

Yeast and Their Uses in Feed



Mika Alewynse, PhD

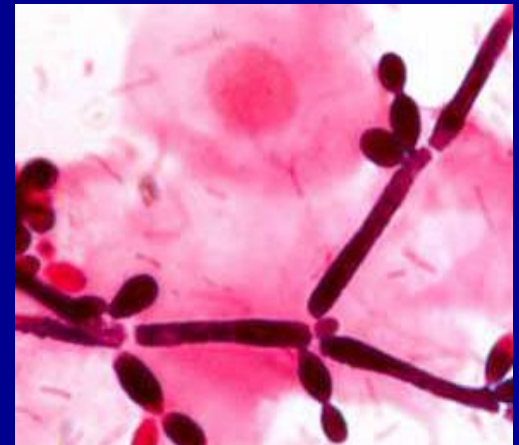
Division of Animal Feeds

Center for Veterinary Medicine

Presented at the April 2010 AAFCO Feed Administrators Seminar,
Hickory Knob State Park, South Carolina

Ingredient Definitions

- Where are they in the AAFCO Official Publication?
 - Yeast
 - Section 96
 - Fermentation products
 - Section 36
 - Various other sections
 - Distillers and miscellaneous products, for example



Tentative Definitions

- If have enforcement discretion letter, are fine with CVM
 - Ingredient name establishes common or usual name
- AAFCO OP has Model Regulation 6(f)
 - Tentative definitions for ingredient shall not be used until adopted as official, unless no official definition exists or the ingredient has a common acceptable name that requires no definition, (i.e. sugar).
- Some firms try to use this clause to say no definition is required
- If no other definition exists, a tentative definition can be used
- What does your state law say?

Appropriate Definitions

- How do I know the appropriate definition?
 - **Yeast** are described using the section 96, **Yeast**
 - **Bacterial** and **mold** ingredients are described using section 36, **Fermentation Products**
 - And never do the two mix.....

Appropriate Definitions (cont)

- So, how do I tell what is what?
 - Look at the scientific name of the organism
 - Look at where the organism is listed
 - Types of yeast are identified in section 96, Yeast
 - Bacteria and molds are identified in section 36, Fermentation Products
 - Exceptions

Appropriate Definitions (cont)

■ Exceptions

- Direct-fed Microorganisms, definition 36.14
 - Yeast (as defined elsewhere)
 - Elsewhere is in section 96, Yeast
- Enzymes
 - Microbial enzyme sources should be listed using section 36, Fermentation products definitions
 - Alpha-galactosidase
 - Invertase
 - Lactase
 - Lipase



Appropriate Definitions (cont)

- I know the section, what's next?
- Like all ingredients, read the definitions closely!
- The text in the definition is your friend!



Yeast Definitions

- Identify what is in the ingredient and its microbial origin
- Only a few organisms
 - *Saccharomyces cerevisiae*
 - *Saccharomyces boulardii* reclassified as *S. cerevisiae*
 - Label must use *Saccharomyces cerevisiae*
 - *Kluyveromyces marxianus*
 - *Candida utilis*, formerly *Torula*
- Two broad categories
 - Whole cells and solubles

Yeast Definitions (cont)

- Whole cells - with and without media
 - Dead – “non-fermentative”
 - 96.1 Primary dried yeast
 - 96.3 Irradiated dried yeast
 - Source of vitamin D
 - 96.7 Candida (Torula) dried yeast
 - 96.5 Grain distillers dried yeast
 - T96.12 Hydrolyzed yeast
 - Viable – “direct-fed microbial” definitions
 - 96.2 Active dry yeast
 - 96.8 Yeast culture



Yeast Definitions (cont)

- **Brewers Yeast – “non-fermentative”**
 - Obtained from the production of beer and ale
 - Separate definition for distillers yeast, 96.5
 - 96.4 Brewers dried yeast
 - 96.10 Brewers liquid yeast
- **Solubles**
 - 96.9 Molasses yeast condensed solubles
 - Liquid fermentation media
 - T96.11 Yeast extract
 - Cell contents of yeast

Yeast Definitions (cont)

- 96.8 Yeast culture* is the dried product composed of yeast (*Saccharomyces cerevisiae* and/or *Kluyveromyces marxianus*) and the media on which it was grown, dried in such a manner as to preserve the fermenting activity of the yeast. The media must be stated on the label.

