Palm Oil Fatty Acids in Soap and Detergent Formulations

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ABSTRACT

Palm oil fatty acids can be used in increasing quantities in combination with selected minor oils from India in making lower cost laundry or toilet soaps and derivatives suitable for use as surface-active compounds in many formulations. Experimental soap formulations using palm oil products and indigenous fats are provided.

INTRODUCTION

The increased availability of palm oil has generated great interest in many countries to supplement edible oil consumption and to produce oleochemicals.

This paper describes how palm oil fatty acids can be important source materials in soaps and fatty acid-based detergent formulations.

EXPERIMENTAL

Laundry soaps are made from palm acid oil and also from palm acid oil mixed with selective fat containing higher saturated fatty acid by the full-boiled process.

Analytical characteristics of the soaps produced, viz., fatty acid composition, total fatty matter (TFM), alcohol insolubles, moisture and chloride content, as well as hardness and foam height as aqueous solution according to routine procedures, are examined.

RESULTS AND DISCUSSION

Considering the average analytical characteristics of laundry and toilet soaps shown in Table I, it is possible to select a wide range of fat blends suitable for making these soaps using palm acid oils alone or in combination with other fats, such as those shown in Table II.

It is reported (1) that toilet soaps can be made from 100% oil palm products, as shown in Table III. There is very little palm oil and palm kernel oil available for direct soap production, but there is a considerable amount of high free fatty acid (FFA) palm oil and palm acid oil available for making soaps in India. It has been our experience that the consistency of laundry soaps based on 100% palm acid oil with 46-48% TFM, 16-20% sodium silicate and 30% moisture is slightly softer than that made from oil blends having higher chain length fatty acids. This problem can be avoided by adding stearic acid and higher saturated fatty acid-rich oils with palm acid oil, as can be seen from the characteristics of laundry soaps made from palm oil fatty acids and palm acid oil blended with other oils (Tables IV and V). In fact, the hardness increases when hydrogenated rice bran oil (HRBO) or sal oil or kusum oil is used along with palm acid oil. It is expected that the soaps from palm oil, because of their soft and sticky characteristics, will have a low rate of extrusion in the Mazzoni system, and the

TABLE I

Average Analytical Characteristics for Laundry and Toilet Soaps

Characteristics	Laundry soap	Toilet soap
Saponification value	200-210	210-220
Iodine value	35-50	30-40
Titer (C)	38-40	40-42
INS factor	130-180	160-180
Solubility ratio	1.1-1.3	1.2-1.5
Short-chain fatty acids (mainly lauric) (% w/w)	0-10	10-20

TABLE III

Characteristics of Toilet Soaps Based on 100% Oil Palm Products (1)

	Samples	
Fatty acids (% w/w)	A	B
C_8	0.7	0.8
C_{10}	0.8	0.8
C_{12}	13.1	8.8
C_{14}	5.8	5.4
C_{16}	34.6	38.1
$C_{16:1}$	trace	trace
$C_{18:0}$	4.0	4.5
$C_{18:1}$	33.4	32.7
$C_{18:2}$	7.0	8.3
$C_{18:3}$	0.2	0.2
C_{20}	0.2	0.2
Saponification value	207.5	205.8
Iodine value	43.4	45.1
Titer (C)	39.4	41.8
INS value	164	161

TABLE II

Major Fatty Acids and Other Analytical Constants of Commonly Used Fatty Materials for Soap Making

Fatty acids (% w/w)	Beef tallow	Palm kernel oil	Coconut oil	Partially hydrogenated rice bran oil	Mowrah	Neem oil	Kusum oil	Sal oil	Palm oil	Palm stearin
$C_{12:0}$	–	40-55	41-56	–	trace	trace	1	–	trace	trace
$C_{14:0}$	3-6	14-18	13-23	–	16-28	14-16	5-8		1	1-2
$C_{16:0}$	25-27	6-11	8-11	17-18	20-25	14-24	5-7	37-46	41-44	60-62
$C_{18:0}$	21-24	1-3	1-4.8	38-40	41-51	49-62	40-67	33-45	4-5	5-6
$C_{18:1}$	42-45	10-23	3-12	40-42	9-14	2-16	2-5	2-4	38-40	25-26
$C_{18:2}$	1-3	1-5	1-4	4-5	–	1-3	20-31	6-12	10-11	6-7
Saponification value	192-202	240-255	250-264	184-195	187-196	193-204	220-234	188-190	190-202	193-206
Iodine value	40-56	16-20	7-12	42-45	55-63	68-76	48-58	37-45	51-55	22-46
Titer (C)	40-47	20-28	20-24	41-42	38-40	35-36	50-52	48-53	40-42	46-54
INS value	146-152	224-235	243-252	142-150	128-133	125-128	172-176	145-150	139-147	160-171

