

PALM KERNEL CAKE APPLICATIONS IN ANIMAL FEEDS FORMULATIONS

Dr Wan Zahari Mohamed

Chief Technology Officer

CKSB Technology Sdn Bhd

SYNOPSIS

- ❖ **Brief introduction on PKC production**
- ❖ **The nutritive value of PKC**
- ❖ **Attributes of PKC**
- ❖ **PKC in rations for ruminants**
- ❖ **PKC in rations for non ruminants**
- ❖ **PKC in rations for other species**
- ❖ **Present research related to PKC utilization for poultry**
- ❖ **Other oil by-palm by-products: OPF, POME, PPF and SBE.**

Abbreviations used

- DM: dry matter
- DMI: dry matter intake
- ADG: average daily gain
- CP: crude protein
- CF: crude fibre
- EE: ether extract (fat)
- ME: metabolisable energy (MJ/kg)
- FCR: feed conversion ratio (g feed/gain)

Introduction

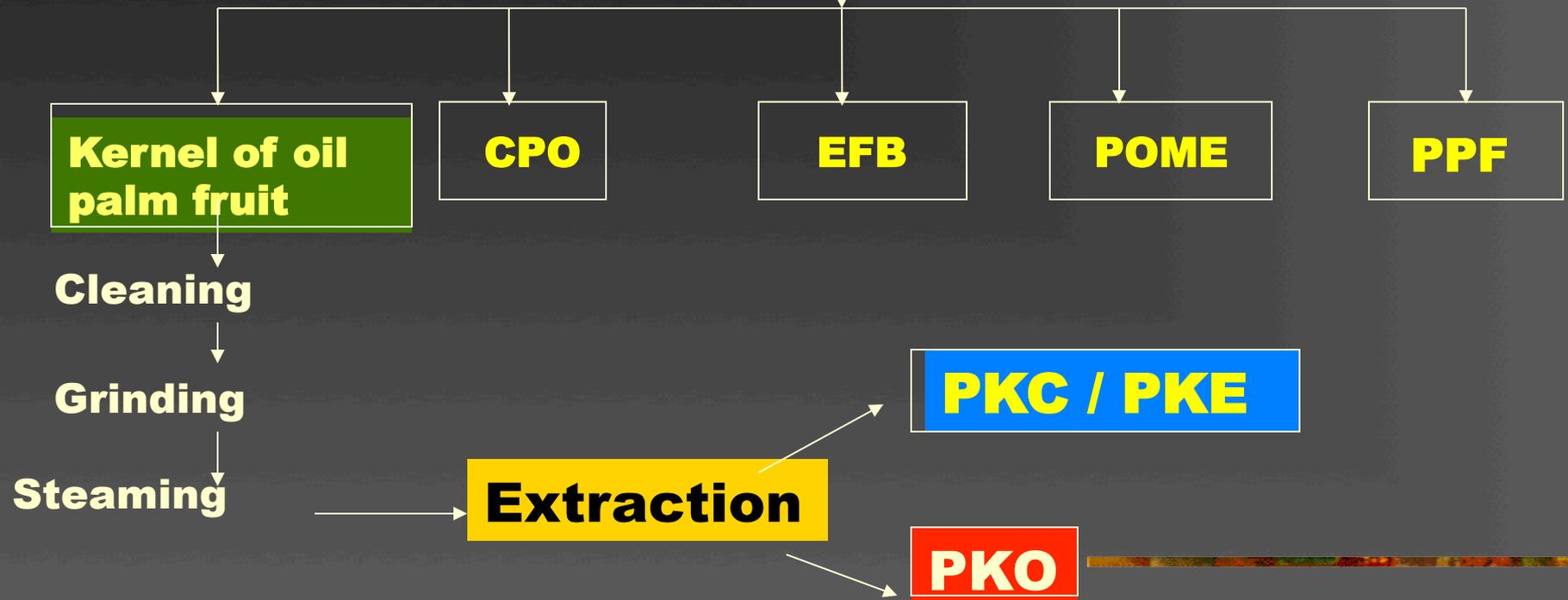
- **Palm kernel cake (PKC) – an emerging feed for livestock**
- **A by-product of the oil palm industry**

Feed Materials From Oil Palm



Fruit Bunch

MILLING PROCESS



PROCESSING OF PKC

2 types / methods of oil extraction process

SOLVENT EXTRACTED (Expensive)
(PKC)