*Note: No reference to media in main ingredient listing is required when yeast culture forms a component of a proprietary mixed feed.

- Grown on ground corn, hominy feed
- When is media listing required?
- Must be on single ingredient feed but could be listed on mixed feed label

Yeast Definitions (cont)

- Definitions are old and need updating
 - Novel yeast species should not be marketed under these definitions as there are concerns
 - Particularly from ethanol production
 - Pathogenicity and potential for toxin production
 - Botanical classification *Saccharomyces* is too broad
 - Asking for comments about proposed yeast culture definition and other yeast species with history of use in feed

Questions

Images courtesy of The Microbe World at www.edu.pe.ca/southernkings/microclass.htm

Fermentation Products in Feed



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Presented at the April 2010 AAFCO Feed Administrators Seminar,
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Fermentation Product Definitions

- Section 36 in the OP
- Identify what is in the ingredient and its microbial origin
- Most are byproducts from other processes
 - Check that substance of interest is still there
- Three broad categories
 - Whole cells, solubles, mixtures
- Terminology
 - Mycelium – composed of cells from a mold
 - Biomass – composed of cells from a bacteria
 - Water soluble – exactly that
 - Broth – growth media, generally from mold fermentation

Fermentation Product Definitions (cont)

- 36.2 Extracted _____ presscake
- 36.13 Extracted _____ (presscake, meal or pellets)
 - Both composed of mycelium (whole organism)
 - Obtained from an organism
 - Penicillium or Streptomyces
 - Obtained from a particular production practice
 - Citric acid fermentation
 - Ask about whether organism historically used for this purpose
 - Firms developing novel organisms and may take advantage of lack of identity

Fermentation Product Definitions (cont)

- 36.9 Undried extracted _____ solids and fermentation solubles
 - Composed of mycelium (whole organism) and broth
 - Obtained from an organism
 - Penicillium or Streptomyces
 - Obtained from a particular production practice
 - Citric acid fermentation
 - Mixture of things

Fermentation Product Definitions (cont)

- 36.4 Dried extracted _____
fermentation solubles
 - Composed of extracted broth (substances must be soluble to be in a broth)
 - Obtained from an organism
 - Penicillium or Streptomyces
 - Obtained from a particular production practice
 - Citric acid fermentation

Fermentation Product Definitions (cont)

- 36.6 Dried _____ fermentation extract
- 36.7 Dried _____ fermentation solubles
 - Both composed of water soluble materials, not particles
 - Only for production of enzymes
 - Refer back to Table 30.1 in section 30 Enzymes for suitable organisms
 - If these ingredients are being marketed as a source of something other than an enzyme, look closely at the composition

Fermentation Product Definitions (cont)

- 36.16 Dried L-lysine fermentation product
- 36.17 Liquid L-lysine fermentation product
 - Both composed of biomass (bacterial cells) and L-lysine
 - Only acceptable organism is *Corynebacterium glutamicum*
 - Only as source of L-lysine

Fermentation Product Definitions (cont)

- 36.11 Dried _____ fermentation product
- 36.12 Liquid _____ fermentation product
 - Very general definitions
 - Widely used in feed for multitude of purposes
 - Including forage and grain inoculants
 - Can be composed of whole organism and/or fermentation media/broth
 - Obtained from a listed organism

Fermentation Product Definitions (cont)

- 36.14 Direct-fed microorganisms (DFM)
 - Listed in ingredients list of label using
 - 36.11 Dried _____ fermentation product
 - 36.12 Liquid _____ fermentation product or occasionally as
 - a mycelium definition
 - Many extraction processes kill the organism
 - Cannot be a solubles definition
 - Solubles do not contain whole microbial cell

What are DFM Products?

