MAXIMIZING USE OF BY-PRODUCT INGREDIENTS – HIGH NUTRIENT POTENTIAL, BUT CHEAP RESOURCE

Major feed importing countries typically importing over 50% of their feed requirement, like the Philippines, are automatically saddled by over 10% higher feed cost, due to shipping, handling and related costs. This translates at least 8% higher production costs over major producers, easily offsetting labor cost advantages.

This underscores the need for a more efficient feed utilization and conversion and maximizing use of locally available and cheaper by-products.

LOCALLY AVAILABLE AND CHEAP RESOURCE

Agricultural by-products ingredients, i.e. rice bran, copra meal, palm kernel meal, guar, etc, are cheap, locally available feed resource. High nutrient potential, but are inherently limited in feeding use by the typically high fiber content.

FIBER/NON-STARCH POLYSACCHARIDE (NSP) PROFILES OF SOME COMMON INGREDIENTS, BY PRODUCTS AND NON-TRADITIONAL INGREDIENTS

	NDF %	ADF %	HC %
Corn grain	9.6	2.8	6.8
Soybean meal	13.3	9.4	3.9
Wheat, hard red	14.0	4.5	9.5
Cassava meal,chips	29.5	9.1	20.4
Rice bran	23.7	13.9	9.8
Brewer's rice (binlid)	12.2	3.1	9.1
Sorghum	18.0	8.3	9.7
pollard	42.1	13.0	29.1
DDGS	43.0	12.8	30.2
Copra meal, solv	51.3	25.5	25.8
Palm kernel meal, exp.	61.5	40.2	21.3

*Adapted fr: Agriaccess data 2004- 2013; NRC 2012
NDF=Neutral Detergent Fiber ADF = Acid Detergent Fiber (cellulose+lignin)
HC = hemicellulose
*CRUDE FIBER IN STANDARD FEED ANALYSIS COMPRISES OF LIGNIN AND CELLULOSE

Total Fiber of byproducts range from 24% to 61%, or from 2 times to 6 times more than the traditional corn-soy (around 12%).

As monogastrics (pigs and poultry) can only tolerate a maximum of 15% Total Fiber, adding just 5% of coprameal in the ration, for example, automatically increases Total Fiber by 2.5 percentage points to the tolerable limits. It is therefore of common experience that levels beyond 5% incorporation rate of coprameal (or 8% rice bran) directly reduces ADG and FCR.

Fibers are known to absorb over 5 times their weight in water. Wet droppings/manure are therefore commonly observed in high fiber diets.

Up to 40% of proteins in plant materials are also trapped in the fiber matrix, making these proteins also indigestible and unavailable to the animal.

Such realities are reflected in the manure. Manure analysis from typical corn-soy rations reveal that up to 60-70% of the protein (N) intake is in the manure, 35%-45% fiber content and at least a 3rd of the feed intake is in the manure (Aarnink, et.al,1997; Lawlor, et.al 2001; Mangalindan J, 2004) .

TARGETED ENZYMES - SPECIFICALLY DESIGNED TO DIGEST THE FIBERS/NSP IN HIGH FIBER BYPRODUCTS

Copra meal, for example, the by-product of oil extraction from copra, is nutrient dense, low cost considering its content, but poorly utilized. The poor utilization has been traced to very high levels of fiber, now more specifically referred to as Non-Starch Polysaccharides (**NSP**) ,that account for more than 50% of its weight/total content, and cause negative digestive and growth effects at high levels of incorporation.