EXPELLER PRESSED / SCREW PRESSED
(PKE)
(99% in Malaysia)

PKC / PKE / PKM : Same
The term PKC is widely used

Nutritive values

- Dry matter – 93 %
- Crude protein – 16%
- Crude fibre – 17%
- ME for ruminants – 10.5 MJ/kg
- ME for poultry – 6.5 MJ/kg
- Highly digestible
- Palatable to all animals
- Minerals highly available

PKC: > 60% cell wall component: 58% mannan, 12% cellulose and 4 % xylan

COMPOUND FEED

- A mixture of feed ingredients obtained from various sources

FEED INGREDIENT

- A constituent of a compound feed
- Need further improvements if it is to be used as a sole ration

Comparative composition

PKC : Generally classified as an energy-feed

	CP (%)	ME (MJ/kg)	CF (%)	EE (%)	CP/ME (% / MJ)
■ PKC	16.0	10.5	17	8.0	16
■ Rice bran	18.0	8.0	24.4	10.3	22
■ Copra meal	20.5	9.9	16.5	16.5	21
■ Wheat pollard	14.4	10.2	9.0	9.0	14
■ Corn gluten feed	18.7	10.7	8.0	1.0	17

Mineral content of PKC

■ Calcium	0.21 – 0.34 %
■ Phosphorus	0.48 – 0.71 %
■ Magnesium	0.16 – 0.33 %
■ Potassium	0.76 – 0.93 %
■ Sulphur	0.19 – 0.23 %
■ Copper	21.0 – 28.9 ppm
■ Zinc	40.5 – 50.0 ppm
■ Selenium	0.23 – 0.30 ppm
■ Ca:P	0.36:1

Selected Amino Acid Content of PKC (g/16g N)

■ Lysine	2.68 *
■ Methionine	1.75 *
■ Histidine	1.91
■ Leucine	6.07
■ Isoleucine	3.22
■ Phenylalanine	3.96
■ Threonine	2.75
■ Valine	5.05

GOOD Protein Quality

GOOD amino acid profile
(better than maize, lower
than SBM)

Availability of amino acids
62 –87%

High by-pass value (65 –
75 %), not broken down in
the rumen, excellent for
dairy cattle

PKC contain high residual fat (10%)

Fatty acids content of kernel oil (g/100g oil)

■ Caproic [C6:0]	0.2
■ Caprylic [C8:0]	3.0
■ Capric [C10:0]	4.0
■ Lauric [C12:0]	48.0
■ Myristic [C14:0]	16.0
■ Palmitic [C16:0]	8.0
■ Stearic [C18:0]	3.0
■ Oleic [C18:1]	15.4
■ Linoleic [C18:2]	2.4
■ Arachidic [C20:0]	0.1

