

FRACTIONATED RBD PALM STEARIN AS POTENTIAL RUMEN BYPASS SUPPLEMENTS

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ABSTRACT. Refined, Bleached and Deodorized Palm Stearin (RBDPS) is a solid fraction obtained from Refined, Bleached and Deodorized Palm Oil after fractionation by crystallization at controlled temperature. Fractionated RBDPS was found to be enriched with C16 fatty acids, lacking in trans fat and has a high melting point. The fractionated RBDPS produced had an iodine value of 13.1 gI₂/100g, C16 content of 79.7% and melting point 60°C. These characteristics indicate fractionated RBDPS has potential as a rumen bypass fat as well as providing desirable carbon chain composition for good milk characteristics.

Keywords: Fat supplement, Ruminant, Triglyceride, Fatty Acid, Bypass Fat, Animal Feed, Palm oil

INTRODUCTION

Fat is an important component in ruminant feed diet. It has been well accepted to include fat as part of animal feed diet to yield more energy compared to other organic nutrients when metabolized by ruminant (B.W. Hess *et al.*, 2007). Fats are used to increase energy density in order to boost milk production, especially in dairy cattle that are dedicated

for high milk yield during early lactation period. Early lactation cattle often have a negative energy balance, as energy intake is not enough to meet their requirement (Coppock *et al.*, 1981). Therefore, it is necessary to maximize the energy intake by increasing energy density of the diet in the form of fat components. However, fat supplementations can also cause reduction of fiber digestion in rumen and reduce the milk fat percentage (Jenkins *et al.*, 1992).

Rumen bypass fat is a rumen inert fat designed to provide the extra energy that lactating dairy cows require, without causing the rumen problems associated with fats and oils. Interest in this type of fat supplement has increased over the past decade. (B.W. Hess *et al.*, 2008). Several studies have discussed on the production of rumen bypass fats from prilled, hydrogenated and calcium salts of fatty acids (Carrol *et al.*, 1990, Cannace *et al.*, 1990, Jenkins and Jenny, 1992). Other acceptable rumen bypass fats are hydrogenated fats derived from various sources of vegetable oils. (Eastridge *et al.*, 1990). However, the use of palm oil as rumen bypass fats has not been reported extensively.

Palm oil is used in a wide range of diverse products and by-products and offers great opportunities for animal feeding systems (*Wan Zahari and Alimon, 2004*). Palm oil after refining can be fractionated to produce different melting point fractions. During this process, it is partially crystallized and separated into a high melting fraction, or Refined, Bleached and Deodorized Palm Stearin (RBDPS), and low melting fraction or Refined Bleached Deodorized Palm Olein (RBDPOL). The RBDPS has a high melting point range of 50-55°C and fulfills one of the characteristics required to be a rumen bypass fat. It is also a very useful source of fully natural hard fat component and therefore an excellent candidate raw material for a rumen bypass fat.

This study investigates the characteristics of fractionated RBDPS which has potential use as a rumen bypass fat. The fractionated RBDPS was characterized in terms of free fatty acid content, iodine value, moisture content, melting point and fatty acid composition.

MATERIALS AND METHODS

RBDPS was obtained from Sime Darby Jomalina Sdn Bhd. Chemicals for the analyses were purchased from Merck (M) Sdn Bhd.

Fractionation of RBD Palm Stearin

Fractionation of RBDPS was conducted with a 50 kg pilot plant scale fractionators and membrane filter. RBDPS was first heated to 80°C for crystal destruction that may present in the material. The melted RBDPS was then fractionated according to cooling program shown in Table 1. The fractionated RBDPS was then pressed with a membrane filter to obtain hard stearin.

Fractionated RBDPS was characterized according to free fatty acid content, moisture, iodine value, slip melting point and carbon chain distribution.

Free Fatty Acid

Free fatty acid was determined according American Oil Chemists' Society (AOCS) method Ca 5a-40 (*AOCS Test*

Table 1. Cooling Program for Fractionation of RBD Palm Stearin

Step	Temperature, °C	Duration (Hour)
1	70	0.5
2	60	1.0
3	55	1.0
4	50	1.0
5	45	1.5

Method, 1998). Free fatty acid measure the extending of hydrolysis which has liberated the fatty acid from their ester linkage with the parent glyceride molecule. 1 g of sample was weighed and 50 ml of neutralized isopropanol was added subsequently to dissolve the sample. Few drops of phenolphthalein were added and the solution was titrated with 0.5N potassium hydroxide solution to a pink end point. The result is reported as percentage of free palmitic acid.

