APISARA

FATTY ACIDS IN SOAPMAKING

Understanding their role for better formulation

Technical and educational guide From beginner to experienced formulator

Purpose of this guide

> To understand how the fatty-acid composition of oils and fats influences soap behaviour, learn to interpret calculator indicators, and build reasoned formulations without turning chemical trends into absolute rules.

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How to use this guide

This document has two reading levels. The main text provides the concepts needed to understand and formulate soap. Technical note boxes explore mechanisms and the limitations of models commonly used in soapmaking.

For beginners

You do not need to memorise chemical formulae. Focus on the main fatty-acid families, their general tendencies, and the method used to analyse a recipe.

For artisans and professionals

Fatty-acid profiles are formulation and comparison tools. They do not replace supplier specifications, accurate alkali calculations, production trials or stability observations.

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1. Why fatty acids matter

In soapmaking, we choose oils, butters and fats. Yet much of a soap's behaviour comes from the fatty-acid composition of those raw materials. Understanding this composition helps move from copying recipes to actually formulating.

An oil is not a single property. It is a complex mixture of triglycerides made from different fatty acids. Two different raw materials can therefore share some characteristics when their profiles are similar; conversely, a natural oil sold under the same name does not have an absolutely identical composition in every batch.

Key idea

Do not choose an oil simply because it is said to be « good ». Choose it because its profile, quality, cost, availability and other constituents meet the formulation objective.

2. From oil to soap: what actually happens

In oils and fats, fatty acids are mainly bound to glycerol as triglycerides. During saponification, a strong alkali hydrolyses these esters. With sodium hydroxide (NaOH), the main products are sodium salts of fatty acids and glycerol.

Simplified equation

Triglyceride + NaOH → glycerol + sodium salts of fatty acids

This is deliberately simplified. A real oil contains many different triglycerides, and the amount of alkali must be calculated from the saponification value of each fat.

Finished soap is therefore not simply « transformed oil ». It is a system containing several fatty-acid soaps, glycerol, residual water, possibly an unsaponified fraction, and the other components of the formulation.

3. Reading C12:0, C18:1, C18:2...

The abbreviated notation indicates carbon-chain length and the number of carbon-carbon double bonds. C18:0 means 18 carbon atoms and no double bond; C18:1 has one; C18:2 has two.

This matters because chain length and degree of unsaturation influence physical and chemical properties. It is therefore too simplistic to consider only a saturated-versus-unsaturated divide.

4. Eight key fatty acids for soap formulation

Fatty acid	Notation	Useful soapmaking tendency
Lauric	C12:0	Solubility, abundant lather, cleansing, hardness
Myristic	C14:0	Lather, cleansing, hardness
Palmitic	C16:0	Structure, hardness, denser lather
Stearic	C18:0	Structure, hardness, creamy/stable lather
Oleic	C18:1	Oleic soap profile; less immediate lather
Linoleic	C18:2	Polyunsaturation; oxidation requires attention
Linolenic	C18:3	Highly polyunsaturated; more challenging oxidative stability
Ricinoleic	C18:1-OH	Distinct behaviour; supports/stabilises lather

Important

Terms such as « hardness », « cleansing », « lather » and « creamy » describe formulation tendencies. An isolated fatty acid cannot by itself predict the real user experience.

Lauric - C12:0

Abundant in coconut and palm-kernel oils. Laurate soaps are relatively soluble and promote quick, abundant lather. A high proportion of lauric oils can, however, produce soap perceived as highly detergent depending on the overall formulation and intended use.

Myristic - C14:0

Often accompanies lauric acid in lauric oils. It contributes to lather, cleansing and hardness. Craft soap calculators frequently combine lauric and myristic acids in their indices.

Palmitic - C16:0

Makes a major contribution to bar structure and hardness. It is prominent in palm oil and occurs at lower levels in many other oils.

Stearic - C18:0

Contributes to structure, hardness and dense, stable lather. Stearic-rich materials can also affect batter rheology and accelerate thickening.

