

ALTERNATIVES TO ANIMAL FAT

Sitaram Dixit

Senior Manager – Applications & Technical Fragrance Development
International Flavours & Fragrances India Limited

Oils and fats either from plant or animal origin is the basic raw material used in soap manufacture. Commonly used ones include animal tallow fat, and vegetable oils obtained from palm oil, coconut oil, palm kernel oil, groundnut oil, rice barn oil, castor oil, etc. Natural triglycerides are formed with different mixes of fatty acids. It is important for a soap manufacturer to know the type and the amount of the fatty acids present in different oils as it is these fatty acids that determine the property of the soaps made out of them. Moreover this knowledge also gives good flexibility to the soap maker in replacing and or substituting oils in the soap oil blend according to market factors of availability and cost.

Soap is the alkali salt of a fatty acid with a general formula $\text{NaOOC}(\text{CH}_2)_n\text{CH}_3$. Soap properties exist when $n+2$ is greater than 8 and less than 20. The best properties occur when $n+2$ equal 12 to 18. The fatty acids used to make soap are obtained from fats and oils. The fatty acids have varying chain lengths, which are all straight chain and contain even number of carbon atoms. There are about 40 different fatty acids occurring in nature, the largest is the group containing 18 carbon atoms.

Of the different fatty acids the most important with respect to soap manufacture are

Lauric Acid	12 Carbon Atoms
Myristic Acid	14 Carbon Atoms
Palmitic Acid	16 Carbon Atoms
Stearic Acid	18: 0 Carbon Atoms
Oleic Acid	18: 1 Carbon Atoms
Linoleic Acid	18: 2 Carbon Atoms
Linolenic Acid	18: 3 Carbon Atoms
Ricinoleic Acid	18: 1 Carbon Atoms

The last four fatty acids in bold letters are unsaturated fatty acids. Unsaturated fatty acids give softer soap with lower melting point and are less stable.

Hard fats like, Mutton tallow, Lard and Palm oil contain longer chain saturated fatty acids and soaps made from these fats are firm, slowly soluble, milder and have a good detergency.

Lauric Oils like Coconut Oils, Palm Kernel Oils, have shorter chain fatty acids which form soap that give faster tighter more copious lather which are less mild than soap from hard fats.

Soft Oils like Groundnut Oils, Cotton seed Oils, Rice Barn Oils, contains more unsaturated fatty acids. Soaps made from these oils are softer less white and less stable

Soft Oils are hardened by catalytic hydrogenation and bleached to improve the properties of soap. There is usually a loss of natural antioxidants found in the oil during the process of bleaching and hydrogenation. Antioxidants may be necessary to prevent rancidity developing in the oils and in the soaps made out of these oils. Excess Linoleic Acid and Linolenic Acid in soap oil blend is not advisable as they develop rancidity faster. In soap making, raw materials are chosen based on the quality parameters required to ensure high quality products at the required price. The quality parameters include saponification value, acid value, titer value, iodine value, Lovibond colour, etc. It can be clearly seen that a judicious blend of oils and fats are necessary to obtain soap with ideal properties. It is also necessary to blend different oils for economic reasons. Blend is so adjusted to control hardness, plasticity, lather, mush, cracking, mildness and discoloration.

Direct saponification of fats and oils with caustic soda is the original method universally used world wide to prepare soap. However, this method is used only in less developed countries today for large-scale manufacture. Nowadays soaps are made by fatty acid neutralisation. Fats and oils are split at high pressure and temperature by water to give fatty acids and glycerine. Apart from economic advantages obtained from this process the lower

boiling fractions of fatty acids can be removed from the fats and oils to give truly superior fatty acids for use in making soap.

Tallow is the most widely used animal fat in soap manufacture. The quality of tallow depends on the type of treatment carried out. Natural decomposition of tallow begins with the slaughter of the animal. The colour and content of the fatty acids increase with time to yield poor quality tallow if no treatment is carried out. All care has to be taken during rendering, handling, and storage of the fat so that degradation is prevented and the fat remains good for soap manufacture.

Tallow is obtained by putting the animal tissue containing the fat through a process called rendering. Rendering consists of separating the fat & tissue from water using heat and pressure. Rendering can be carried out by two methods namely wet and dry. When taste, colour and odour are important parameters then the wet method is preferred for extracting edible animal fat. Dry method is used for non-edible quality animal fat.

