



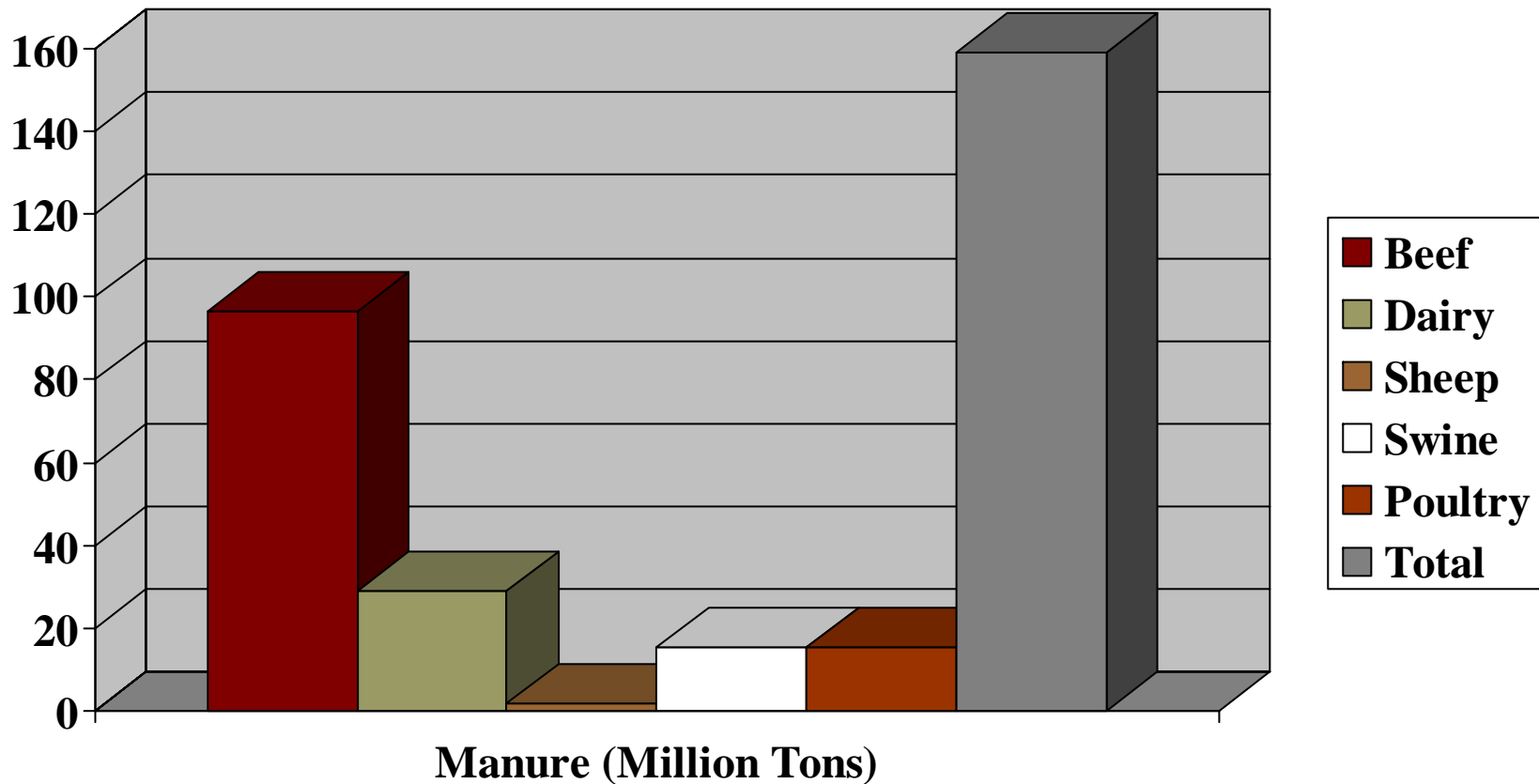
The Impact of Feeding Corn DDGS and Phytase on Manure Phosphorus Management in Pork Production

Dr. Jerry Shurson

Department of Animal Science

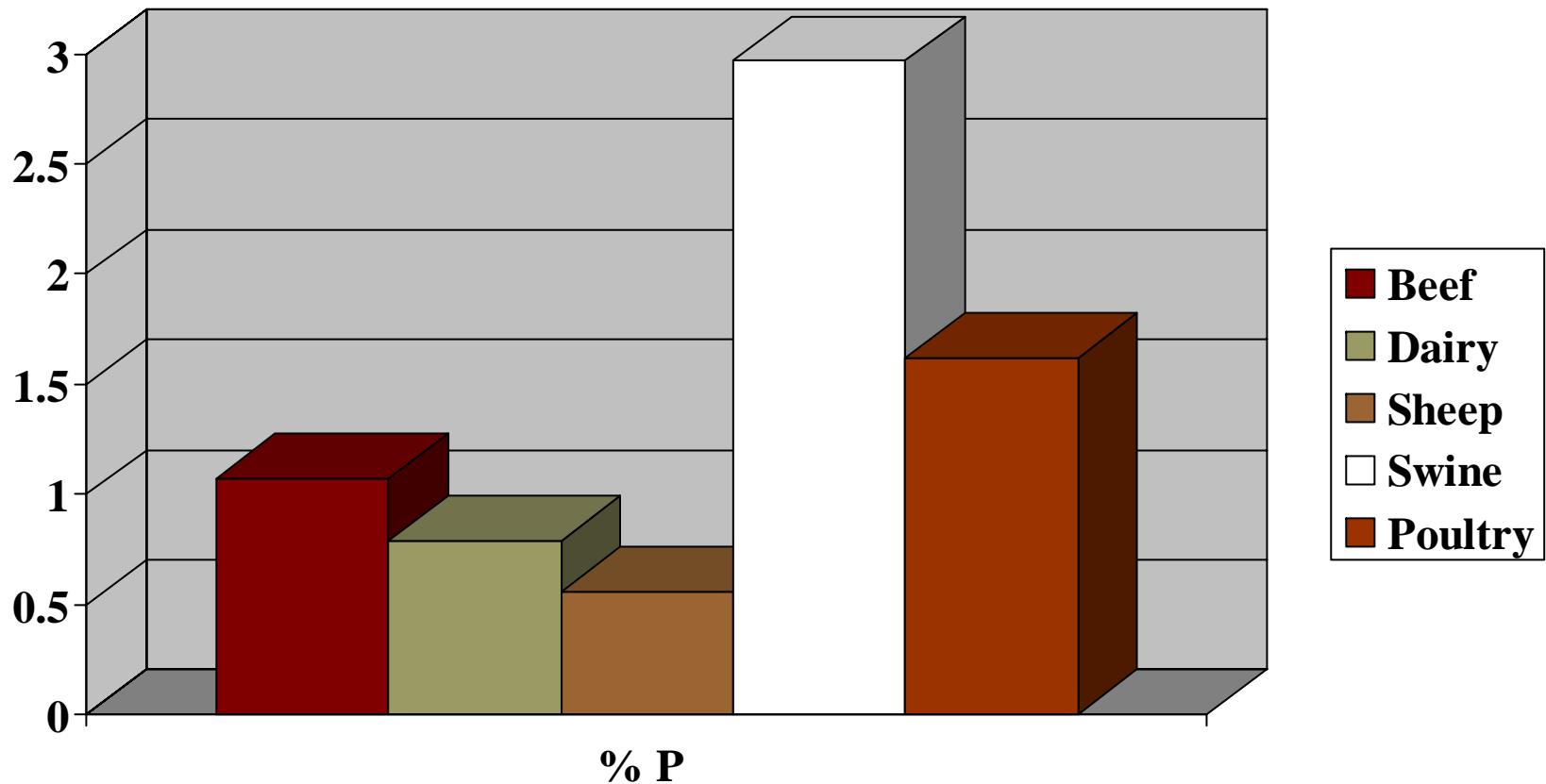
University of Minnesota

Quantity of Manure Excreted Annually By Livestock and Poultry in the U.S.