Oleic - C18:1

Important in olive oil and high-oleic oils. Very oleic soaps may produce less immediate lather and can change noticeably during an extended cure.

Linoleic - C18:2

A common polyunsaturated fatty acid in many seed oils. Its higher unsaturation generally makes it more oxidation-sensitive than oleic acid.

Linolenic - C18:3

With three double bonds, it is more susceptible to oxidation mechanisms. This does not make linolenic-rich oils unsuitable; it means formulation and storage need to be considered carefully.

Ricinoleic - C18:1-OH

Characteristic of castor oil. Its hydroxyl group gives it distinctive behaviour; castor oil is commonly used at moderate levels to support lather and modify system solubility.

5. Comparing fat and oil profiles

The profiles below are indicative. Natural oils vary with cultivar, origin, season, processing and commercial specification. For professional work, the supplier's technical specification or batch analysis should take precedence over generic values.

Raw material	Dominant profile to remember	Formulation reading
Coconut oil	Lauric + myristic; other shorter/medium-chain saturates	Fast lather, high solubility and cleansing
Olive oil	Predominantly oleic	Oleic soap; quieter lather, evolves with cure
Palm oil	Palmitic + oleic	Structure and hardness; useful balancing profile
Conventional sunflower	Often rich in linoleic	High polyunsaturation; stability deserves attention
High-oleic sunflower	Very high oleic	Very different profile from conventional sunflower
Castor oil	Strongly dominated by ricinoleic	Specialised material, usually used at moderate levels

Natural variability

Codex Alimentarius gives composition ranges for named vegetable oils rather than one universal value. This is good technical practice: an average value is a reference point, not the absolute identity of an oil.

6. Connecting profiles with soap properties

Hardness. Sodium salts of longer-chain saturated fatty acids, particularly palmitic and stearic, make an important contribution to bar structure. Hardness to the touch and rate of wear are not synonymous.

Solubility and lather. Lauric and myristic soaps generally encourage rapid, abundant lather. Lather itself is complex: volume, bubble size, stability and creaminess are different characteristics.

Cleansing. Systems rich in relatively soluble soaps can show high detergency. Cleansing power, lather quantity and perceived mildness should not be treated as the same property.

Process behaviour. The fatty-acid profile also influences the batter, including thickening, working temperature, unmoulding and cure. Formulation therefore means designing both a finished product and a manufacturing process.

Technical note

The properties of a soap mixture are not simply the sum of eight independent fatty-acid properties. Interactions between components, water phase, temperature, electrolytes, glycerol and microstructure all influence real behaviour.

7. Limits of soap-calculator indices

Soap calculators may display values labelled « hardness », « cleansing », « conditioning », « bubbly » or « creamy ». They are useful for rapid comparison, but remain indicators derived from the fatty-acid profile.

- They do not physically measure the soap you have made.
- They may not account for microstructure, cure or actual residual water.
- The same score can arise from different profiles.
- Suggested « ideal » ranges are not universal standards.
- A value outside a suggested range does not automatically mean a poor formulation.

Apisara rule

Use the calculator to understand and secure the calculation, then use testing to verify actual behaviour. Calculation and experimentation complement each other.

8. Three educational formulations compared

The following examples are designed only to illustrate reasoning. They are not universal recipes ready for commercial production. Every batch requires recalculation of the alkali using appropriate SAP values, together with suitable trials.

Educational formula	Oil distribution	What it demonstrates
A - Very oleic	Olive 80% • Coconut 15% • Castor 5%	Oleic dominance; quieter lather, with limited lauric oil and castor.
B - More balanced	Olive 45% • Coconut 25% • Palm 25% • Castor 5%	Broader distribution of oleic, lauric/myristic and palmitic fractions.
C - Very lauric	Coconut 60% • Olive 35% • Castor 5%	Shows the effect of a high lauric-oil fraction; do not judge the formula by lather alone.

The purpose is not to choose a « winning » formula. Each represents a different profile. Intended use, superfat, lye concentration, cure, climate, available raw materials and economics can all change a formulator's decision.