- Contain living (viable) microorganisms
- Two main categories
 - 1) Feed inoculants
 - Intended to affect composition and/or digestibility of feed component
 - May or may not be viable when consumed by animal
 - Examples
 - Inoculants for silage and high moisture grain

What are DFM Products? (cont)

- 2) DFM products are intended to provide living (viable) microorganisms for addition to animal feed
 - Why do the firms want to do that?
 - Scientific literature suggests beneficial effects in animals
 - Mirrors consumer interest in “natural” foods

New Organisms

- Applicable to DFMs and feed inoculants
- Obtain AAFCO ingredient definition
 - No history of unsafe use / inhabitant of GI tract
 - Pathogenicity
 - No commercial production of antibiotics
 - Manufacturing data
 - Information on the intended use

Microorganisms

- Accepted organisms listed in Fermentation products definition 36.14
- Unique label aspects – organisms are listed using 2 definitions
 - The Genus species as listed in 36.14
 - The type of fermentation product

Inoculants and the OP

- Model regulations
 - Guarantees - regulation 4(g)
- Statement for uniform interpretation and policy #23
 - Registration and labeling of silage additive products
 - Guarantees, directions for use, suitable ingredients

DFMs and the OP

- Model regulations
 - Acceptability and content - regulation 9(b)(4)
 - Guarantees - regulation 4(g)
- Pet & specialty pet food regulations
 - Guarantees – regulation PF4(h)

DFM Labels

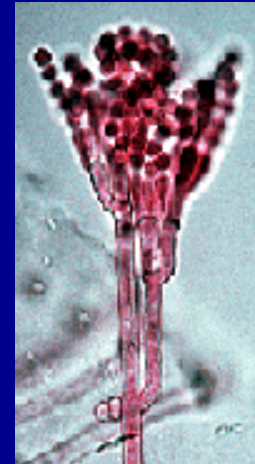
- DFM labels are not unique
- Everything that is needed for a “regular” feed label is also needed for DFMs
- So, what should be there?
 - If marketed as DFM, regulation 9(b)4II requires the statement
 - “contains a source of live (viable) naturally occurring microorganisms”

Complete Label

- Name
- Purpose (content) statement
- Guarantees
- Ingredient list
- Detailed use directions
- Caution/ warning statements
- Manufacturer/ distributor identifier
- Firm name and location
- Net content

Problem Areas

- What organisms
- Ingredient list
- Use directions
- Guarantees
- “Use by” dates (not mandated)



What Organisms to Use?

- Accepted organisms are listed in definition 36.14
 - Includes bacteria and fungi as listed
 - Yeast (as defined elsewhere)
- Yeast are defined in Section 96
 - Two yeast organisms are acceptable
 - *Saccharomyces cerevisiae*
 - *Kluyveromyces marxianus*
 - *Candida* (*Torula*) definition is not for viable organisms

What Organisms to Use? (cont)

- What about microbes in the Enzyme table, 30.1?
 - There is some overlap, but the organism must be in definition 36.14
- Why is the list so short?
 - Living microbes grow and reproduce
 - Concerns about toxin production and ability to cause human and animal illnesses

Ingredient List

- Do not list just the name
 - *Aspergillus niger*
- Use Fermentation definitions from Section 36
 - Liquid *Lactobacillus plantarum* fermentation product
 - Dried *Aspergillus oryzae* fermentation product

Potential Definitions

- Which fermentation ingredient?

- Look at the definitions

- 36.11 Dried _____ Fermentation Product

is the product derived by culturing _____ on appropriate nutrient media for the production of one or more of the following: enzymes, fermentation substances, or other microbial metabolites, and dried in accordance with approved methods and good manufacturing practices. Protein, amino acids, fat, fiber, **cell count**, enzyme activity or nutrient metabolite level shall be guaranteed where applicable...