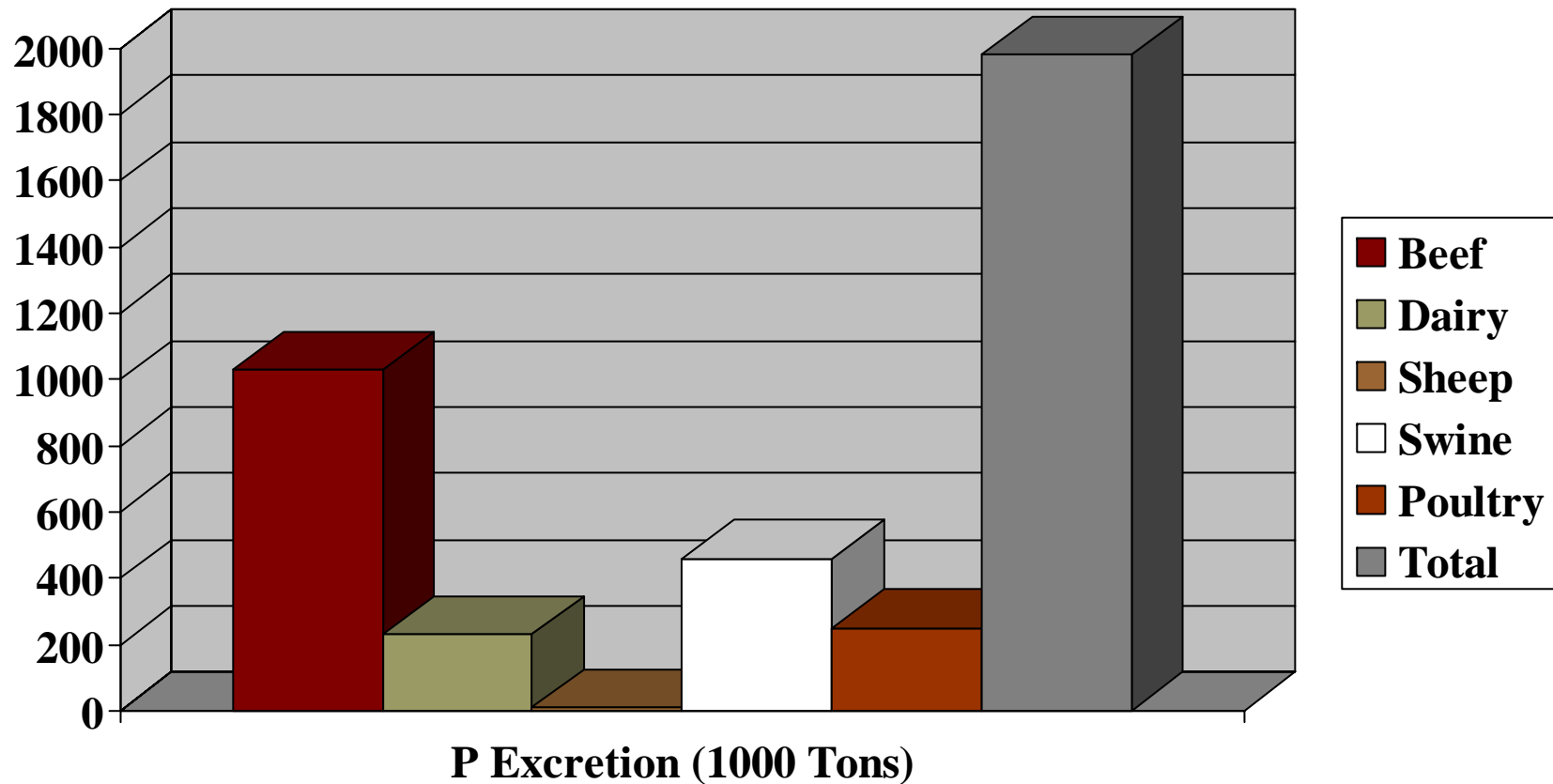
Source: Cromwell (2002)

% Phosphorus in Livestock and Poultry Manure



Source: Cromwell (2002)

Annual Amounts of Phosphorus Excreted in Livestock and Poultry Manure in the U.S.



Source: Cromwell (2002)



Phosphorus in Swine Manure

- Swine manure has a N:P ratio of 3:1
 - Lower than needed by crops grown (e.g. corn 6:1)
 - When manure is applied to meet the N needs of the crop:
 - Excess P is applied
 - Excess P in soil has potential for leaching and runoff that contributes to eutrophication of surface water



Chemical Forms of Phosphorus In Manure

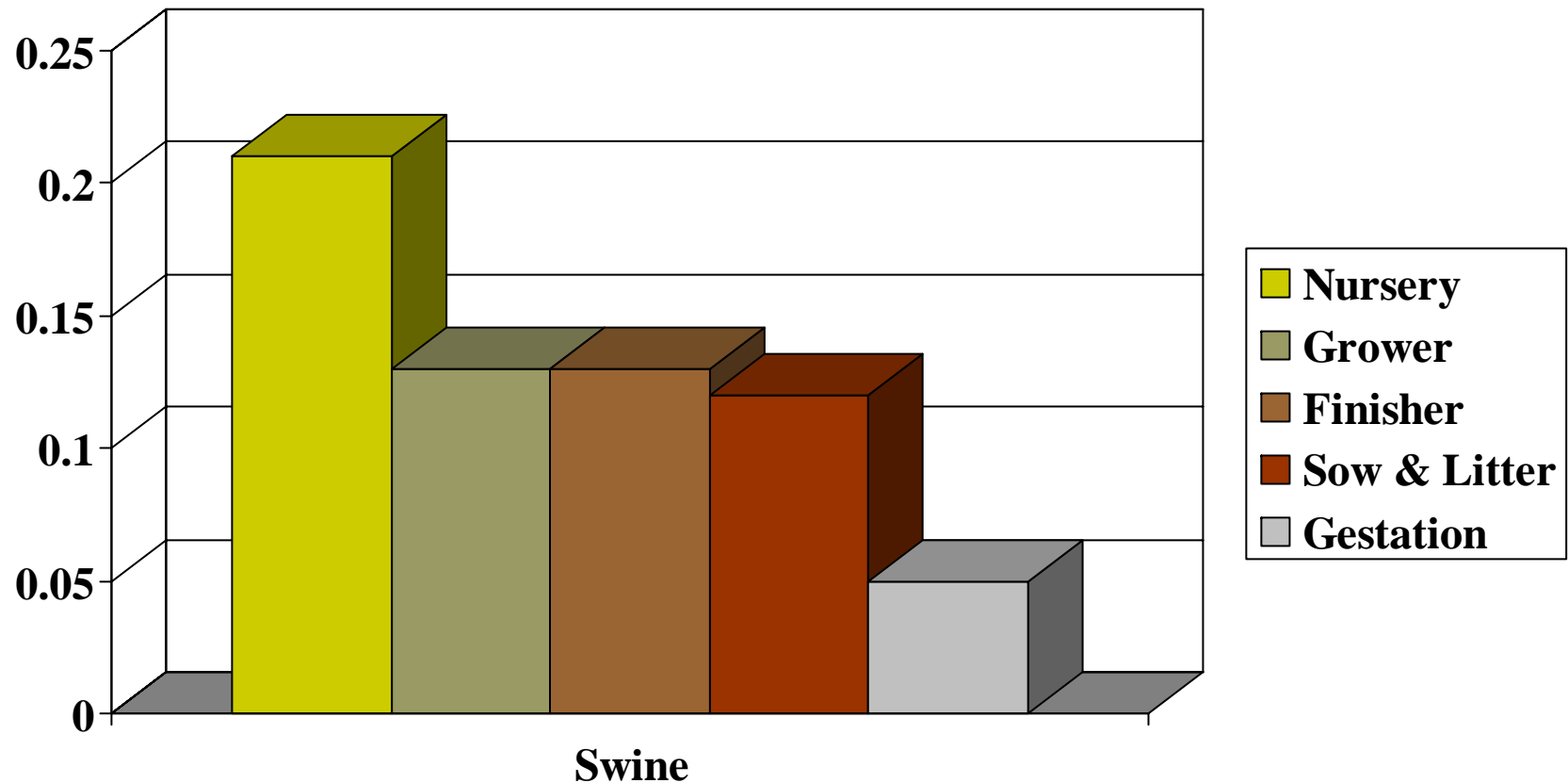
- Phosphorus compounds in manure vary in:
 - Solubility
 - Availability for plant uptake
 - Absorption potential in soils
- Manure P composition is affected by:
 - Age of the animal
 - Diet
 - Amount and type of bedding material
 - Storage method