Exercise

Take one of your recipes. Before looking at calculator indices, identify the dominant families: lauric/myristic, palmitic/stearic, oleic, polyunsaturated and ricinoleic. Write down your expectations, then compare them with the calculator and with your real observations.

9. Oxidation and stability

Double bonds are particularly involved in oxidation reactions. For comparable structures, increasing the number of double bonds generally increases oxidative susceptibility: C18:0 < C18:1 < C18:2 < C18:3.

This hierarchy is a chemical tendency, not a shelf-life prediction. Actual stability also depends on initial oil quality, naturally occurring antioxidants, light, oxygen, temperature, trace metals, packaging and storage.

Do not confuse

An antioxidant and an antimicrobial preservative do not perform the same function. An antioxidant slows oxidation reactions; it does not automatically replace a preservation system when one is required.

10. A practical formulation method

1. Define the use.

Toilet soap, hand soap, household soap, shaving, a particular climate, desired rate of wear...

2. Define the constraints.

Available materials, cost, origin, process, temperature, regulatory and commercial requirements.

3. Examine the profile.

Identify the main fatty-acid families instead of accumulating oils.

4. Look for imbalances.

Very high lauric fraction? Many polyunsaturates? Too little structure? Redundant ingredients?

5. Calculate the alkali.

Any change to a fat requires a new NaOH/KOH calculation. Never adjust alkali by eye.

6. Make a test batch.

Record temperatures, trace, moulding, unmoulding, mass, cure and observations.

7. Test over time.

Lather, feel, wear, cracking, softening, odour and visual changes.

8. Change one variable at a time.

This is the clearest way to learn what actually caused a change.

11. Ten common mistakes

- 1. Believing an oil has only one property.

- 2. Assigning an absolute property to one isolated fatty acid.
- 3. Trying to maximise every calculator index.
- 4. Confusing a hard bar with a long-lasting bar.
- 5. Confusing abundant lather with effective cleansing.
- 6. Treating an average oil composition as an analytical constant.
- 7. Treating all unsaturated oils as equivalent.
- 8. Changing an oil without recalculating the alkali.
- 9. Making a final judgement too early in the cure.
- 10. Believing a calculator removes the need for testing.

12. Quick-reference sheet

The reasoning in one minute

Lauric / myristic: rapid lather, solubility, cleansing. Palmitic / stearic: structure and hardness, denser lather. Oleic: basis of highly oleic profiles; different behaviour from lauric soaps. Linoleic / linolenic: polyunsaturation; increased attention to oxidation. Ricinoleic: distinctive castor-oil profile, often useful at moderate levels.

Formulate = define an objective → choose a profile → select raw materials → calculate → test → document → adjust.

Key takeaways

- An oil is a mixture of fatty acids and other constituents.
- Soap is a mixture of fatty-acid salts; its properties emerge from the whole system.
- Fatty-acid profiles help explain a formula but do not predict everything.
- Natural compositions vary: use ranges and supplier data when precision matters.
- Calculator indices are decision aids, not quality certification.
- Theory guides formulation; testing verifies it.

13. References and limitations

Main normative reference

Codex Alimentarius FAO/WHO. CXS 210-1999 - Standard for Named Vegetable Oils, version referenced as 2024. The standard includes identity criteria and composition ranges for a range of vegetable oils.

Codex Alimentarius FAO/WHO. CXS 33-1981 - Standard for Olive Oils and Olive Pomace Oils, version referenced as 2024.

Additional technical basis

The principles in this guide also draw on established chemistry of fatty acids, triglycerides, saponification, surfactants and lipid oxidation. For industrial, regulatory or analytical use, consult the standards, supplier specifications and scientific literature relevant to the exact materials and processes concerned.

Important limitation

This guide is an educational resource. It does not replace laboratory analysis, a safety data sheet, supplier specifications, a cosmetic safety assessment or the regulatory obligations applicable to the product and jurisdiction.

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