium salt is potassium hydrogen tartrate, acid potassium tartrate or $\text{KHC}_4\text{H}_4\text{O}_6$. Since it is not unlikely that the author obtained his tartaric acid from argol (cream of tartar) the acid used was probably *d*-tartaric acid, the acid potassium salt of which is only poorly soluble in water.

⁷ This is the first time it has been demonstrated experimentally that splitting fats into free fatty acids and glycerin causes the weight to increase. For the fats used, this increase amounts to some 6 % so that 100 parts of fat should give 96 parts of constituent fatty acids and 10 parts of glycerin. The extraction of the evaporation residue with alcohol apparently failed to recover all the glycerin since several fats yielded less than 9 parts.

⁸ The French is 'Graisse acide hydratée', which sounds different from the 'graisse acidifié' for which (*cf.* endnote 5, above) the term *constituent fatty acids* has been introduced. However, since both French terms mean the same, they will both be translated by *constituent fatty acids*.

⁹ This melting point is called the "titer" and the author introduced its use for the characterization of animal fats. It has been incorporated in the *Official Methods and Recommended Practices of the American Oil Chemists' Society* Cc 12 (1997), IUPAC method 2.121, ISO 935 (1988) and other national methods.

¹⁰ A density of 0.821 (g/mL) corresponds to 90.7 % by weight or 93.7 % by volume.

¹¹ The purification procedure comprises a recrystallization step followed by a washing step of the filter cake. Because of its low melting point, oleic acid does not precipitate on cooling whereas the saturated fatty acids do, at least partially. Consequently, the first alcoholic liquor that was isolated probably contained most of the oleic acid and its content of saturated fatty acids reflected their solubility. The second alcoholic liquor contained less oleic acid but had the same saturated fatty acid content; hence its higher melting point. The same holds for the third alcoholic liquor and whether the residue still contains oleic acid is not clear since no mention is made of the amount of alcohol used to wash the saturated fatty acid crystals. Given the melting point of 51.5°C, there may well have been some oleic acid left.

¹² Here the author uses terms that can also mean the carbonates but in this instance, he means the oxides. Using the data from the table allows us to calculate the average relative molecular mass of the constituent fatty acids. Doing this on the basis of the carbonates yields values of 448 and 515 for the potassium and sodium carbonates respectively. Using the oxide gives values of 305 and 301 respectively, which are much closer to literature values of around 280.

¹³ Throughout the book, 'acide hircique' has been translated as 'hircic acid' since it is not clear what acid is meant or what it would be called nowadays.

¹⁴ This is not quite clear. It could well be that the hot alcoholic solution is filtered to get rid of impurities that did not dissolve, that the filtrate is then cooled and filtered and that the filter cake that resulted from this second filtration is then washed, pressed and dried.

¹⁵ Analysis by hydrochloric acid means determining the potassium content via its chloride. When a potassium soap is acidulated with hydrochloric acid, the aqueous layer contains the potassium chloride and the excess hydrochloric acid. Since the latter is volatile, evaporation to dryness leaves just the potassium chloride.

¹⁶ The text says just 'acid' but what is meant is surely *constituent fatty acids*.

¹⁷ The amounts of potassium oxide are much lower than what would correspond to the potassium soaps shown in the previous table on page 176. Consequently, there must be some free fatty acids present in the solid material that has been previously referred to as bpalmitate or bistearate.

¹⁸ This density corresponds to 86.5 % by weight or 90.6 % by volume.

¹⁹ According to the *Oxford English Dictionary* (2003), 'adipocere' is "a greyish waxy substance formed by the decomposition of soft tissue in dead bodies subjected to moisture."

²⁰ These samples will have contained variable amounts of linoleic acid since their method of preparation does not entail the separation of the various unsaturated fatty acids.

²¹ This is absolute alcohol.

²² As mentioned in endnote 7 on the previous page, the amount of glycerin should be around 10 parts and here again, some glycerin has apparently been lost.

²³ See also endnote 5 and 8 of this chapter.

²⁴ As mentioned before by the author, his supply of jaguar fat was rather limited. So he used a smaller sample but maintained the strength of the alcoholic solution.

²⁵ Still the same olein to alcohol ratio of 1.234.

²⁶ These 89 parts are less than expected. A value of 96 would have been more likely. See also endnote 7 of this chapter.

²⁷ This is not surprising since (*cf.* endnote 22) the amounts of glycerin from the stearins were considered to be on the low side.

²⁸ According to H.A. Boekenoogen (*De Scheikunde der Oliën en Vetten*, Oosthoek's Uitgeversmaatschappij Utrecht, 1948), lard has a saponification value of 193-200. This means that 1 g of lard requires 193 to 200 mg KOH for its saponification. Since the use of three molecules KOH (relative molecular mass $3 \times 56.1 = 168.3$) releases one molecule of glycerin (relative molecular mass 92.1), the saponification of 100 parts of lard should release 10.6 to 10.9 g of glycerin, *i.e.* more than reported. On the other hand, the amount of constituent fatty acids reported here is more realistic than the figures reported before.

²⁹ Butyryn is what we would now call tributyrin; accordingly, 'phocénine' could be called 'tri-isovalerate' but this term has not been used in the translation since the author had not yet realised that oils and fats consist of triglycerides containing three fatty acid moieties per molecule, as also indicated by their more formal name: triacylglycerols.

³⁰ This question really touches the heart of the matter. Is there a compound called stearin and another compound called olein and can everything be explained in terms of the ratio in which these compounds are mixed? We now know that olein and stearin consist of a whole range of different triglycerides but this was only discovered later. At the time the question was asked, people looked for the most simple answer and would only contemplate a more complicated answer if the simple one failed to answer the question.

³¹ This list of properties is indicative of what could be investigated and was felt to include properties that might highlight possible differences between compounds.

³² There is a misprint here somewhere because four lines earlier, this mutton tallow stearin still melted at 44°C.