Phosphorus in Soil

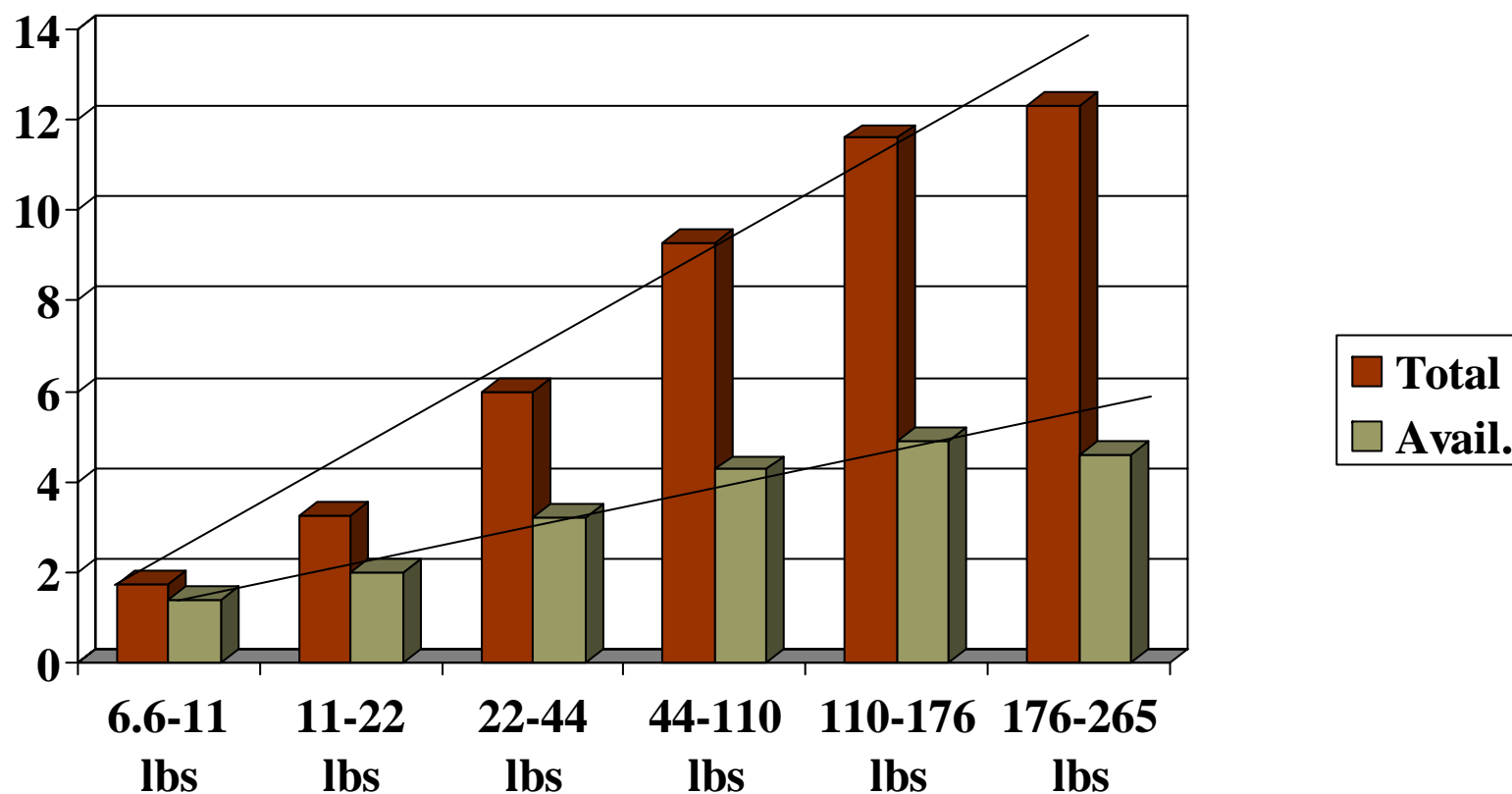
- Soils contain between 100 to 3000 ppm P
 - Soluble P
 - Form is available for plant uptake
 - Predominantly orthophosphates
 - Reactive P
 - Found in fresh organic material
 - Converted over time to soluble P
 - Stable P
 - Largest portion of soil P
 - Crystalline compounds with very low solubility
 - Stable organic compounds that are not available to plants

