CALCIUM SOAPS DERIVED FROM PALM FATTY ACIDS

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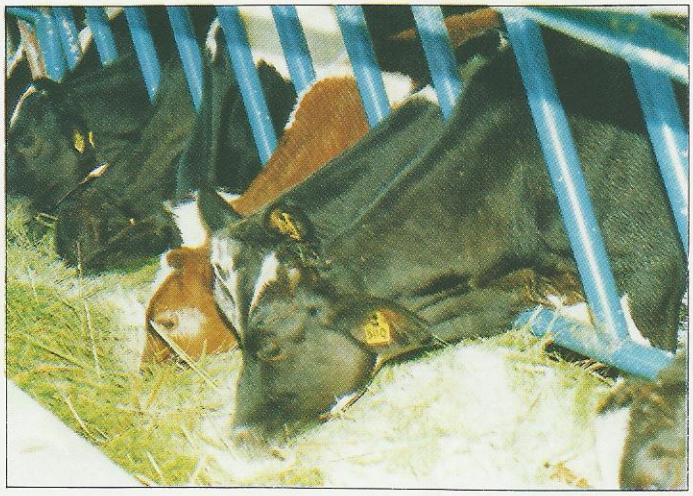
INTRODUCTION

Calcium soap is the product of saponification reaction between fatty acids and calcium ions. Calcium soap in the form of stearate is widely used as hardening agent for mineral oil, mould-releasing agent for plastic, in injection and extrusion products and in polyolefin industry. In the livestock industry, calcium soap from mixed fatty acids is commonly added to animal feed. It is known as "By-Pass Oil" and specially fabricated as oils and fats replacer in animal feed. Addition of supplementary energy containing material such as oils and fats is necessary to enhance milk production and other activities of lactating livestock. However, oils or fats *per se* have negative effect on carbohydrate digestion in ruminants (Ward *et al.*, 1957; Brooks *et al.*, 1954 and Devendra *et al.*, 1974) and therefore modified fats or oils in the form of calcium soap are beneficial replacer.

Studies have shown that ruminants fed with additional calcium soap had higher milk yield and improved carbohydrate digestion (Palmquist *et al.*, 1980; Palmquist, 1984; Finn *et al.*, 1985; Drackley *et al.*, 1985 and Ferlay *et al.*, 1992). Several studies on ruminants fed on feedstuffs containing palm-based calcium soap were found to have an increase in the milk production (Chalupa *et al.*, 1988; Ferguson *et al.*, 1988 and Aii *et al.*,1993). Besides milk production, the study by Chalupa *et al.* (1988) also showed that there was an improvement in milk quality, energy balance in lactating ruminants, health and fertility. The beneficial effects of calcium soap in animal feed initiate this study on the properties of calcium soap derived from palm products.

PROCESSING

Calcium soap does not need special manufacturing conditions and can be added to animal feedstuffs in the range of 10-20% (King, 1988). There are two ways of preparing the calcium soap, namely fusion and precipitation processes. The raw materials used for the preparation of calcium soaps in this project are palm acid oil (PAO), palm fatty acid distillate (PFAD), distilled palm oil fatty acid (DPOFA) and distilled palm stearin fatty acid (DPSFA). The two methods are described below:



(a)

(b)

Figure 1. Animal feed mixed with grass. (a) calves feeding, and (b) animal feed containing calcium soap

1. Fusion Process

In this process, the reaction is between the fatty acids and calcium hydroxide and proceeds as in the equation.

$2C_{17}H_{35}COOH + Ca(OH)_2 \text{ -----> } Ca(C_{17}H_{35}COO)_2 + H_2O$

(Fatty acid) (Calcium hydroxide) (Calcium soap) (Water)

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Fatty acid is melted in the soap kettle and calcium hydroxide is slowly added with agitation. Once the soap is formed, it will be removed from the reactor and dried. The neat soap is ground to the desired size to obtain the grain-like form.

2. Precipitation Process

This is a two-step reaction process which involves the formation of sodium soap and followed by reaction of the soap with calcium chloride to produce the calcium soap. The two-step reaction is shown below.