Additional Nutritive Value

High in beta carotene

4.3 – 11.8 mg/kg

14 – 39,000 IU vitamin A

High in vitamin E

0.35 mg/kg

0.3 IU / kg)

Natural antioxidant

Attributes of PKC

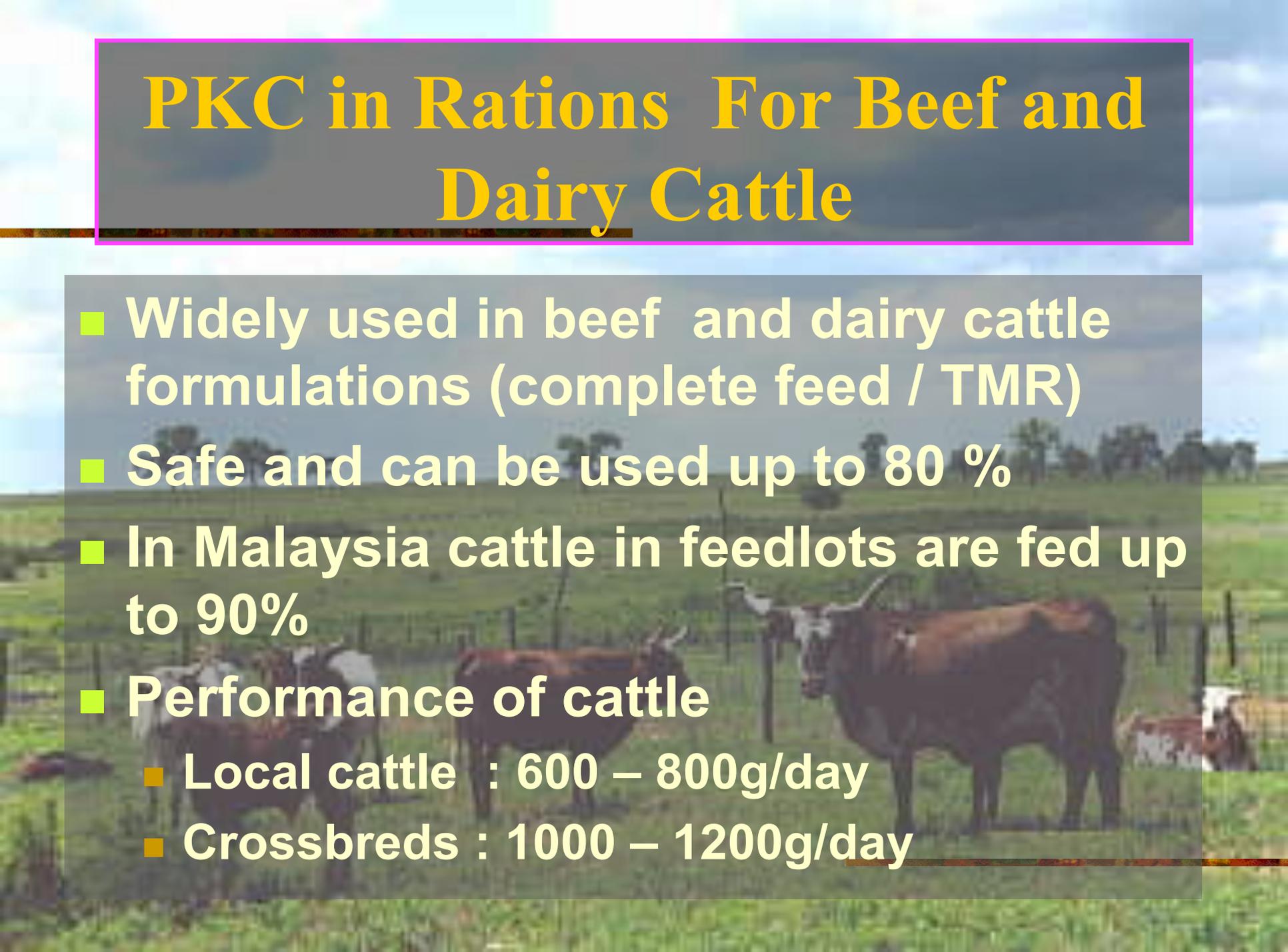
- **Safe for all livestock**
- **No dioxin**
- **No aflatoxin**
- **No heavy metals**
- **GMO free**
- **No pesticides**

PKC in Rations For Ruminants

- PKC is widely used in many ruminants rations
- Commonly used in rations for cattle, buffalo, sheep, goats and also deer - feedlots
- Suitable for combination with other low energy roughages

PKC in Rations For Beef and Dairy Cattle

- Widely used in beef and dairy cattle formulations (complete feed / TMR)
- Safe and can be used up to 80 %
- In Malaysia cattle in feedlots are fed up to 90%
- Performance of cattle
 - Local cattle : 600 – 800g/day
 - Crossbreds : 1000 – 1200g/day



PKC in Rations for Beef Cattle

■ Example of beef cattle formulation:

- | | |
|---------------|--------|
| ■ PKC | 80 % |
| ■ Rice bran | 4.0 % |
| ■ Grass/hay | 15.0 % |
| ■ Limestone | 0.5 % |
| ■ Vitamin mix | 0.5 % |

BEEF CUTS: SUPERIOR

Performance of beef cattle fed PKC in Malaysia

Breed	ADG (kg)	DMI (kg)	FCR
SF/LJ	0.59	5.34	9.05
Kedah Kelantan	0.66	5.71	8.65
Sahiwal Friesian	0.75	4.77	6.36

SF/LJ – Sahiwal Friesian x Jersey

PKC in Rations for Dairy Cows

- Commonly included in dairy rations
- Average yield: 10 – 14 L/day/head
- Ability to increase milk fat
- May be included as supplement of at least 1 kg/day or 20 – 50% of total ration

PKC in Rations for Dairy Cows

Example of a dairy ration

PKC	50.0 %
Grass/hay	42.0 %
Molasses	5.0 %
Limestone	1.5 %
Premix	1.0 %
Salt	0.5 %