Lbs. of P₂O₅ per Lb. of Animal Wt./Yr

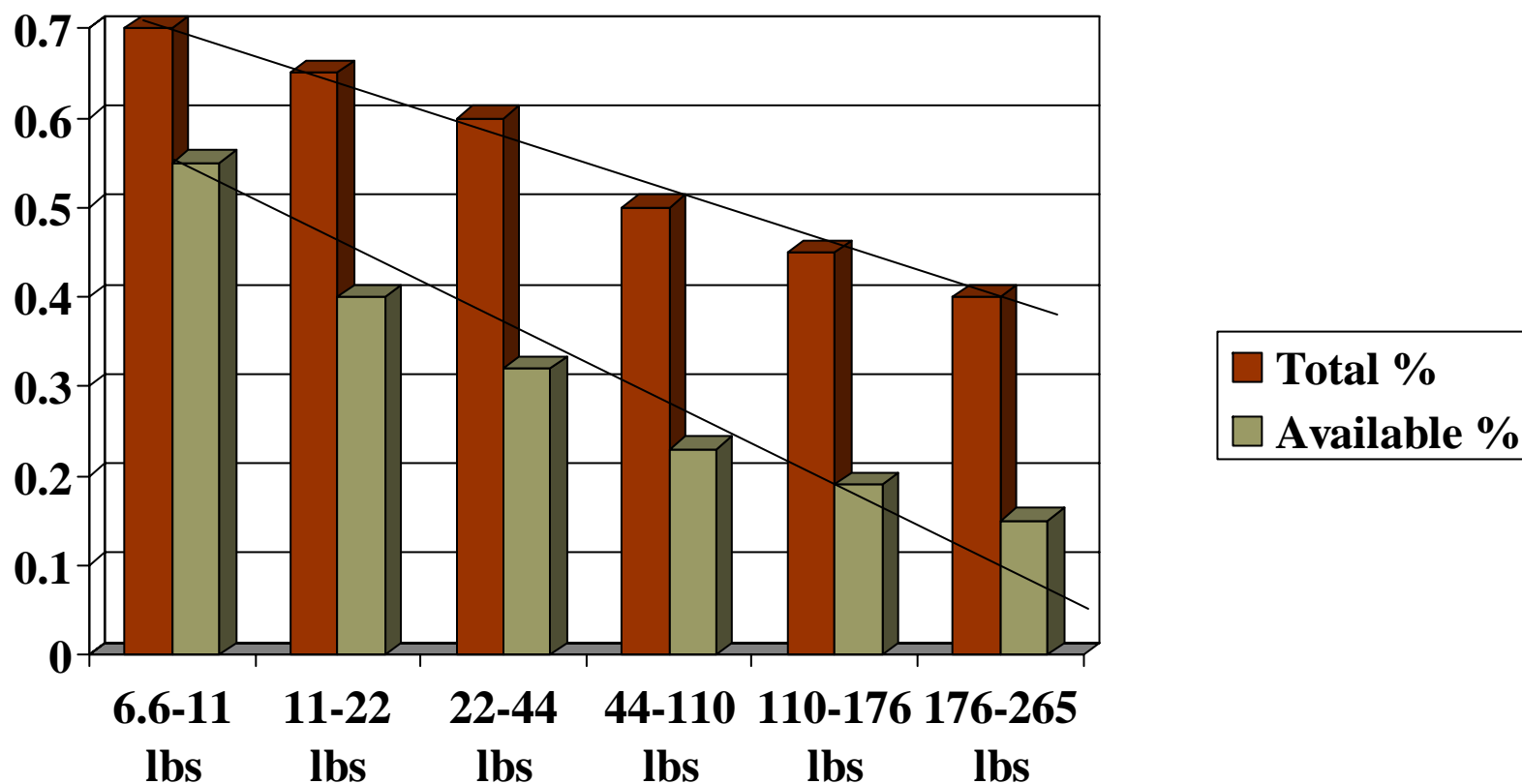


Source: Estimating Manure Nutrients from Livestock and Poultry. NebGuide G1334, 1997.

Total and Available P Requirement (g/day) of Growing Pigs (NRC, 1998)



Total and Available P Requirement (% of diet) of Growing Pigs (NRC, 1998)