- 36.12 Liquid _____ Fermentation Product

is the liquid product derived by culturing or fermenting _____ on appropriate liquid nutrient media for the production of one or more of the following: enzymes, fermentation substances, or other microbial metabolites, and stabilized by approved methods in accordance with good manufacturing practices. Percent solids, **cell count**, enzyme activity or nutrient metabolite level shall be guaranteed where applicable...

Potential Definitions (cont)

- For definitions 36.11 and 36.12, fill in the blank with organism from 36.14
 - Dried Bacillus subtilis fermentation product
- If the definition states “extract,” “extracted,” or “solubles,” probably not suitable for viable product

Yeast in a DFM product

- Yeast are different!
- Do not use Fermentation definitions
 -  Dried *Saccharomyces cerevisiae* fermentation product
- Use yeast definitions in Section 96
- The yeast must be alive, so firms should check with their supplier
 - Active dry yeast, 96.2
 - Yeast culture, 96.8
- If the definition states “non-fermentative,” yeast are dead and it is not a DFM

Use Directions

- Remember the end user
- Include avoiddupois units
 - If different species or animal classes require different amounts of microbes, state that
 - Use rates often differ among species

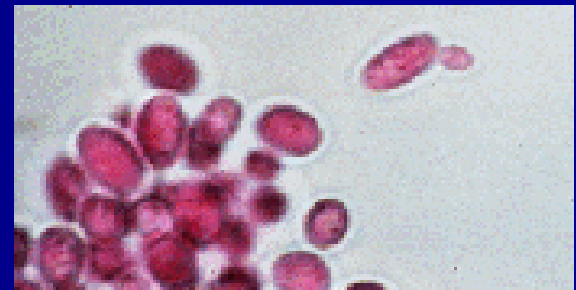
Guarantees

- Regulation 4(g)

- Guarantees for microorganisms shall be stated in colony forming units per gram (CFU/g) when directions are for using the product in grams, or in colony forming units per pound (CFU/lb) when directions are for using the product in pounds.
- A parenthetical statement following the guarantee shall list each species in order of predominance.

Guarantees (cont)

- Either avoirdupois or metric, correspond to the use directions
- Include microorganisms
 - Not required that individual species be listed separately
- Include colony forming units
 - Not cell count



Guarantees (cont)

- What is in the guarantee?

Bacillus subtilis.....1 million CFU/ g

Add 1 kg (1000 g) to each ton of complete feed

- Microorganism – B. subtilis
- Units – 1 million CFU/ g
 - in metric since use directions are metric

Guarantees (cont)

Total lactic acid bacteria..... 1×10^6 CFU/ lb
(Lactobacillus plantarum, Lactobacillus acidophilus,
and Enterococcus faecium)

Feed 2 ounces per head per day

- Bacterial type – Total lactic acid bacteria
 - Cannot include yeast in this guarantee as yeast are not bacteria
- Units – 1 million CFU/ lb
- Microorganisms – L. plantarum, L. acidophilus, E. faecium

Guarantees (cont)

Lactobacillus plantarum1 x 10⁴ CFU/ lb
Lactobacillus acidophilus1 x 10⁴ CFU/ lb
Enterococcus faecium1 x 10⁶ CFU/ lb

Feed 2 ounces per head per day

- Microorganisms – L. plantarum, L. acidophilus, E. faecium
- Units – 10⁴ and 10⁶ CFU/ lb
 - in avoirdupois since use directions are avoirdupois
- Guarantees can be long, especially if there are multiple organisms

Other Issues

- “Use by” dates not required
 - Why include them?
 - DFM must contain living microorganisms
 - Everything dies even with preservatives
 - Use of “use by” dates prevents questions concerning guarantees with an out-of-date product
- Heat
 - Many organisms adversely affected by heat
 - Pelleting
 - Storage