In Europe PKC is used mainly in dairy rations

PKC in Rations for Sheep and Goats

- Safe for sheep and goats
- Grazing sheep often supplemented with PKC
- Optimum allowance – 50% of ration
- Risk of copper toxicity if fed 80-90%
- Can be overcome by adding $ZnSO_4$ or Ammonium molybdate
- Performance of sheep: 200-250 g/day

100 ppm Zinc sulphate or 5.2 ppm ammonium molybdate + 440 ppm sodium sulphate

PKC in Rations for Sheep and Goats

Example 1

PKC	50 %
Grass/hay	30 %
Rice bran	10 %
Soya bean meal	9.0%
Premix	1.0%

Example 2

PKC	92.6%
Limestone	2.8%
Salt	1.0%
Na_2SO_4	440mg/kg
$\text{NH}_4 \text{MoO}_4$	5.2mg/kg

PKC in Poultry Rations

- Due to high crude fibre the use of PKC in poultry rations is limited
- Broiler chickens can tolerate up to 20 % PKC
- Layer chickens can tolerate up to 25% PKC
- Ducks can tolerate up to 30 %

PKC for Poultry

Broiler ration (%)

■ PKC	20.0
■ Palm oil	6.0
■ Maize	39.8
■ Soya bean meal	25.0
■ Fish meal	5.0
■ Lucerne meal	2.0
■ DCP	1.5
■ Salt	0.25
■ Premix	0.30
■ DL-methionine	0.15

PKC for Poultry

(layer Ration)

■ PKC	20.0
■ Palm oil	2.0
■ Maize	45.4
■ Soyabean meal	14.5
■ Fish meal	7.0
■ Lucerne meal	2.0
■ DCP	1.5
■ Limestone	3.0
■ Oyster shell	4.0
■ Premix	0.3
■ Salt	0.3

Performance of Layer - Breeders (21-51 Weeks)

Diet	% Egg prodn.	Egg mass (kg)	FCR
Control	69.8	6.9	2.51
20% PKC	72.6	7.0	2.43
40% PKC	65.4	6.4	2.64

PKC in Meat Duck Ration (%)

■ PKC	25
■ Palm oil	5.3
■ Maize	45.1
■ Soyabean meal	17.3
■ Fish meal	3.0
■ Salt	0.25
■ DCP	1.56
■ Limestone	0.12
■ DL methionine	0.06
■ Lysine	0.06