Edible quality fat has a low colour and free fatty acids levels and is generally used to make food products for human consumption. The consumption of animal fat by humans is reducing largely due to health concerns and evolving consumer preferences. Soap made out of edible quality tallow (ET) is the best both in terms of performance and aesthetics. However, they are expensive for soap manufacture, and so their usage is limited. Top white (TW) and Fancy Bleachable (BFT) grades of tallow are used for soap manufacture. Both these grades of tallow are very similar to edible grade tallow and yield high quality soap but at a lower price.

Fat obtained from hogs and fowls are called as Choice white grease (CWG). They are unstable due to the high unsaturated fatty acid content and are used for cheaper quality toilet and laundry soaps. For making toilet soaps tallow used should be as white as possible. The whiter the tallow, the brighter the colour of the soap obtained. Good quality tallow when used in soap making requires lower amount of opacifiers, and lower optical brightener levels. The fragrance level requirement is also lower as smaller amounts are required to mask the base odour. Also fragrance stability in the soap is better if superior quality animal tallow is used.

Toilet soaps usually contain 10 to 30% Lauric Oils (Coconut oil, Palm Kernel Oils, etc.) Coconut oil is the most important vegetable oil used in soap manufacture. Its main contribution is to improve solubility and foam properties of the soap manufactured. Coconut oil is usually mixed with other non Lauric oils like animal fat, fractions of other vegetable oils, marine oils, hydrogenated oils, etc., to make soaps.

We know that tallow is the primary fat raw material used in soap making all over the world. Coconut oil is added invariably to improve the quality of soap and to obtain soap that has superior foam and performance characteristics. In regions where tallow is not available locally available fatty substances are used as substitutes. In tropical regions like Malaysia Palm oils and Palm stearin is used as a replacement for tallow, whereas in other regions, it is replaced by vegetable oils obtained from local plant sources that are partially or totally hydrogenated and some times split and distilled.

India a predominantly Hindu country strongly believes in non-violence against all living beings. In line with this unique Hindu philosophy, the Indian soap industry does not use animal fat for soap manufacture. However due to the inherent shortage of edible oils, it has carried out significant research in the production, purification, pre-treatment and use of different varieties of locally available non-edible varieties of oils like Rice barn oil, Castor oil, Neem oil, Mowrah oil, Karanjia Oil, etc., as replacement of animal fat.

We are aware that animal tallow and coconut oil have been the chief raw materials used in the soap manufacture. Similarity in the fatty acid composition of tallow and palm oil has made it technically possible to replace one with the other. The same is the case between coconut oil and palm kernel oil. Due to this reason and also because of their ready availability palm oil, palm kernel oil, palm stearin, and their products are very popular now with soap manufacturers. The quality of soaps made from palm products is very high and comparable to that of commercial tallow based soaps. Soaps made out of palm stearin is hard, however by blending palm stearin with optimal portions of other soft and lauric oils a high quality soap can be produced that is comparable to tallow.

Generally, freshly produced good quality palm based soap made out of neutral fats or oils has a sharp clean odour. Soaps made from palm fatty acids have a sharp fatty odour. The odour of the soaps made can increase on ageing. This incremental change has to be masked by use of a suitable fragrance. The odour of a product as perceived and interpreted by a consumer is the combined effect produced by the fragrance and the base odour.

Fragrance used should perform a dual role of masking the inherent odour of the raw material used and impart a distinct identity to meet any special requirement of the finished products.

A comparative study carried out on the effect of fragrance in distilled palm oil / palm kernel oil and animal tallow / coconut oil fatty acid soap at varying temperatures and dosage levels has the following conclusions to offer on intensity, performance and colour effect. It is found that at all levels (0.8 to 1.2%) of fragrance dosages, the intensity of fragrance was higher in palm based soaps than in animal tallow based soaps, indicating that palm based soaps retain perfume better. The odour profile at the end of the study was also pleasant and well accepted by the consumers. Also the degree of Whiteness observed between soaps made out of distilled palm oil / palm kernel oil and animal tallow / coconut oil fatty acid soap during storage was also comparable.