WHY COPRA MEAL IS POORLY UTILIZED

TYPICAL ANALYSIS COPRA MEAL, PHIL. SAMPLES		
Crude Protein	20.8%	
Gross Energy	3210 kcal	
TOTAL FIBER	**51.3%**	
Neutral Detergent Fiber (NDF)	51.3%	
1.Acid Detergent Fiber (ADF)	25.5%	
2.Hemicellulose (HC)	25.8%	
2.1 **Betagalactomannan**		**>16.50%**
2.2 Betaglucan		<3.60%
2.3 Betamannan		<2.50%
2.4 Others		<3.30%

NDF – Total Fiber ADF – cellulose + lignin, insoluble HC – soluble fibers

Copra meal Total Fiber or NDF comprise over half (>51%) of its weight. The NDF in turn is almost equally made up of the insoluble fiber ADF (cellulose + lignin) and the soluble fiber HC. Almost 64% of the HC is betagalactomannan (16.5% by weight of coprameal), with the rest made up of betaglucan (3.6%% by weight), betamannan (2.5% by weight) and other minor Hemicellulosic forms.

As fibers are indigestible to simple stomach animals, i.e. pigs and poultry, the actual digestible energy of copra meal for these animals is less than half, or only around 1600 kcal.

As NSPs are known to be very viscous and absorb over 5 times their weight in water, they in effect depress nutrient absorption in the intestines, and create a filling effect, restricting feed intake specially in poultry which have limited gut volume. Up to 40% of the protein can also be bound in the NSP matrix, reducing actual protein bioavailability.

These facts explain why traditional Copra meal use at >10% incorporation rate in pigs and >5% in poultry invariably lead to negative digestive and growth effects.

SCIENCE BASED SOLUTION

TARGETED EXOGENOUS ENZYMES – effective tools in digesting NSPs

Advancements in enzyme production, isolation, and purification have made possible the targeted, efficient and economic use of exogenous enzyme supplements as tools in improving digestibility and increasing utilization of high NSP feed ingredients - allowing maximized use of cheap but high-calorie potential ingredients, like copra meal, palm kernel meal, rice bran, pollard, and other agricultural products and by-products, **without the usual digestive and growth depressant effects** .

Similarly, the specific, particular fibers contained in plant ingredients have been identified, together with the individual indicative levels. These have allowed the formulation of specifically targeted enzyme blends, designed to digest up to 70% of the fiber substrates in the targeted ingredients/rations.

MAJOR NSP SUBSTRATE (FIBER) PROFILES OF COMMON FEEDSTUFFS/RATIONS

CORN-SOY	GRAINS	OIL SEEDS	OIL NUTS
	wheat	soybean meal	copra meal
	rice	canola meal	palm kernel meal
	corn		guar meal
	brans		
cellulose	cellulose	cellulose	cellulose
xylan	xylan	betamannan	betagalactomannan
betaglucan	betaglucan		

*ADAPTED FR: AGRIACCESS DATA 2013

WHY ENZYME USE SHOULD BE TARGETED

1.**Specificity in action**

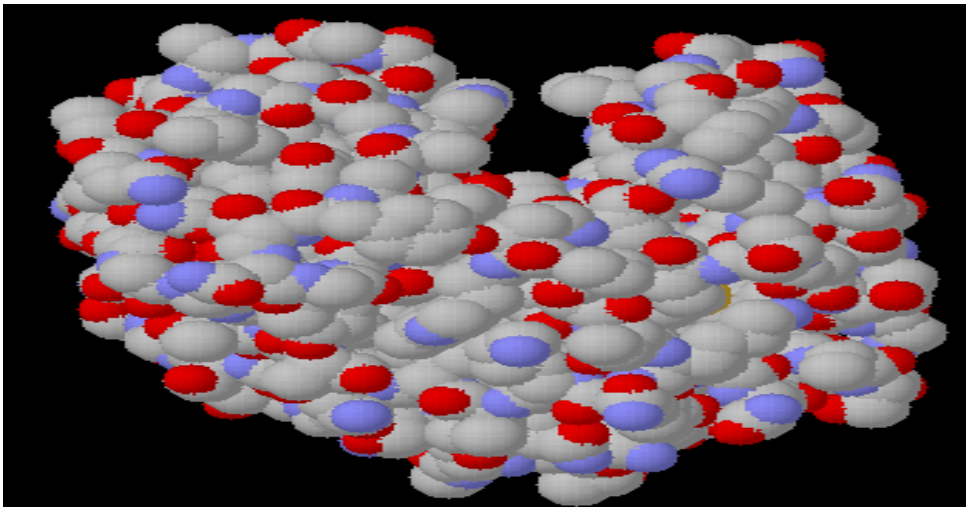
Enzyme activity is a target substrate specific – meaning an enzyme will act only on the specific substance it was designed for. Thus, *lactase* enzyme will act only on lactose, *cellulase* will act only on cellulose, *mannanase* will act only on mannans, and *betagalactommananase* will act only on betagalactomannan.