DFM Claims

- Must be based on scientific data in animal species of interest with the specific microbial species
 - “Yeast supplementation can aid in maintaining cellulolytic bacteria population in the rumen of animals fed diets containing greater than 50% concentrate”
- CPG Sec. 689.100 Direct-Fed Microbial Products
<http://www.fda.gov/ICECI/ComplianceManuals/CompliancePolicyGuidanceManual/ucm074707.htm>
- CVM Policy On Competitive Exclusion Products
<http://www.fda.gov/AnimalVeterinary/NewsEvents/CVMUpdates/ucm127971.htm>

DFM Claims (cont)

- Use of “probiotic” or “prebiotic” on the label now acceptable
- Guidance for Industry - Complementary and Alternative Medicine Products and their Regulation by the Food and Drug Administration -
<http://www.fda.gov/RegulatoryInformation/Guidances/ucm144657.htm>
 - “Probiotics may be regulated as dietary supplements, foods, or drugs under the Act, depending on the product's intended use”

Issues for Microbes

- Taxonomy changes
- Production of antimicrobials
- Nontraditional genus species
- Bioengineered organisms
 - Food Additive approval needed
- Pathogenicity and toxin testing
 - Different animals, different susceptibilities

Mikrobal Good Stuff

Contains a source of live (viable) naturally occurring microorganisms

Guaranteed Analysis

Lactobacillus plantarum (min.)	1 x 10 ⁵ CFU/ lb
Lactobacillus acidophilus (min.)	1 x 10 ⁵ CFU/ lb
Enterococcus faecium (min.)	1 x 10 ⁶ CFU/ lb

or

Lactic acid bacteria (min.) 1.2 x 10⁶ CFU/ lb
(Enterococcus faecium, Lactobacillus plantarum, Lactobacillus acidophilus)

Ingredients: Ground limestone, dried Enterococcus faecium fermentation product, dried Lactobacillus plantarum fermentation product, dried Lactobacillus acidophilus fermentation product, sodium sorbate (preservative), mineral oil

Directions for Use

Feed 2 ounces per cow per day

Feed 0.5 oz per pig per day

Store at room temperature and in a dry place

Use within 12 months of manufacture

Manufactured by Mika Industries, 7519 Stand Place, Rockville, MD 20855

Net Wt 44 lb (20 kg)

Manufactured 4/12/10

Questions?

Pictures courtesy of Tree of Life (www.tolweb.org/Ascomycota)

Enzymes Used in Feed



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Division of Animal Feeds
Center for Veterinary Medicine

Presented at the April 2010 AAFCO Feed Administrators Seminar,
Hickory Knob State Park, South Carolina

Enzymes and the CFR

- Approved ingredients listed in:
 - Title 21 Code of Federal Regulations
 - 582.1585 Papain
 - 582.1685 Rennet
 - 573.130 Aminoglycoside 3'-phosphotransferase II for use in bioengineered oilseed rape, tomato, cotton
- Nothing unique in CFR for enzymes
 - Novel enzymes
 - Food additive regulation

Enzymes and the OP

- Accepted enzyme/ source organism combinations listed in Table 30.1
- Unique aspect – Enzyme Marketing Coordination document
- Model regulations
 - Acceptability - regulation 9(b)(5)
 - Purpose – regulation 3(a)(3)(VI)
 - Guarantees - regulation 4(h)
- Pet & specialty pet food regulations
 - Guarantees – regulation PF4(h)

Enzyme Specific Uses

- Why are there so many different enzymes used in feed?
 - Added to affect processing of ingredient
 - amylase
 - Added to alter digestibility of feed ingredient
 - phytase
 - Added to alter characteristics of digesta
 - xylanase

Enzyme Specific Uses (cont)