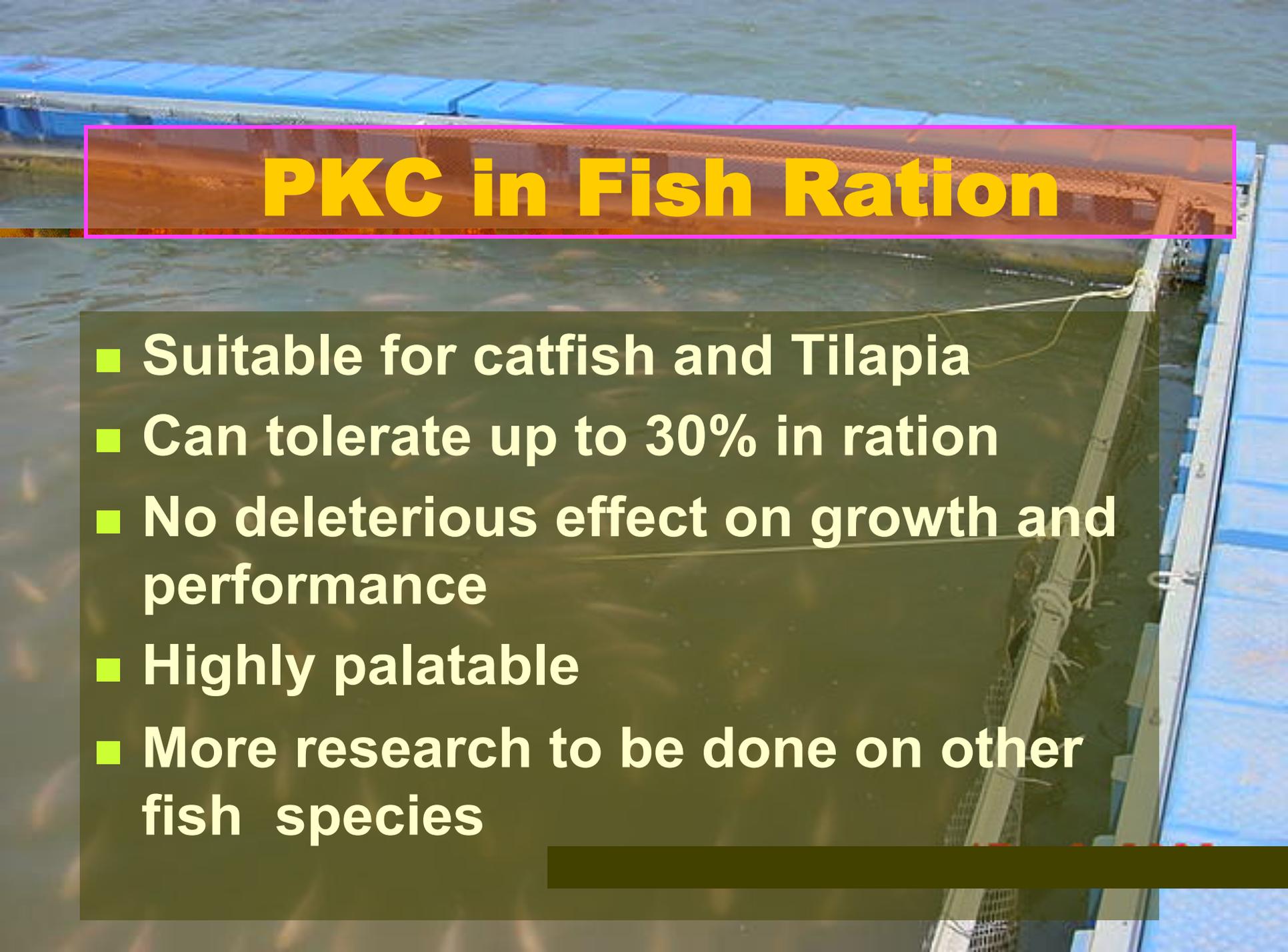
PKC in Ration for Swine

- Safe for swine
- Growers and finisher : 20 – 25 %
- Suitable for gestating sows
- Also for breeder boars
- No effect on back fat
- No aflatoxin

PKC in ration for Swine

%

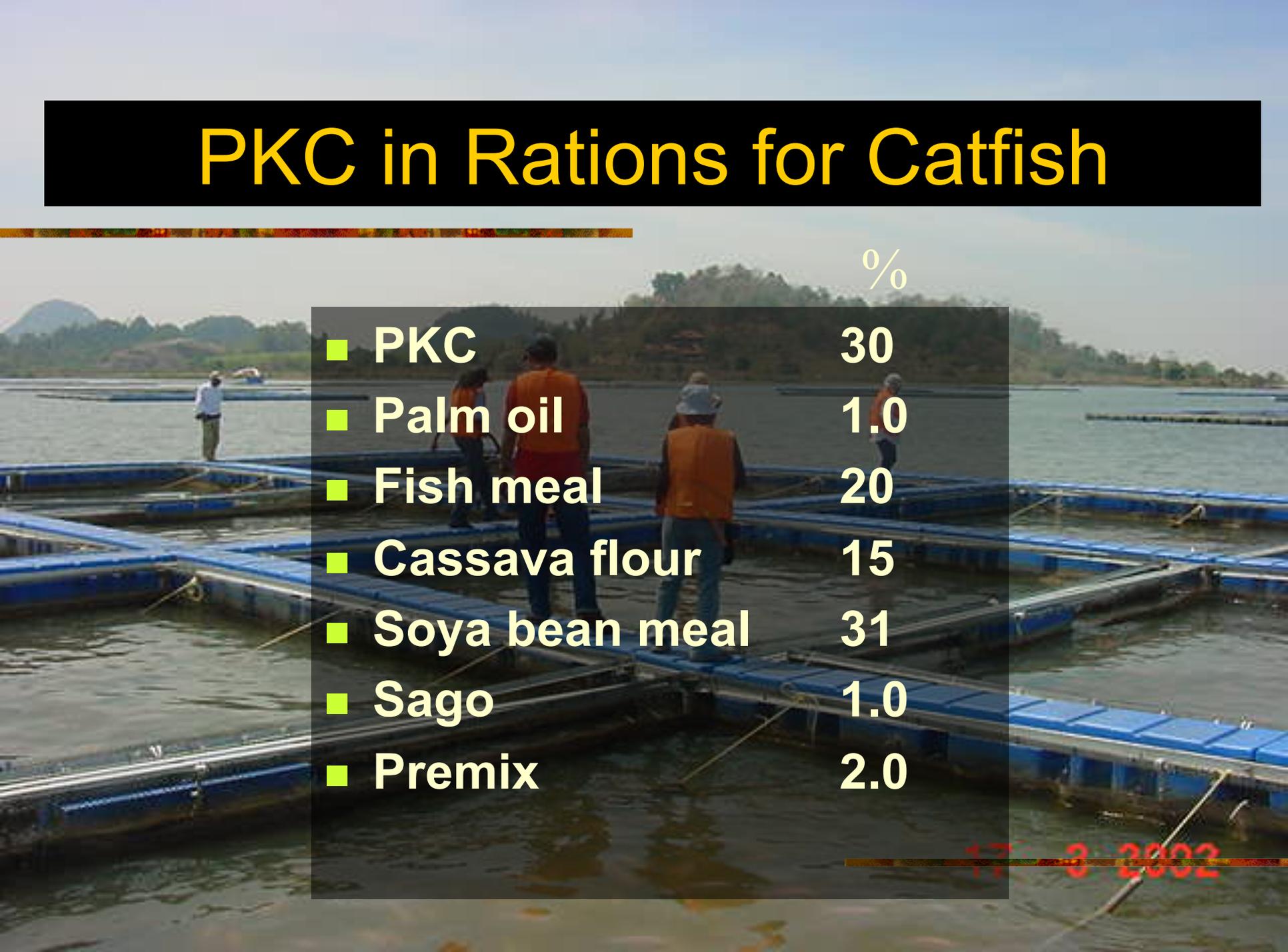
■ PKC	20
■ Maize	65.5
■ Soyabean meal	9.5
■ Fish meal	3.0
■ DCP	1.5
■ Salt	0.3
■ Premix	0.2