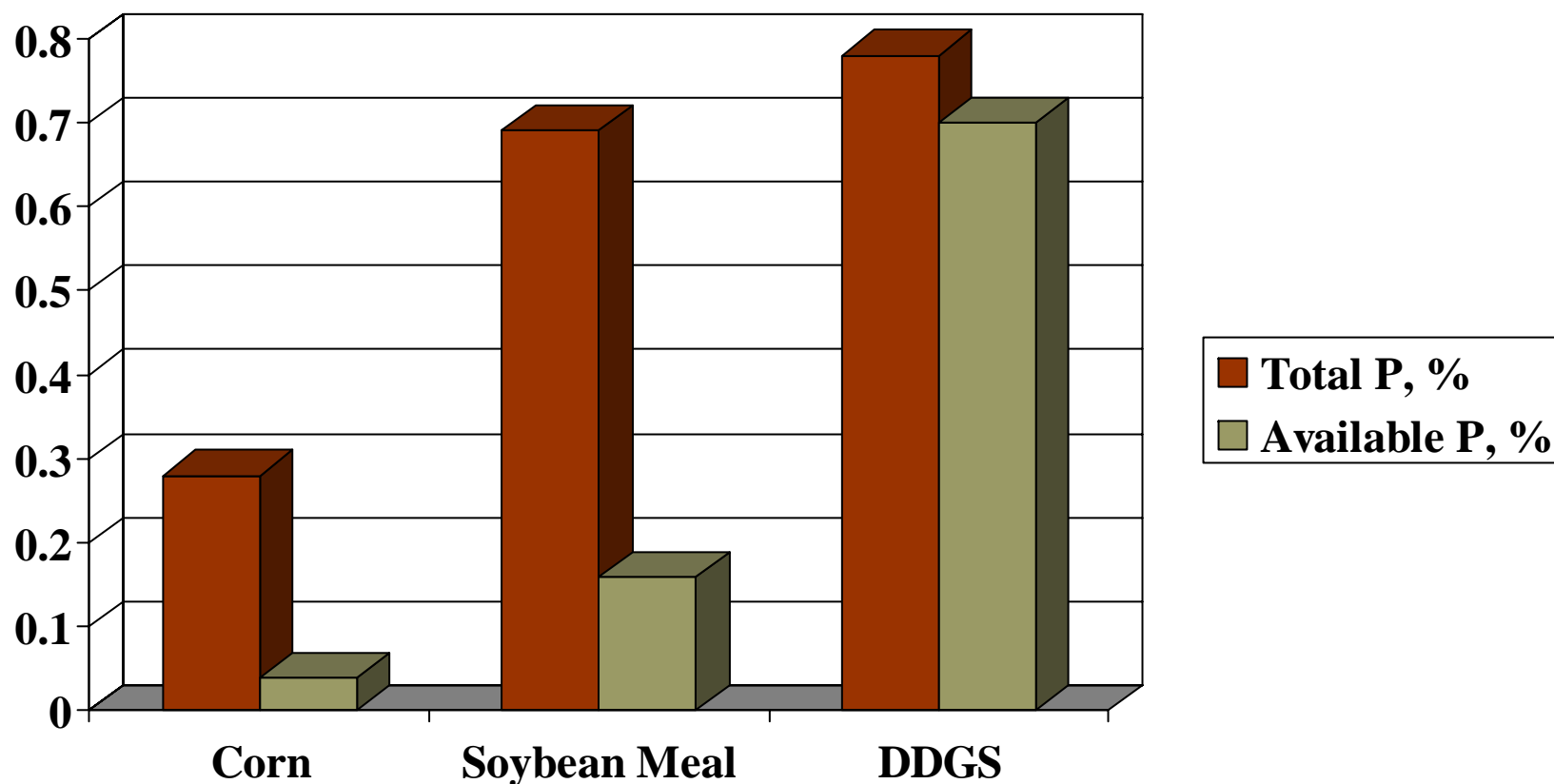




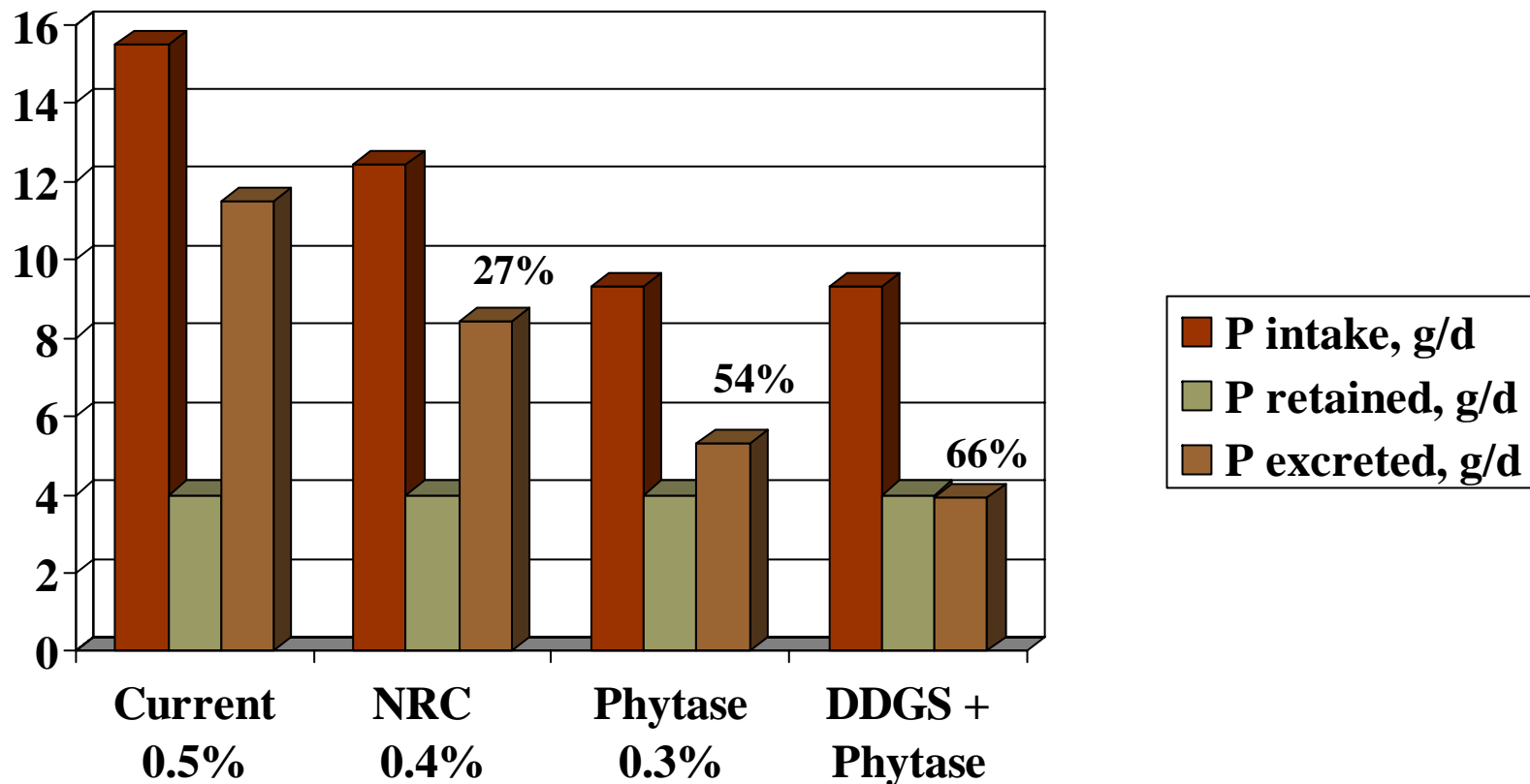
Nutritional Methods to Reduce Manure Phosphorus

- Use ingredients that are high in digestible or bioavailable P
- Minimize “safety margin” for P when formulating diets
- Add phytase to the diet
- Maintain a 1:1 to 1.5:1 calcium-to-phosphorus ratio when formulating diets
- Minimize feed wastage

Comparison of Total P Concentration and P Bioavailability Between Corn, Soybean Meal (47.5%) and DDGS for Swine

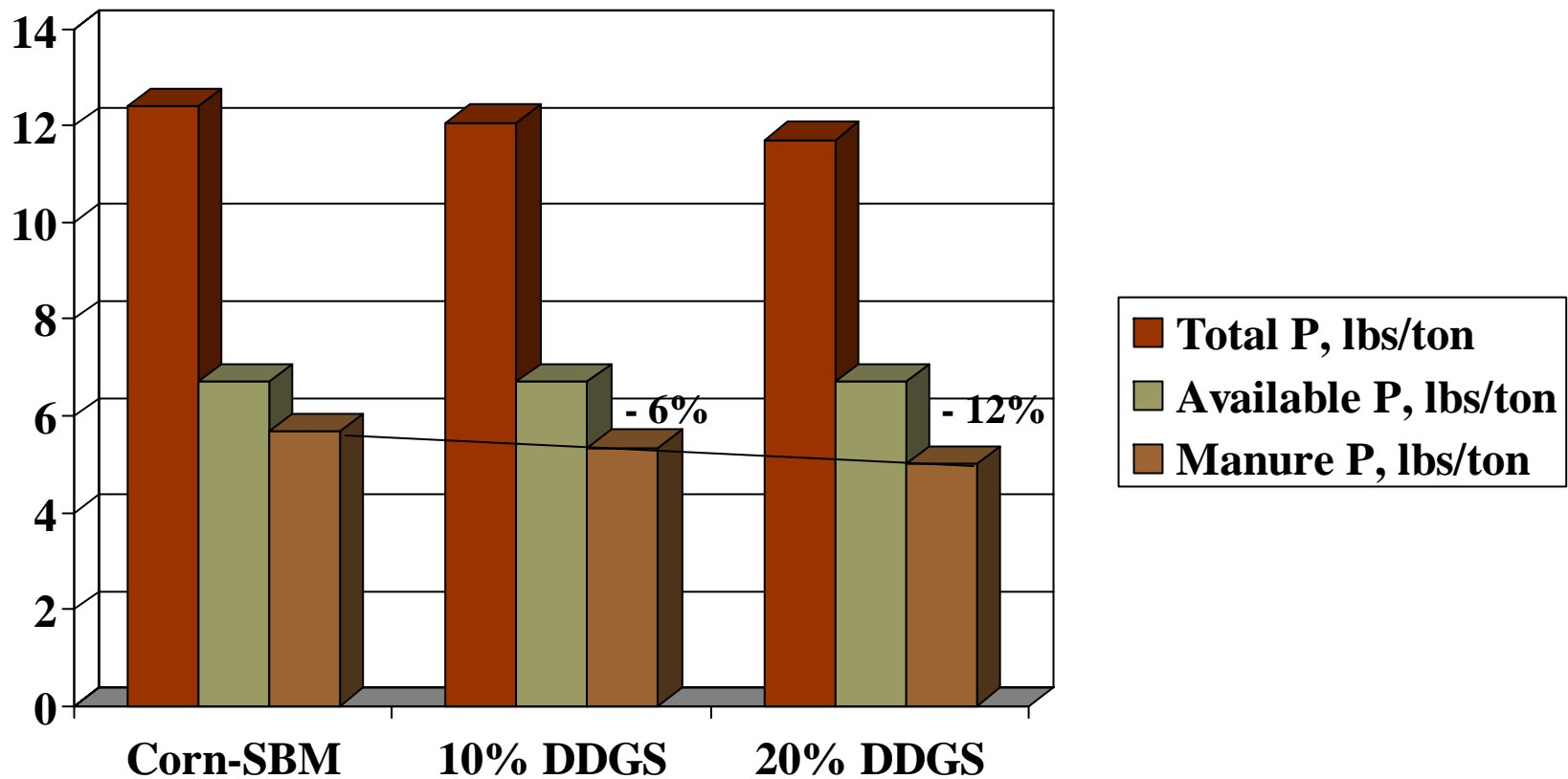


Potential for Reducing P Excretion in Manure From 175 Lb Pigs



Source: Adapted from G.L. Cromwell, Feedstuffs, October 7, 1991.