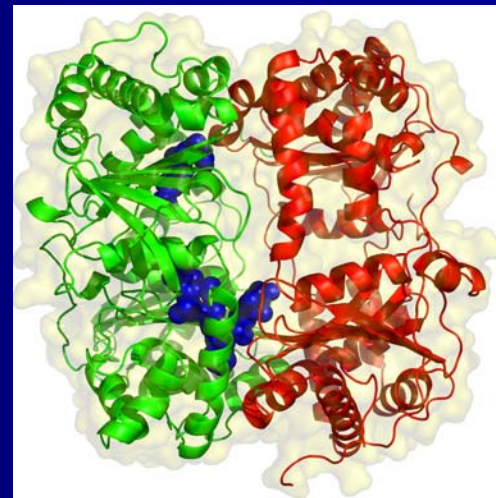
- There is no such thing as a generic animal feed
 - Multitude of species
 - Companion animals, traditional livestock, non-traditional species (fish, llamas, ostriches)
 - All stages of an animal's lifespan
 - Neonate, growing, mature, breeding, elderly (primarily companion animals)
- Current supported use statements are animal species specific
 - Reduction of digesta viscosity with poultry diets
- Functionality statements are not
 - Hydrolyzes phytate

Enzyme Specific Uses (cont)

- Plants and byproducts are large proportion of many feeds
- Often contain undesirable components
 - Phytate, reduces phosphorus availability
 - Stachyose and raffinose, less available sources of energy

Enzyme Labels

- Where are the enzyme regulations
- What should be on the label
- Trouble spots



Complete Label

- Name
- Purpose statement
- Guarantees
- Ingredient list
- Detailed use directions
- Caution/ warning statements
- Manufacturer/ distributor identifier
- Firm name and location
- Net content

Problem Areas for Labels

- Ingredient list
- Use directions
- Guarantees
- "Use by" dates (not mandated)

Ingredient List

- No
 - Phytase
 - Phytase from *Aspergillus niger*
 - *Aspergillus niger* fermentation extract (phytase)
- Yes
 - *Aspergillus niger* fermentation extract
- If product contains a fermentation ingredient
 - Use definition from Section 36, Fermentation Products

Ingredient List (cont)

- Can I use an organism listed in 36.14, the Direct-fed Microorganisms, for an enzyme product?
- An enzyme and the organism that produces it are linked, as indicated in Table 30.1
 - Cannot mix and match

Potential Definitions

- Which fermentation ingredient?
- Look at the definitions
 - 36.6 Dried ____ Fermentation Extract
is the dried product resulting from extracting and precipitating by means of non-aqueous solvents or other suitable means, the water soluble materials from a fermentation conducted for maximum production of enzymes using a non-pathogenic strain of the microorganism in accordance with good manufacturing practices.
 - 36.7 Dried ____ Fermentation Solubles
is the dried material resulting from drying the water soluble materials after separation of suspended solids from a fermentation conducted for maximum production of enzymes using a non-pathogenic strain of the microorganism in accordance with good manufacturing practices.

Potential Definitions (cont)

- 36.11 Dried _____ Fermentation Product

is the product derived by culturing _____ on appropriate nutrient media for the production of one or more of the following: **enzymes**, fermentation substances, or other microbial metabolites, and dried in accordance with approved methods and good manufacturing practices. Protein, amino acids, fat, fiber, cell count, enzyme activity or nutrient metabolite level shall be guaranteed where applicable...

- 36.12 Liquid _____ Fermentation Product

is the liquid product derived by culturing or fermenting _____ on appropriate liquid nutrient media for the production of one or more of the following: **enzymes**, fermentation substances, or other microbial metabolites, and stabilized by approved methods in accordance with good manufacturing practices. Percent solids, cell count, enzyme activity or nutrient metabolite level shall be guaranteed where applicable...

Potential Definitions (cont)

- What about enzymes obtained from plants or animals?
 - What is the common and usual name of the “ingredient?”
 - Dried pineapple
 - Fig extract
 - Dried pancreas
 - Phytase canola

Use Directions

- Remember the end user
 - Include avoiddupois units
 - If different species or animal classes require different amounts, label should state that
 - Phytase - use rates often differ among layers, broilers, turkeys, and swine

Those @*!! Guarantees

- Regulation 4(h)

- Guarantees for enzymes shall be stated in units of enzymatic activity per unit weight or volume, consistent with label directions. The source organism for each type of enzymatic activity shall be specified, such as: Protease (Bacillus subtilis) 5.5 mg amino acids liberated/min./milligram. If two or more sources have the same type of activity, they shall be listed in order of predominance based on the amount of enzymatic activity provided.