This specificity is more aptly described as a "**lock and key**" principle – a specific key can only work on the lock it was made for.

2**. Right Enzyme combinations**

As plant fibers exist in an interlocking and multi-layered matrix, the right combination of enzymes (and in sufficient amount of units) corresponding to the target substrate/s in the ingredient/ration is necessary to be able digest up to the inner layers of the fiber matrix.

For example, wheat NSP is primarily composed cellulose and xylanase in an interlocking and layered complex – thus requiring both cellulase and xylanase to effectively digest the NSP.



Molecular view of **Xylan** and **cellulose** complex in grains showing 3D physical, geometric and surface characteristics, and trapping of **proteins and other nutrients** inside fiber matrix

3. **Enzyme units:target substrate concentration**

In the live animal, as the movement of food from the mouth to the ileum is time constrained (more or less 40 minutes in the pig), the amount of enzyme units supplemented must be sufficient to digest the

expected amount of target substrate in the feed within the transit time, or else, whatever substrate is digested after the ileum will no longer be absorbed as desired.

Thus, the dose of the enzyme supplement must be target ingredient inclusion rate dependent – meaning it is increased or decreased according to the incorporation level of target ingredient.

PELLETING HEAT IMPACT

The supplement must retain enough desired activity after exposure to pelleting heat (>85degC). Enzymes are proteins , therefore inherently sensitive to heat. Thus, as a general rule, enzymes are recommended for post-pelleting application.

HOW WILL ONE KNOW THE ENZYME SUPPLEMENT WORKS

OBSERVABLE, MEASURABLE IMPACT OF ENZYME SUPPLEMENTATION

Manure size, consistency and form

As these enzyme supplements break down indigestible materials which normally end up as manure, the significantly reduced size of manure is a readily observable enzyme effect, and can be seen the next day. Drier and well formed manure will also be evidence of reduced manure NSP content **(>35% manure reduction)**

Laboratory Assay of Feed and Manure

The level of enzymatic degradation of NSPs in the feed can be accurately documented thru the measurement of NDF, ADF and HC in the manure, comparing with feed intake fibers **(>30% reduction in NSP content).**

FCR/Performance Gains

Achieved FCR/Performance gains will be proportional to digestibility and nutrient bioavailability improvements.

Lower Feed Intake at similar or better performance – a consistent feature of appropriate enzyme supplementation – leading to consistent FCR improvement **(>11% improvement in FCR)**

Lower Feed Cost

Significant reduction feed cost and feed cost/gain **(8-11%)**

COST COMPARISONS/ADVANTAGE OF BYPRODUCTS

2014 Philippine prices indicate the ff:

Corn	15/kg
Soy bean meal solv 46%	22
Rice bran d1	11
Copra meal	10
Palm kernel meal	8

For example, a 20% copra meal incorporation rate can effectively replace 14% corn and 6% soybean meal, plus an appropriate targeted enzyme supplement, on an isocaloric and isonitrogenous basis.

Thus:	200 kg Copra meal @10PhP/kg = 2,000	
	Replacing	
	140 kg corn @15/kg =	2,100
	60 kg of soybean meal @22/kg =	1,320

		3,420

SAVINGS 1,420 PhP/ton or 1.42PhP/kg

Depending on the prevalent price, by-products can partially, effectively replace higher priced ingredients, with the appropriate use of targeted enzymes, allowing more flexibility in the formulation strategy, at similar, or better performance levels.

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Updtd 2/1/2016