Iodine Value

The iodine value is a measurement of unsaturation of fats and oils. It is expressed as the number of grams of iodine absorbed by 100 g of the fat under the test condition used. (*PORIM Test Methods*, 1995). Iodine value was determined according to AOCS method Cd 1b-87. Sample (1 g) was weighed and dissolved in 20 ml of cyclohexane before 25 ml of Wijs solution was added. The solution was kept in a dark room for 30 min. 20 ml of potassium iodide solution and 50 ml of distilled water were added to the solution. The solution was titrated with 0.1N sodium thiosulfate to a colourless end point.

Moisture Content

Moisture content was determined by gravimetric method. Sample (5 g) was heated up to 105°C in an oven for 1 hour. The sample was then cooled down in a dessicator before weighing. The sample

was later heated to 105°C for another 30 minutes. This step was repeated until the sample obtained constant weight.

Melting Point

Melting point was determined by dipping a capillary tube into melted sample to a depth of about 10 mm. The sample was allowed to solidify in the tube for 16 hours at 10°C. The tube was later attached to a thermometer such that the lower end is level with the bottom of the thermometer. The thermometer was suspended in a beaker containing distilled water with temperature adjusted to 10°C lower than estimated melting point. Result was taken once the sample in the tube melted.

Fatty Acid Composition

Fatty acid composition was determined according to AOCS method Ce 1b-89. Sample was initially converted to methyl ester using boron trifluoride and was subsequently injected into gas chromatograph to obtain fatty acid composition.

RESULTS AND DISCUSSION

RBDPS was characterized according to free fatty acid, moisture, iodine value, slip melting point and carbon chain distribution. The results obtained were tabulated in Table 2. The hard stearin produced was benchmarked against typical specifications

for rumen bypass fat supplement products that are available.

Table 2 shows that RBDPS was not suitable as fat supplement itself. RBDPS has an iodine value 38.7 g I₂/100g and melting point 50.8°C, which corresponds to a high percentage of oleic acid at 32%. Both parameters fall outside the specifications for rumen bypass fat. Therefore, RBDPS was further fractionated to remove excessive olein and to obtain hard stearin with lower IV and higher melting point.

Hard stearin obtained after fractionation has higher melting point and lower iodine value. This is due to removal of the olein fraction. This is reflected in the carbon chain composition for hard stearin, whereby the palmitic acid increased from 54.36% to 79.7%. The unsaturated portion such as oleic (C18:1) and linoleic acid (C18:2) were decreased from 32.3%

to 12% and 6.7% to 2.3%, respectively. The increase in saturation and decrease in unsaturation of the fatty acids contributed to lower IV value and increased in melting point.

Maczulak *et al.*, (1981) investigated the effect of saturated and unsaturated long chain fatty acid on growth of rumen bacteria. It was found that palmitic and stearic acids does not greatly affect the growth of rumen bacteria. Whereas, Chalupa *et al.*, (1984) reported that oleic acid significantly inhibits the growth of cellulolytic species. Therefore, the saturated fatty acid promotes a better rumen environment for the bacteria and does not confer detrimental effects on its activities.

Further reports also illustrate the importance of carbon chain and types of fat supplements to fiber digestion in dairy

Table 2. RBDPS and Hard Stearin Characterization

Parameter	RBD Palm Stearin	Hard Stearin	Specification Required
Moisture, %	0.035	0.042	0.5 max
FFA as Palmitic Acid, %	0.034	0.03	0.1 max
Iodine Value	38.73	13.10	20 max
Slip Melting Point, °C	50.80	60.00	56-60
Carbon Chain Distribution, %			
C12	0.16	0.10	N/A
C14	1.16	1.07	N/A
C16	54.36	79.70	70-80
C18	4.71	4.54	4-6
C18:1	32.31	11.96	10-15
C18:2	6.68	2.27	2-4
C20	0.37	0.29	N/A

cattle. Steele and Moore (1968) found that shorter carbon chain caused greater depression in fiber digestion compared with longer carbon chains. The use of free fatty acid as fat supplement can also cause greater depression in fiber digestibility than corresponding triglycerides (Macleod and Buchanan-Smith, 1972).

CONCLUSION AND RECOMMENDATION

Fractionated RBD Palm Stearin has an iodine value 13.1 g I₂/100g and with the high melting point, it is insoluble at rumen environment temperature. This product appears to possess optimum characteristics as a fat supplement for dairy cattle consumption due to its inertness towards rumen activities fatty acid composition for milk quality. This study shows that further investigation of fractionated RBDPS for formulation and digestive evaluation trials using dairy cattle is warranted.

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