Potential for Reducing P Excretion in Manure By Feeding Swine Grower Diets Containing 10 or 20% DDGS



Source: Adapted from G.L. Cromwell, Feedstuffs, October 7, 1991.

Phosphorus Balance in the Pig

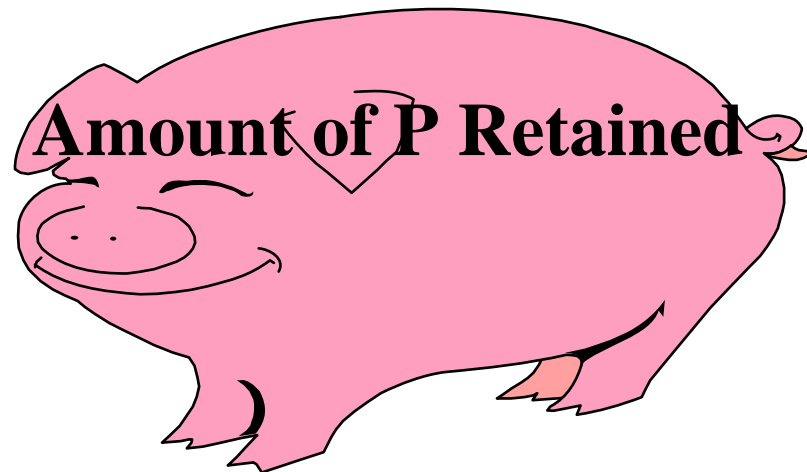
(Feed Intake x % P in Diet)

(Amt. Feces Excreted x % P in Feces)

+

(Amt. Urine Excreted x % P in Urine)

Amount of P Consumed – Amount of P Excreted =





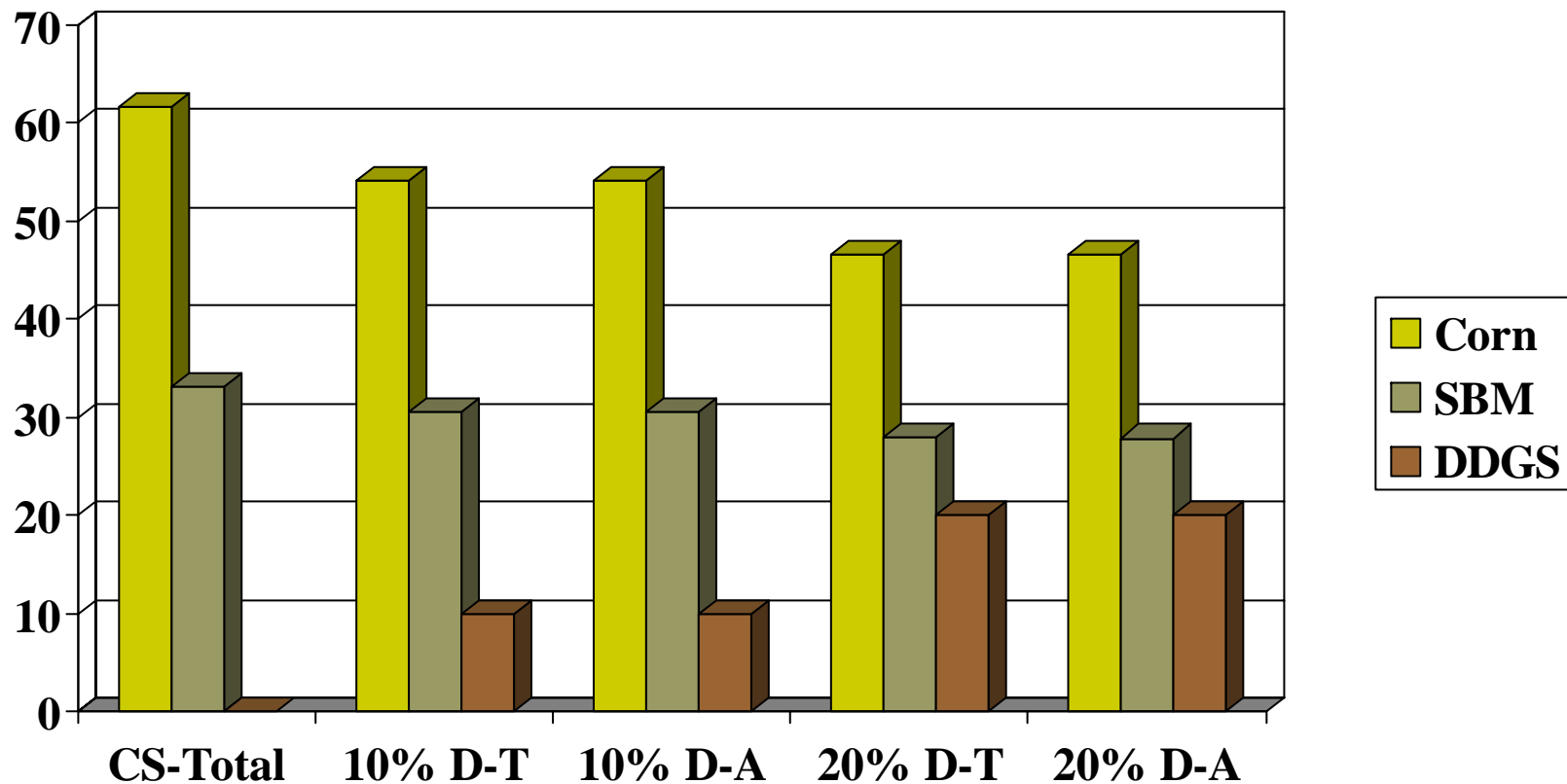
Effect of DDGS Level and Diet Formulation Method on Manure Phosphorus Excretion in Nursery Pigs (23 lbs.)