PKC in Fish Ration

- **Suitable for catfish and Tilapia**
- **Can tolerate up to 30% in ration**
- **No deleterious effect on growth and performance**
- **Highly palatable**
- **More research to be done on other fish species**

PKC in Rations for Catfish



	%
■ PKC	30
■ Palm oil	1.0
■ Fish meal	20
■ Cassava flour	15
■ Soya bean meal	31
■ Sago	1.0
■ Premix	2.0

Present Research

- Improvement of PKC utilization through fungal treatment
- Use of enzymes such as mannanase to improve fibre digestibility
- Supplementation with other by-products
- Balance of minerals through supplementation

**BIOMASS
FROM
TREE**

**FEED
INGREDIENTS
FROM
PROCESSING**

OPF

EFB

OPT

PPF

PKC

**FATS FOR
FEED**

POME



Usage

As a source of
roughage (fibre) & energy
for ruminant animals.

Oil Palm Fronds (OPF)

Continuously available in the plantation

Collected during pruning and replanting

Made up of a petiole (70 %) and rachis & leaflets (30%)



OIL PALM FRONDS (OPF)

Oil Palm Fronds - Advantages

- Superior roughage source
- Good palatability
- Supply energy and fibre
- Nutritive value between hay and straw
- Meets maintenance requirements for energy and protein
- Practical and cost effective
- Ideal for total mixed ration (TMR) or complete feed

Oil Palm Fronds - Nutritive Value

Dry matter (DM)	32.6 %
Crude protein (CP)	4.5 %
Crude fibre (CF)	25.4 %
Ether extract (EE)	0.6 %
Ash	3.6 %
N-free extract (NFE)	54.5 %
Calcium (Ca)	0.18 %
Phosphorus (P)	0.05 %
Total Digestible Nutrient (TDN)	46.5 %
Metabolisable energy (ME)	6.76 MJ/kg