TABLE IV

Characteristics of Laundry Soaps Made from Palm and Other Oils

Fat charge	Sample	Fatty acid composition (% w/w)		Soap characteristics TFM (% w/w)	Alcohol insoluble (% w/w)	Moisture (% w/w)	Chloride (% w/w)
Palm Oil – 75%		$C_{16:0}$	36	49	16.5	30	1.05
Soapstock – 10%	A	$C_{18:0}$	16				
Acid oil – 15%		$C_{18:1}$	40	46	17.0	32.5	1.10
Titer – 37.8 C		$C_{18:2}$	8	44	17.5	34.0	1.35
Iodine value – 51							
Palm oil – 60%		$C_{16:0}$	30	46	21.5	28	0.95
HRBO – 15%		$C_{18:0}$	23				
Soapstock – 10%	B	$C_{18:1}$	39	45	21.5	29	1.00
Acid oil – 15%		$C_{18:2}$	8	44	21.5	30	1.10
Iodine value – 48							
Palm oil – 50%		$C_{16:0}$	30	46	22.0	28.5	0.90
HRBO – 25%		$C_{18:0}$	30				
Soapstock – 10%	C	$C_{18:1}$	36	45	21.5	29.5	0.95
Acid oil – 15%		$C_{18:2}$	4	44	21.5	28.5	1.10
Iodine value – 41							
Palm oil – 60%		$C_{16:0}$	32	46	21.5	28.0	0.90
Sal oil – 15%		$C_{18:0}$	20				
Soapstock – 10%	D	$C_{18:1}$	42	44.5	20.5	30.5	0.95
Acid oil[a] – 25%		$C_{18:2}$	4				
Titer – 40.5 C		$C_{20:0}$	2	42.0	21.5	30.5	1.05
Iodine value – 42							
Palm oil – 60%		$C_{16:0}$	35	46	21	28.5	0.75
Kusum oil – 15%		$C_{18:0}$	20	44	22	30.8	0.78
Soapstock – 10%	E	$C_{18:1}$	36	42.5	23.5	30.7	0.90
Acid oil[a] – 15%		$C_{18:2}$	4				
Titer – 39.5 C		$C_{20:0}$	5				
Iodine value – 40							
Palm oil – 50%		$C_{16:0}$	30	46	20.5	29	0.60
Kusum oil – 25%		$C_{18:0}$	25	43	23.5	29	0.65
Soapstock – 10%	F	$C_{18:1}$	36	41.5	24.5	29.5	0.70
Acid oil[a] – 15%		$C_{18:2}$	4				
Titer – 40.5 C		$C_{20:0}$	7				
Iodine value – 40							

[a]Hydrogenated.

TABLE V

Characteristics of Soaps

Sample	Foam height (mm) 0.5% aqueous solution 0 min	5 min	Penetration value	Hardness	Remarks
	50	30	200	Soft, sticky	Low rate of extrusion in Mazzoni at higher moisture content
A	46	25	210	Soft, sticky	Difficult to emboss without storage, due to stickiness
	42	20	220	Soft, sticky	
	50	40	180	Medium hard, not sticky	Medium rate of extrusion in Mazzoni
B	48	39	172	Medium hard, not sticky	No problem in direct embossing
	48	35	172	Medium hard, not sticky	
	48	39	176	Medium hard	High rate of extrusion in Mazzoni
C	48	38	175	Medium hard	No problem in direct embossing
	46	38	170	Medium hard	
	46	36	180	Medium hard	High rate of extrusion in Mazzoni
D	46	38	175	Medium hard	No problem in direct embossing
	45	35	171	Medium hard	
	45	35	170	Medium hard	High rate of extrusion in Mazzoni
E	42	34	165	Medium hard	Direct embossing no problem
	42	30	165	Medium hard	Color of soap improves
	42	35	170	Medium hard	High rate of extrusion
F	42	35	162	Medium hard	Direct embossing
	42	36	160	Hard	Color improves
					Cracking develops at higher chloride
					Less compactness