Guarantees (cont)

- Enzyme Marketing Coordination document
 - Either avoiddupois or metric, correspond to the use directions
 - Include source organism
 - Include units
 - List sources by contribution of enzymatic activity

Guarantees (cont)

- What is in the guarantee?

Protease (**Bacillus subtilis**) 5.5 mg amino acids liberated/ minute/ gram

- Protease – type of enzyme activity

- B. subtilis – source organism

- mg amino acids liberated/ minute/ g – unit of enzymatic activity

Guarantees (cont)

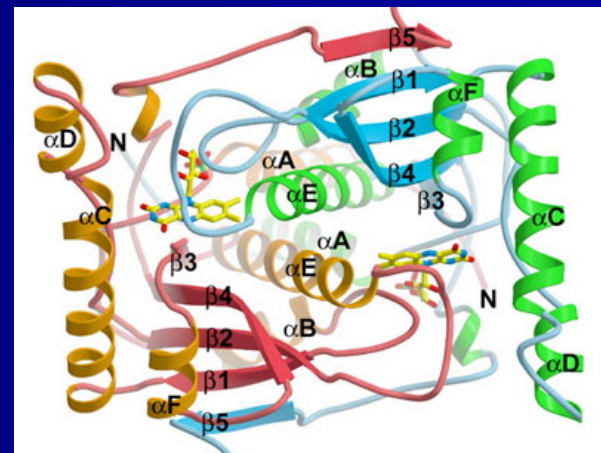
- Guarantees can be long
 - Protease (Bacillus subtilis) 5.5 mg amino acids liberated/ minute/ gram
- Firms can split and can explain units elsewhere on label
 - Protease (Bacillus subtilis) 5.5 units*/ g
 - 1 unit of protease activity liberates 1 mg amino acid from casein/ minute
 - Should mention assay conditions, i.e., pH, temperature

Guarantees (cont)

- Most problematic are the units
- What is there?
 - mg amino acids liberated/ minute/ g
 - mg amino acids liberated – what the enzyme does
 - minute – time unit
 - g – unit of enzyme product

Guarantees (cont)

- Units are enzyme specific – what enzyme does
- Units are also assay specific for a particular type of activity



Guarantees - Enzyme Specific

mg amino acids liberated/ minute

- Look at Function in Table 30.1
 - Phytase – hydrolyzes phytate
 - Protease – hydrolyzes proteins
 - Lipase – hydrolyzes triglycerides (fat)
 - Cellulase – breaks down cellulose

Guarantees - Assay Specific

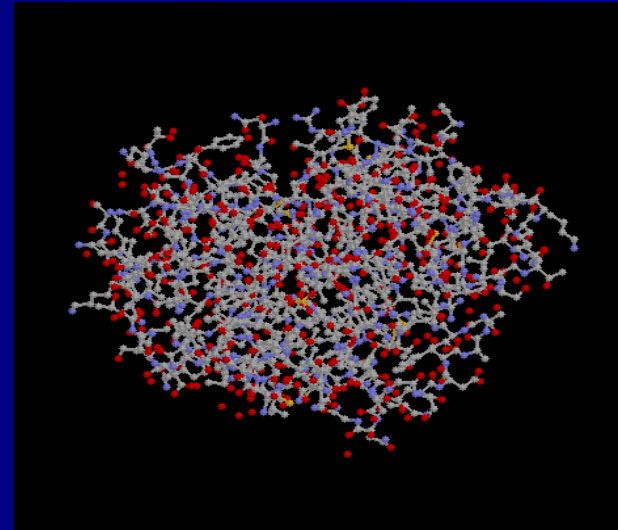
- Units are also assay specific for a particular type of activity
- Few standard assays
- Assay can measure 1 of 2 things
 - Change in substrate
 - Decrease in protein concentration
 - mg casein hydrolyzed/ minute
 - Change in end product
 - Increase in amino acid levels
 - mg amino acids liberated/ minute

