

USDA Ongoing Research with Dietary Fiber



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Current Research at USDA

- Enhance nutrient utilization and animal health to increase production efficiency and minimize nutrient release to environment.
- Multidisciplinary/collaborative approach.
 - Integration of physiological, molecular, and whole animal studies.

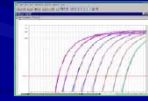
Physiological biomarkers



"Feed & weigh"



Gene expression analysis



Proteins

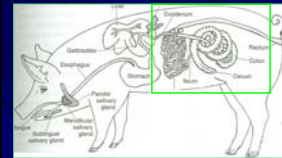


Fiber in Swine Diets

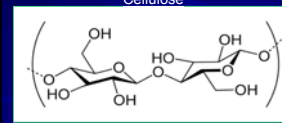


- Increase endogenous protein loss
 - Increased mucin production, increased digestive enzymes.
- Decrease absorption of dietary N and lipids
 - Decrease urea excretion
 - Lipid metabolism and meat quality
- Increase in intestinal mass (some cases)
 - Maintenance requirements
 - Increased O₂ consumption by portal drained organs
- Increased heat increment
- Feed intake
 - Variable effects
- Dealing with fiber in swine diets
 - Feed little to none
 - Enzymes
 - Genetics...

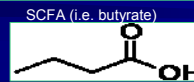
Dietary Fiber-holistic approach



Nutrient utilization; Effects of fiber on intestinal and whole body energy metabolism, gene expression, and inflammation.



Physiological responses to dietary fiber.



SCFA effects on growth, energy metabolism, body composition and immune function.

The fiber source



	NDF	ADF	HC	Cell.	Lignin
Corn	10	3	7	--	1
SBM	8	6	2	5	1
DDGS	26	10	16	14	4
CGM	53	12	41	10	2
HP-DDG	20	12	9	--	--
Alfalfa Meal	45	35	10	24	11
Wheat midds	37	10	27	2	8

Hemicellulose Dose Response

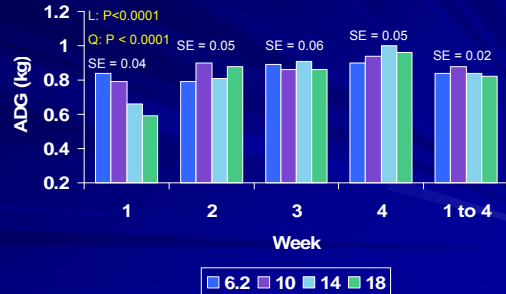


- Objectives: 1) Corn fiber (NDF, HC) tolerance by growing pigs; 2) Physiological adaptations to high fiber.
- n = 48 growing gilts (30.8 ± 0.9kg), individually penned
- 4 dietary fiber/hemicellulose levels
 - 6.2-18% HC, ME allowed to float.
- BW and ADFI measured weekly
- Plasma energy metabolites on lowest and highest fiber levels.
- Small intestine, colon, and liver tissue collected for enzyme, mRNA, and proteins.
 - Genes involved in oxidative metabolism.
 - Intestinal and hepatic AMPK activation.
 - Tissue abundance of mitochondrial respiratory protein (COXII).

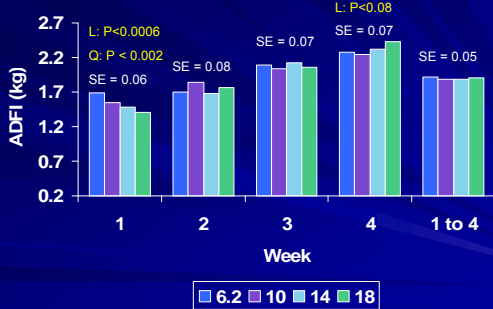
Diet Composition

HC level	6.2%	10.0%	14.0%	18.0%
Corn, %	71.04	62.60	63.76	44.94
SBM, %	25.70	21.65	17.50	13.30
CGM, %	--	12.55	25.60	38.69
NDF, %	9.67	14.57	19.67	24.79
ADF, %	3.50	4.56	5.67	6.78
ME, kcal/kg	3.31	3.26	3.21	3.16
CP, %	17.8	18.7	19.7	20.7
Lys, %	1.05	1.03	1.02	1.00

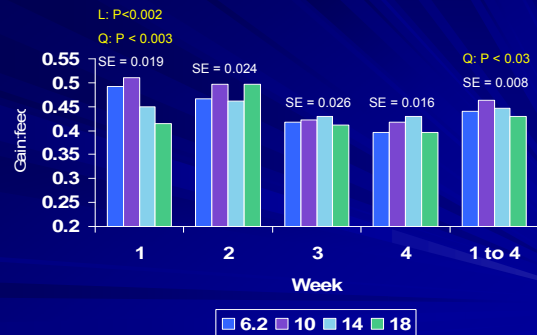
Growth Performance



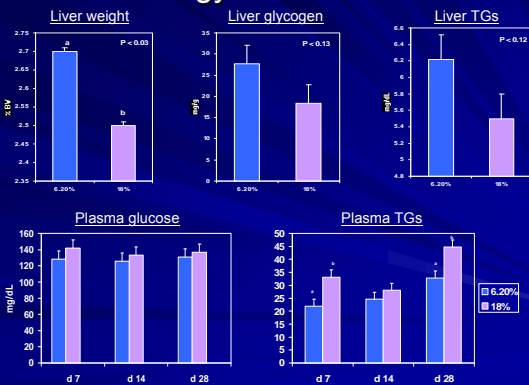
Feed Intake



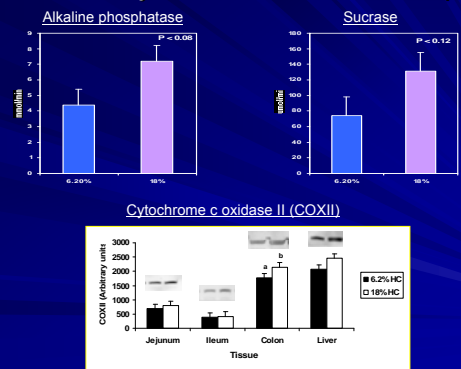
Feed Efficiency



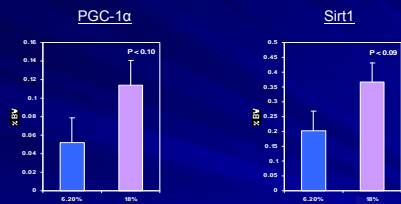
Energy metabolites



Intestinal enzyme and mitochondrial proteins



Colonic gene expression



Study Outcomes

- Growing pigs can tolerate relatively high levels of fiber from CGM.
 - Model for feed efficiency?
 - Balance for energy or will pig compensate?
- Part of adaptive response includes increased serum TGs and decreased hepatic energy stores.
- Intestine adapts by increased enzyme production and oxidative metabolic capacity.
 - Mechanisms for increased mitochondrial protein?

Future Directions



- Evaluating impact of other fiber sources on whole body energy metabolism and molecular pathways.
 - Cellulose, pectin, resistant starch
 - "Modern" genetic lines.
- Impacts of dietary fiber and other nutrients on inflammation and animal health.
 - Fiber may impact translocation of bacteria and endotoxin.
 - Systemic inflammation due to alterations in energy metabolism.

Questions?