TABLE VI

Derivatives and Applications of Fatty Acids

Fatty acids	Derivatives	Applications
Palm fatty acid/pure palmitic/ stearic acid	(1) α-Sulfo fatty acid (2) Alcohol sulfate (3) Ethylene oxide, propylene oxide condensate and epoxies (4) Alkanol amide sulfate (5) Amine derivatives, ethoxylated (6) Ethoxylated oleic acid dimer (7) Fatty alcohols; monoglycerides, ethoxylated and acetylate	(1) In detergent powder along with olefin sulfonated products (2) Biodegradable detergents (3) In nonionic detergent (4) In lime soap dispersing agents (5) Emulsifying agents in textile and other formulations (6) Nonionic detergent (7) Cosmetic formulation (15-30%)

soaps may be difficult to emboss without storage. When there is a stearic acid-rich oil in combination with palm acid oil, the hardness of the soaps is much increased, and as a result there is improved rate of extrusion in the Mazzoni equipment and also direct embossing. Similar results are obtained when an oil containing more stearic acid and arachidic acid is used along with palm acid oil.

This study, therefore, indicates that palm oil fatty acid in combination with higher saturated fatty acids can replace the tallow fatty acids in making soaps.

Table VI shows that palm oil fatty acid or pure palmitic acid, oleic acid and even stearic acid (made by hydrogenation) which can be isolated from palm oil fatty acids can be used in making a number of surface-active agents using known production technologies. These surface-active compounds find uses in different detergent formulations as emulsifying agents in textile and other formulations. The fatty alcohols are used directly in cream formulations.

In India, tallow is difficult to obtain on a regular basis for use in soap production and, recently, its import has been very much restricted. On the other hand, palm oil fatty acids or palm acid oil and even high vacuum steam-stripped palm fatty acids from physical refining plants can be imported in view of lower cost and guaranteed availability for the purpose of producing soaps in combination with the minor oils in India and also for making surface-active compounds other than soaps.

REFERENCE

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Hydroformylation of Unsaturated Fatty Acids

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ABSTRACT

When hydroformylation of unsaturated fatty materials is done with rhodium-triphenyl phosphine (or phosphite) catalysts, a number of advantages become apparent compared to cobalt carbonyl-catalyzed reactions. With rhodium, the reaction can be carried out (a) at pressures as low as 200 psi, (b) at each double bond location in a polyunsaturated fatty acid, and (c) in high yield and conversion. Solubilized catalyst can be recovered from distillation residue and readsorbed on spent catalyst support by thermal treatment in a rotary kiln. The reconstituted catalyst is more active than the original catalyst and can be recycled indefinitely at a relatively low cost. Recently developed supports for "homogeneous" catalysis may make catalyst recovery even more effective. Acetalation, oxidation with air to polycarboxylic acids and catalytic hydrogenation to hydroxymethyl compounds can be done easily and in high yield on mono-, di- and triformyl derivatives alike. Other reactions investigated for monoformyl fatty esters include reductive amination to form aminomethyl derivatives and Tollen's condensation with formaldehyde to form geminal *bis*-hydroxymethyl compounds. Although the Northern Center has carried out some basic investigations on the hydroformylation reaction and on the chemistry of the hydroformylated products, there is a great deal more that can be done with regard to synthesis of new compounds and development of new applications.

INTRODUCTION

The reaction of synthesis gas with olefins in the presence of cobalt carbonyl as a catalyst, producing isomeric mixtures of aldehydes, was discovered by Otto Roelen in the laboratories of Ruhrchemie AG and first reported in 1938 (1-3). The reaction is identified variously as the Roelen reaction, the oxo synthesis or the hydroformylation reaction. Since its first application, it has rapidly become one of the most important industrial reactions, and 4-5 million metric tons of products are produced annually. The reaction is applied to propylene, e.g., in the synthesis of butyraldehyde, from which 2-ethyl-1-hexanol is made for producing di(2-ethylhexyl)phthalate, an important primary plasticizer for vinyl plastics. More recently, rhodium carbonyl catalysts have been applied to hydroformylation and other reactions with great commercial success in spite of the high costs of rhodium.

Both catalyst systems have been investigated for the hydroformylation of unsaturated fatty materials, but apparently this application is not now used on a large industrial scale. Failure to apply hydroformylation to unsaturated fatty materials probably can be ascribed to the wide dis-