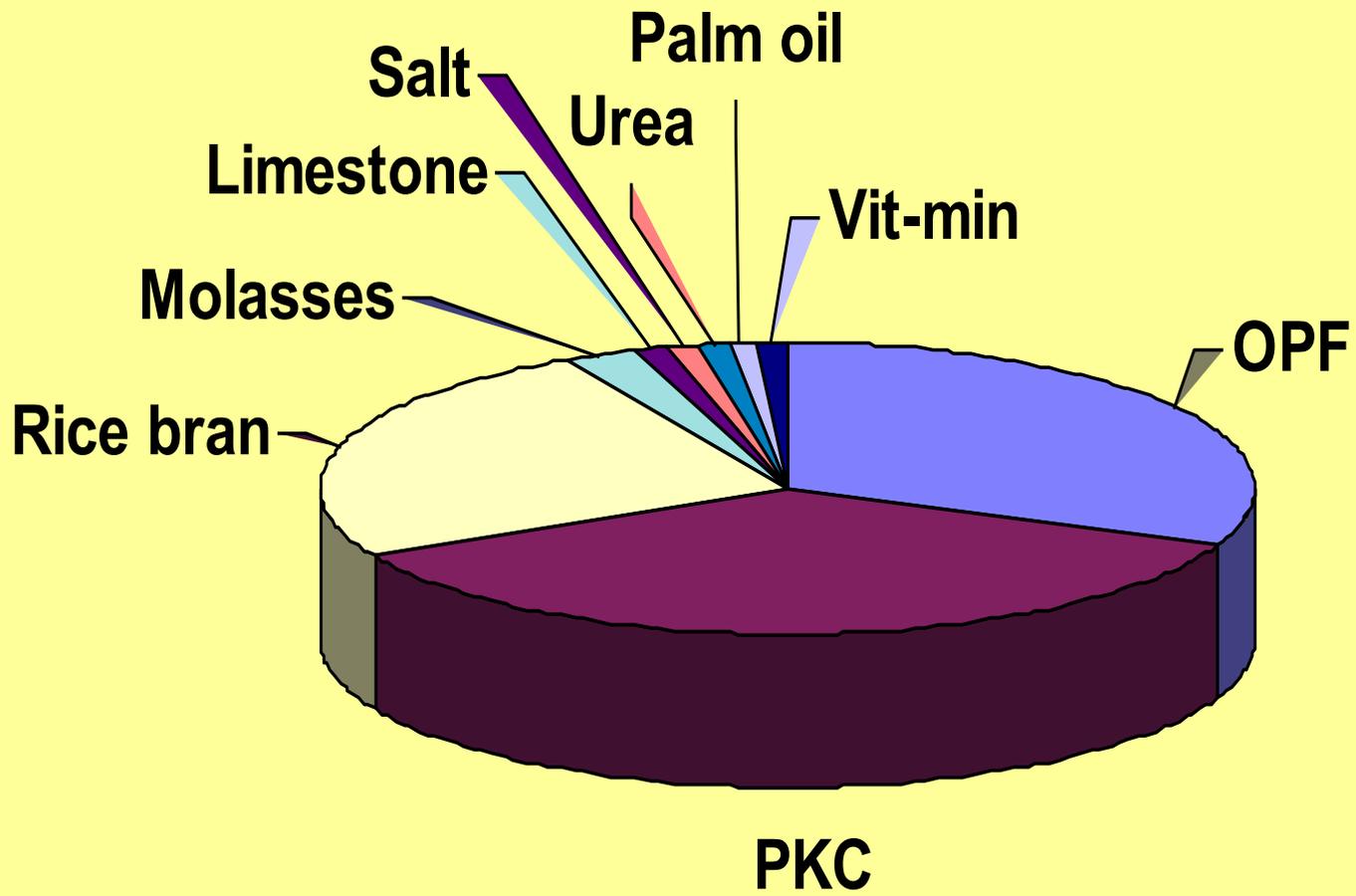
OPF SILAGE MADE IN DRUMS



OPF PELLETT



OPF CUBES



Formula of OPF pellet

OPF Feeding on Beef Cattle

Diet	Rate of growth (g/day)	Management System
OPF (30%) PKC (70%)	500 – 750	Feedlot
OPF (15 %) PKC, corn, molasses and grasses (75 %)	1,200	Feedlot



KEDAH-KELANTAN CROSSES

OPF UTILISATION BY DAIRY CATTLE

Intensive Dairying

Milk yield: 15 - 20 liter/day

Feed cost: US 0.17/kg

Intake : 14 kg/d

Complete diet based on OPF was shown to be equally effective in supporting milk production as that based on grass

Palm Oil Mill Effluent (POME)

- Discharge from palm oil extraction in the mill.
- Residue left from the purification of CPO
- Includes various liquids, residual oil and suspended solids.
- Contains about 95 % water.
- Wide variability in ash content
- Wide different in feeding values
- Usually utilized as organic fertilizer in crop cultivation