In today's scenario India is the largest producer of vegetable oil based soaps and Malaysia is the world largest producer and processor of Palm based fatty derivatives for soap making. Palm Oil and its derivatives like palm stearin is becoming more and more attractive for soap manufacturers. This is not only because it is cost competitive and technically suitable but also due to specific consumer preference.

Vegetable oil based soaps are becoming popular and if the current trend continues it will not be far when all soaps made will be from vegetable oil and not animal fat.

FATTY ACID COMPOSITIONS & PROPERTIES OF COMMERCIAL PALM BASED SOAPS

FATTY ACID COMPOSITIONS	% WEIGHT	PROPERTIES	VALUES
08:0	Less than 1.0	Iodine Value	39.0 to 43.8
10:0	Less than 1.0	Titer °C	39.2 to 43.2
12:0	7.0 to 14.0	% Free caustic Alkali	Less than 0.1
14:0	3.5 to 6.0	% Moisture	6.9
16:0	3.7 to 44.7	Penetration value (mm)	19.0 to 32.0
18:0	3.7 to 4.2	% Salt (NaCl)	Less than 1.0
18:1	30.0 to 33.3	% Total Fatty Matter	83.0 to 86.0
18:2	6.5 to 7.5	Foamability (ml) (immediate)	460
18:3	- 0.10	Foamability (ml) (measured after five minutes)	295
20:0	Less than 0.5	Hunter Whiteness (%)	81.4 to 86.4
Others	- 0.2		

MERITS & DEMERITS OF PALM BASED SOAP V/S ANIMAL TALLOW SOAPS

PARAMETERS	SOAPS MADE FROM PALM BASED PRODUCTS (RBD)	SOAP MADE FROM NON - EDIBLE ANIMAL TALLOW
Detergency	Good	Less
Solubility	Good	Less Soluble
Foaming fair	Fair	Less
Hardness	Very hard & crumbling	Hard
SUITABILITY FOR		
White toilet soap	Less suitable	More suitable
Coloured soap	Fair	Good
STABILITY FOR		
Colour	Fair	Good
Fragrance	Fair	Fair
Glossiness	Fair	Less
Texture	Hard but smooth	Less smooth

TYPICAL PHYSICAL PROPERTIES OF INDIVIDUAL SOAP

Fats & Oils	Colour of Resultant Soap	Consistency of Soap	Foaming Qualities	Cleansing Qualities	Action on skin	Solubility Number at		Abrasion No (g) at		Hardness Ratio
						55.55°C 100°F	61.11°C 110°F	55.55°C 100°F	61.11°C 110°F	
Coconut Oil	White to Pale yellow	Very hard	Quick but not lasting lather	Excellent	Biting	100	125	45	54	20
Palm Kernel	White to Yellow	Very hard	Quick but not lasting lather	Excellent	Biting	100	111	47	57	15
Tallow	Buff to White	Fairly hard	Slow but lasting	Fair	No action	5.1	15.3	7	12	3
Palm Stearin (RBD)	White to Cream	Hard and Crumbling	Fair	Fair	No action	5.3	16.5			7
Palm Oil (RBD)	White to Cream	Fairly hard and Crumbling	Fair & quick	Very Good	No action	5.3	16.5	6	10	5
Castor Oil	Straw colour	Hard and Tough	Quick break-down	Fair						
Ground Nut	Buff to White	Medium Soft	Quick & medium lasting	Good	No action					1.25
Rosin	Brown	Soft and sticky	Thin and greasy	Medium	No action					
Mowrah	Creamish Yellow	Hard	Fair & Quick	Good	No action					
Ricebarn	Greenish Yellow	Soft	Thin	Fair	No action					

TYPICAL OIL BLENDS – SOAPS MADE IN INDIA – VEGETABLE OILS ONLY

RBD Palm Stearin	40%	Palm Stearin	55%	Palm Stearin	60%	Palm Stearin	45%
RBD Palm Oil	40%	Castor Oil	15%	Rice Barn Oil	20%	Soft Oils	45%
Coconut Oil / Palm Kernel Oil	20%	Rice Barn Oil	15%	Coconut Oil / Palm Kernel Oil	20%	Coconut Oil / Palm Kernel Oil	15%
		Coconut Oil / Palm Kernel Oil	15%				