$C_{17}H_{35}COOH$ + NaOH -------> $NaC_{17}H_{35}COO$ + H_2O
(Fatty acid) (Sodium hydroxide) (Sodium soap) (Water)

$2C_{17}H_{35}COONa$ + $CaCl_2$ ----> $Ca(C_{17}H_{35}COO)_2$ + 2NaCl
(Sodium soap) (Calcium chloride) (Calcium soap) (Sodium chloride)

Fatty acid is melted in the soap kettle and subsequently saponified with sodium hydroxide to form the neat sodium soap. The sodium soap is dissolved in water and calcium chloride solution is slowly added with agitation. The solid calcium soap is filtered out. The residue is washed with water and dried. The soap is ground to the desired size particles.

FATTY ACID COMPOSITION

Calcium soap from PAO, PFAD, DPOFA and DPSFA were prepared using the fusion method. In this method, efficient stirring is necessary to ensure complete neutralization. This method is chosen because the moisture content of the final product is low and, in the absence of vacuum or spray drier, the product dries easily and rapidly in the oven. Precipitation is the conventional method for producing calcium soap on a large scale. The fatty acid profile of the various raw materials used for the preparation of calcium soaps is shown in *Table 1.*

In all the samples, fatty acid content analysis shows that the most significant fatty acids are palmitic and oleic acids, with a small amount of linoleic acid. In milk production, the mammary glands can synthesize short chain fatty acids from acetic, propionic and butyric acids. These three acids are the fermented products of fibre in the rumen. Long chain fatty acids need to be added to the animal feed. All the C 18 fatty acids and 50% C16 fatty acid in the milk come from fat supplement in the animal ration.

Figure 2 shows the various calcium soaps derived from the various fatty acids. Calcium soaps derived from palm acid oil and palm fatty acid distillate are found to be slightly coloured. Therefore the raw materials, PAO and PFAD, need to undergo pretreatmant before processing into calcium soap. A second refining or chemical treatment of these raw materials to the required specification is necessary.

Table 2 shows the fatty acid profile of the calcium soaps derived from the raw materials in *Table 1.* Palm based calcium soap containing high C16 and C18:1 with a small amount of linoleic acid, therefore can be incorporated to enhance energy dense materials in the animal feed. Of the four products, calcium soaps obtained from PAO contained the highest unsaturated fatty acid content, followed by PFAD, DPOFA and DPSFA. Commercial calcium soap from PAO is available under the name of Megalac. Another product Priplus Prime has a typical fatty acid content of 44% palmitic acid, 35% stearic acid and 12% oleic acid and is derived from mixed acids (King,1988). DPFA can be used as feedstock for calcium soap if mixed with other fatty acids such as stearic acid to increase the amount of long chain fatty acids in the final product.

CONCLUSION

Lifestock performance especially in the lactating cows can be enhanced by incorporating calcium soap to the level of 10-20% (King, 1988) without affecting the rumen microorganism activities. The addition of calcium soap will increase energy density of the diet especially for animals with poor lactating capability. With the abundance of palm oil derived raw materials, calcium soaps can be manufactured easily at a competitive price. Studies have also supported the addition of calcium soap and that palm-based calcium soap increased the yield and quality of the milk.

TABLE 1. FATTY ACID COMPOSITION OF THE RAW MATERIALS (%)

FATTY ACIDS	PAO	PFAD	DPOFA	DPSFA
Lauric C12:0	0.1	1.0	0.3	0.2
Myristic C14:0	1.0	1.5	1.0	1.0
Palmitic C16:0	44.3	48.9	50.1	60.8
Palmitoleic C 1 6: 1	0.1	0.2	0.2	0.1
Stearic Cl8:0	4.4	4.0	4.9	4.9
Oleic C18:1	39.0	35.7	37.5	26.3
Linoleic C18:2	9.6	8.1	5.9	5.4
Arachidic C20:0	0.7	0.4	-	0.3

Figure 2. Calcium Soaps Derived from Various Palm Fatty Acids

TABLE 2. FATTY ACID COMPOSITION OF CALCIUM SOAPS (%)

FATTY ACIDS	PAO	PFAD	DPOFA	DPSFA
Lauric C12:0	0.1	0.5	0.3	0.2
Myristic C14:0	1.0	1.4	1.0	1.0
Palmitic C16:0	45.1	53.1	52.2	68.6
Palmitoleic C 16:1	0.1	0.2	0.2	0.2
Stearic C18:0	4.4	4.2	5.3	5.9
Oleic C18:1	39.0	34.3	36.9	22.5
Linoleic Cl8:2	9.6	6.1	3.7	1.3
Others	0.3	0.2	0.4	0.3

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