Continue:

- Satisfactory LWG (0.47 - 0.78 kg/day) for cattle obtained with a mixture of POME - PPF - PKC based diets.
 - LWG and FCE of poultry reduced when POME was fed above 15 %.
 - Optimum POME levels in diets for broilers and layers were 15 and 10 % respectively.
-

POME – Nutritive Value

Dry matter (DM)	91.1 %
Crude protein (CP)	11.1 %
Crude fibre (CF)	17.0 %
Ether extract (%)	12.0 %
Ash (%)	9.0 %
Nitrogen free extract (NFE)	50.5 %
Calcium (Ca)	0.70 %
Phosphorus (P)	0.50 %
Total Digestible Nutrient (TDN)	45.0 %
Metabolisable energy (ME)	6.52 (MJ/kg)

Palm Press Fibre (PPF)

- More than 2 million tonnes /year
- Mainly used for fuel in palm oil mills.
- A fibrous by-product of crude oil extraction of the mesocarp.
- Low CP (4 %) and ME value
- low digestibility (about 22.3 %)
- Optimum inclusion level 20 %
- Fed in the form of fresh or silage.
- Bolus formation and impairment of rumen activity at higher levels.

Palm Press Fibre (PPF) – Nutritive Value

Dry matter (DM)	86.2 %
Crude protein (CP)	5.9 %
Crude fibre (CF)	48.6 %
Ether extract (%)	5.8 %
Ash (%)	3.3 %
Nitrogen free extract (NFE)	36.5 %
Calcium (Ca)	0.32 %
Phosphorus (P)	0.27 %
Total Digestible Nutrient (TDN)	29.8 %
Metabolisable energy (ME)	4.02 (MJ/kg)

Crude Palm Oil (CPO)

- High palmitic acid (C16:0) (37.0 %) and oleic acid (C18:1) (47.0 %).
- The B-carotene : 54 g/100 ml of CPO.
- Fatty acid about 5 %.
- Pro-vitamin A activity 640 I.U./g.
- Used at about 5 % level in diets for pigs and poultry as a source of vitamins A and D.
- Higher levels of up to 10 % in diets for growing and finishing pigs
- Supplementation of 2 - 8 % of CPO increased yield and milk fat content in dairy animals.

SPENT BLEACHING EARTH (SBE)

- By-product from the palm oil refineries
 - 25 – 30 % CPO
 - Useful source of energy, minerals and vitamins
 - 160,000 tons / year
 - No toxic minerals
 - Potential as a feed ingredient
-

Rumen By-Pass (Rumen Protected) Fats

- High producing dairy cows
- Negative energy balance in early lactation.
- Weight loss over the first 60 – 80 days of lactation
- Mobilizes body reserves such as body fat to meet the energy demand.
- Maximum efficiency of milk production achieved when fat contributes between 16 % -18 % of the dietary ME intake.

Oil Palm Based Protected Fats

- Formaldehyde protected fat
- Calcium soaps
- Calcium salts
- Palm fatty acid distillate (PFAD).

CONCLUSION

- Malaysia - consistent supplier of PKC
- PKC - excellent feed ingredient
- Ideal feed for growing, finishing animals
- Can be used at high levels in ruminants without deleterious effects
- Limited use in poultry rations: safe at 15-25 %
- Ducks can tolerate PKC better than chickens
- PKC can also be used for fish and other aquaculture species

Summary of Inclusions in livestock rations

■ BEEF CATTLE	50 - 90 %
■ DAIRY CATTLE	25 - 50 %
■ SHEEP	50 - 90 %
■ MEAT GOATS	50 - 90 %
■ DAIRY GOATS	30 - 40 %
■ SWINE	20 - 35 %
■ POULTRY	20 - 25 %
■ FISH	20 - 25 %

Conclusion

PKC can be used extensively as the main ingredient for ruminant and non-ruminant livestock, with confident.

Other oil-palm by-products such as OPF, POME and PPF can be utilized as additional ingredients to PKC based feed.

Complete feed based on PKC is practical and cost-effective for current and future livestock development in Malaysia and Vietnam.

A background image of several pink flowers with green leaves, slightly out of focus. The flowers are the main visual element of the slide.

**Oil palm industry – Environmentally
Friendly, Sustainable, Zero waste**

THANK YOU