Diet Composition

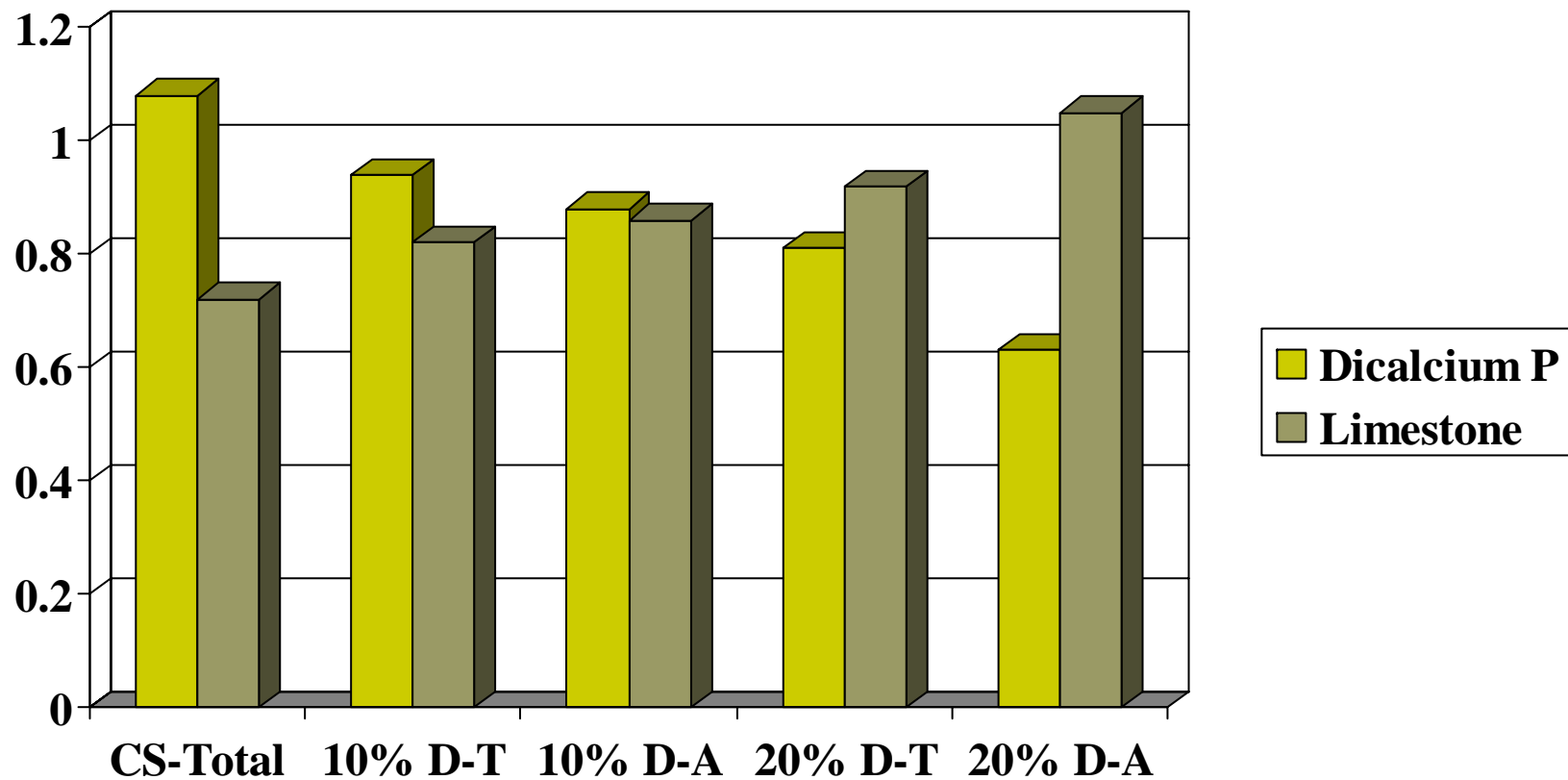
Formulation Method

1. Corn-Soybean meal	Total P/Available P
2. 10% DDGS	Total P
3. 10% DDGS	Available P
4. 20% DDGS	Total P
5. 20% DDGS	Available P

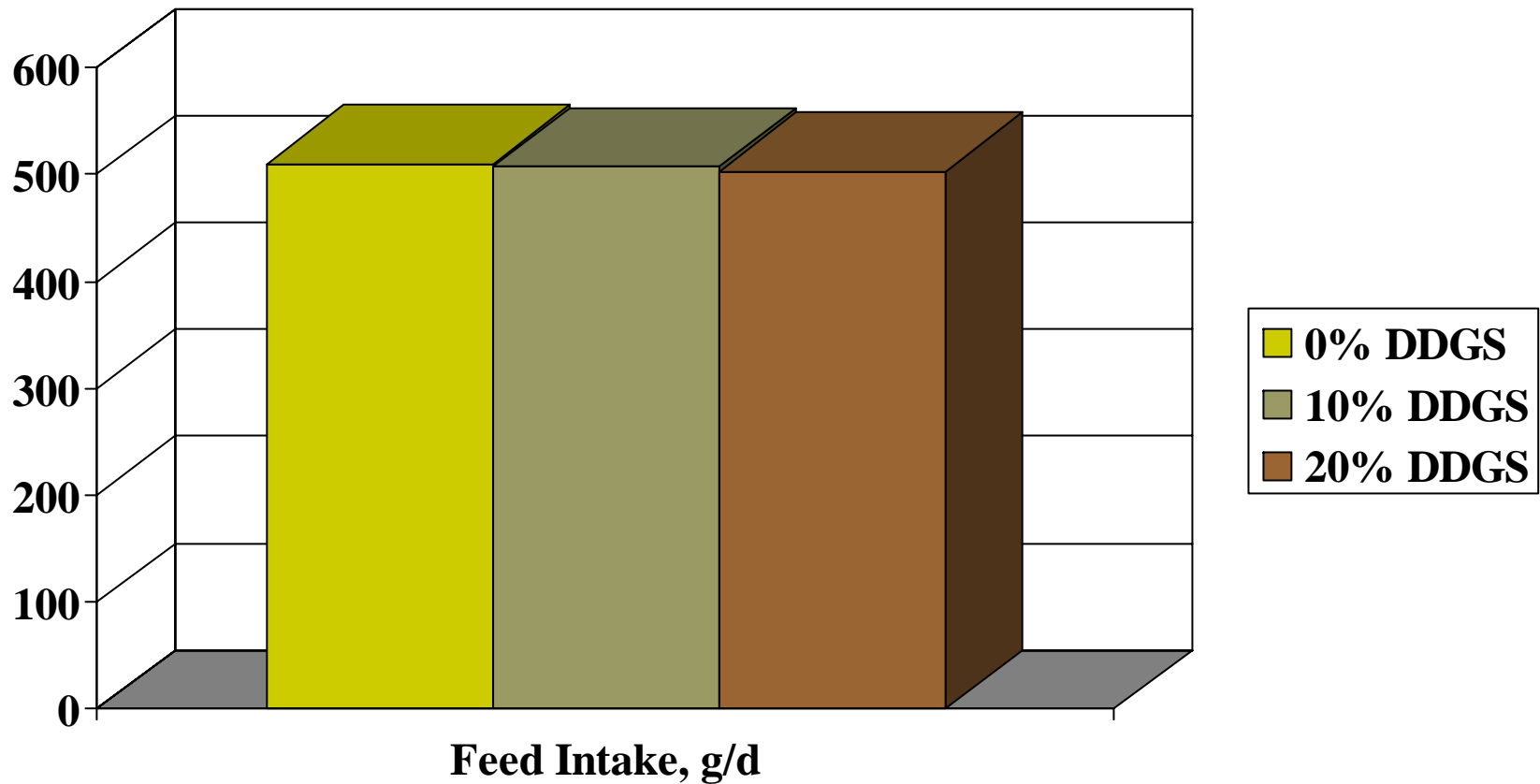
Percentage of Corn, Soybean Meal, and DDGS in Experimental Diets