Guarantees-Assay Specific (cont)

- What to choose?
 - Pick easiest to measure, generally, breakdown product
 - Protease – increase in amino acid concentrations
 - Phytase – increase in amount of free phosphorus
 - Amylase – increase in sugar levels

Guarantees (cont)

- Are there any Standards?
 - AOAC
 - Food Chemical Codex



“Use by” Dates

- Not required
- Why include them?
 - Enzymes are proteins and activity depends on protein structure
 - Protein structure degrades with time even with preservatives
- Inclusion could prevent questions concerning guarantees with an out-of-date product

Mikazyme

Contains a source of phytase, derived from *Aspergillus oryzae*
Phytase increases the digestibility of phytin-bound phosphorus in swine and poultry diets

Guaranteed Analysis

Phytase (*A. oryzae*) min. 2500 FTU/ g

One FTU is the amount of phytase which liberates 1 micromole of phosphorus per minute from sodium phytate at pH 5.5 and 37 C (under conditions of the assay)

Ingredients: Sodium sulfate, ..., ..., hydrogenated vegetable oil, starch, dried *Aspergillus oryzae* fermentation extract

Directions for Use (mixing directions)

For swine add 200-400 g/ton complete feed to provide 500 FTU/ kg feed

For broilers add 200 – 400 g/ton complete feed to provide 500 FTU/ kg feed

For layers add 100-200 g/ton of complete feed to provide 250 FTU/ kg feed

Store at room temperature and in a dry place

Use within 12 months of manufacture

Warning (human health concern)

May cause eye, skin, and respiratory irritation

Inhalation may cause allergic reaction in sensitized individuals

Manufactured by Mika Industries, 7519 Stand Place, Rockville, MD 20855

Net Wt 44 lb (20 kg)

Manufactured 4/12/10

Mikazyme's Swine Feed with Phytase

For starter pigs weighing 11 to 44 lb

Phytase increases the digestibility of phytin-bound phosphorus in swine and poultry diets

Guaranteed Analysis

Crude protein (min.) 20%

Lysine (min.) 1.2%

etc

Phytase (*A. oryzae*) (min.) 500 FTU/ kg*

Ingredients: Corn, ...,, ..., dried *Aspergillus oryzae* fermentation extract, cobalt carbonate, calcium iodate, sodium selenite

Feeding Directions

Feed as the complete ration to starter pigs weighing 11 to 44 lbs

*One FTU is the amount of phytase which liberates 1 micromole of phosphorus per minute from sodium phytate at pH 5.5 and 37 C (under conditions of the assay)

Manufactured by Blue Bird Feed Mill, City, State Zip

Net Wt 50 lb (22.67 kg)

Questions?

Images courtesy of www-news.uchicago.edu, www.wpi.edu, www.chemlin.net

Other Questions

- Spirulina - blue-green algae
 - Falls under limited use ingredients for species whose nutritional requirements are not well understood
 - Accepted for use in ornamental (aquarium) fish diets only
 - Not acceptable in other animal diets
 - No data and information submitted to support these other uses
 - Testing is necessary, generally for microbiological, heavy metal, and chemical contaminants
- Acacia petals (*Acacia nilotica*)
 - Accepted for use in cockatiel bird diets only

Other Claims

- Must be based on scientific data in animal species of interest with the specific species
- Must relate back to the nutritional content of product
 - Nutritive value, aroma, flavor
- These statements are probably OK
 - Supports the Digestive System
 - Supports the Immune System
- These claims are not for a microbial product
 - Promotes Healthy Shiny Hair Coat
 - Acceptable for a product with vitamin E or essential fatty acids
 - Promotes Vitality in older horses