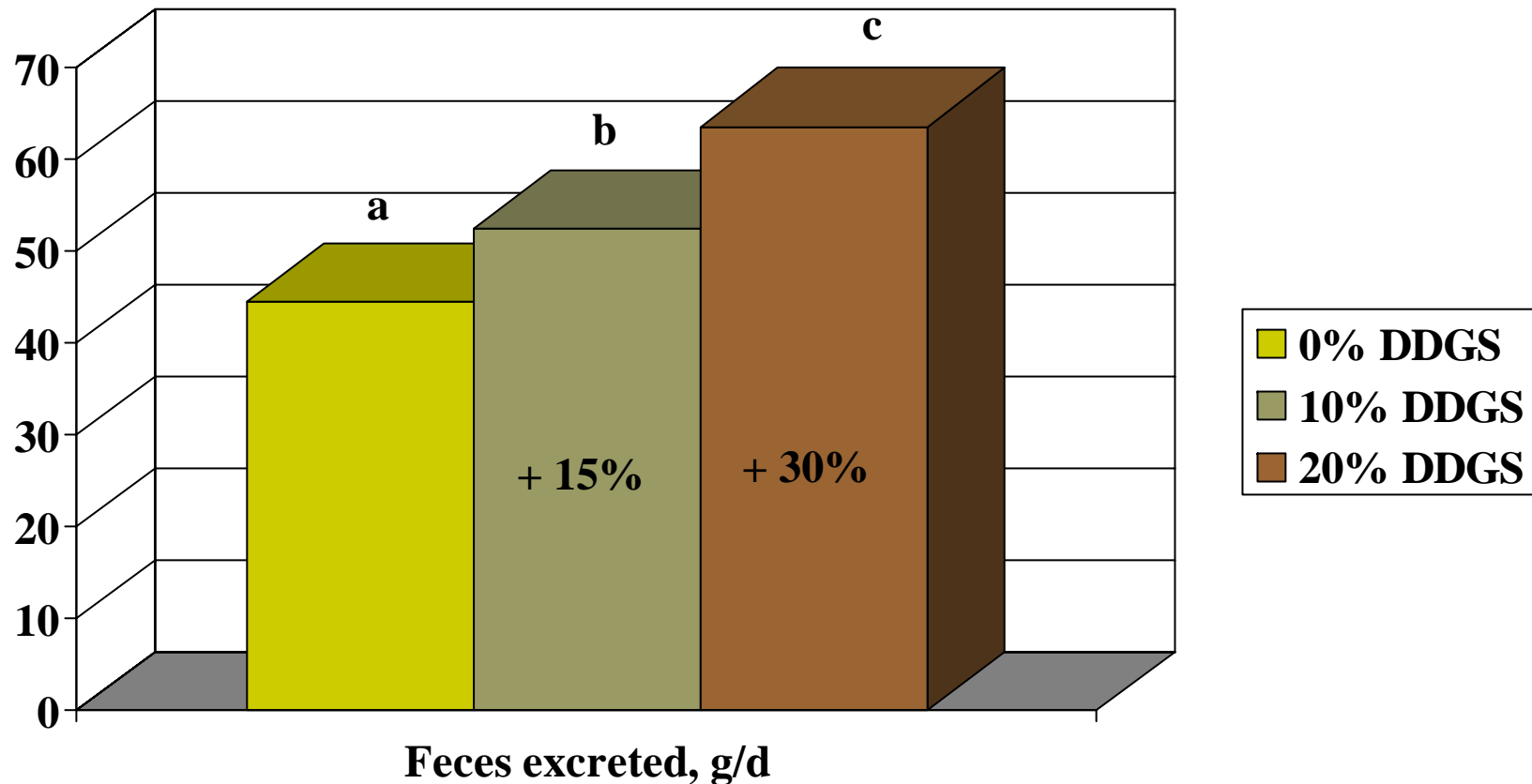
Percentage of Dicalcium Phosphate and Limestone in Experimental Diets



Effect of Dietary Level of DDGS on **Feed Intake** of Nursery Pigs (g/day)

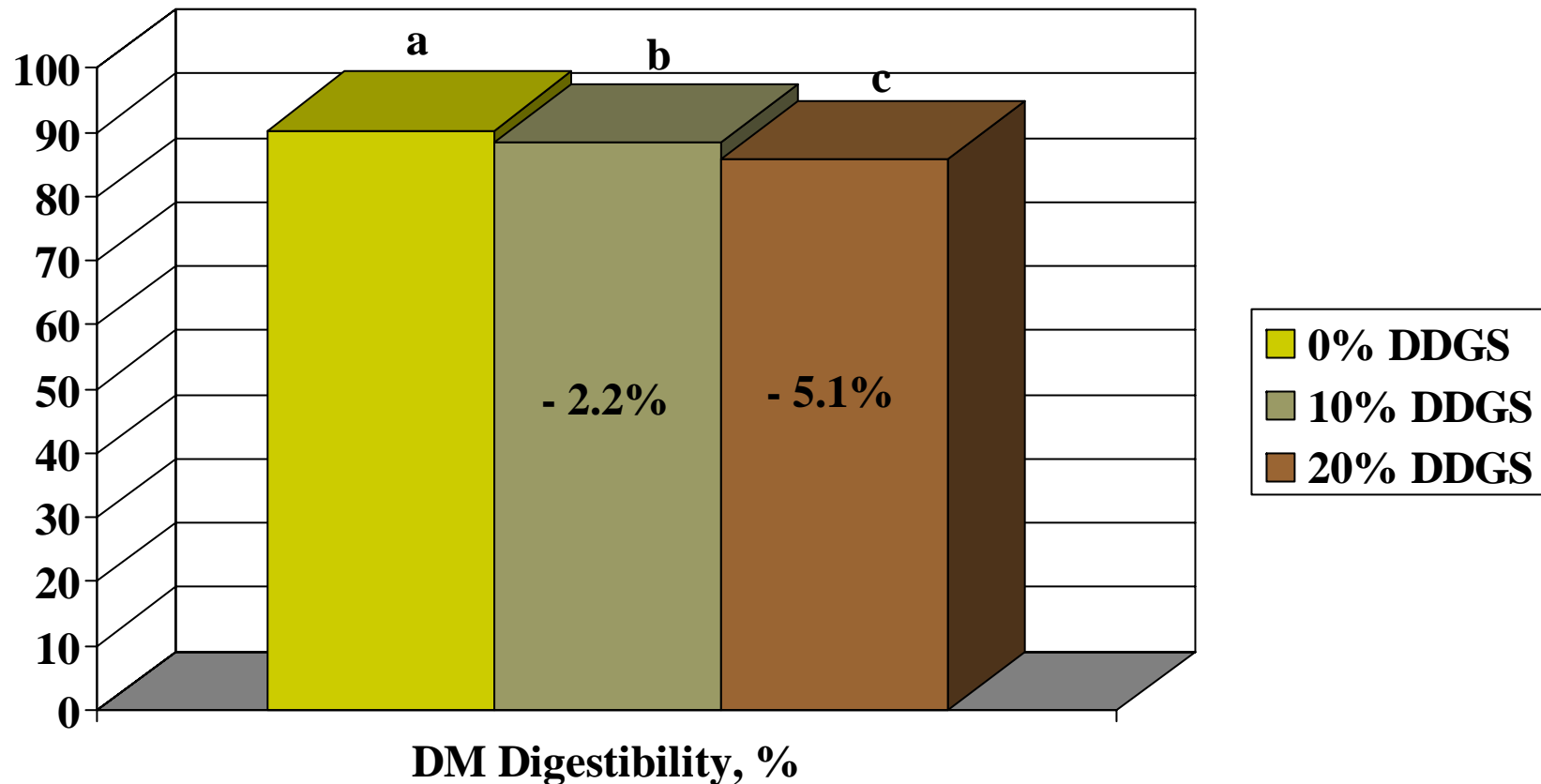


Effect of Dietary Level of DDGS on Daily Fecal Excretion (g/d)



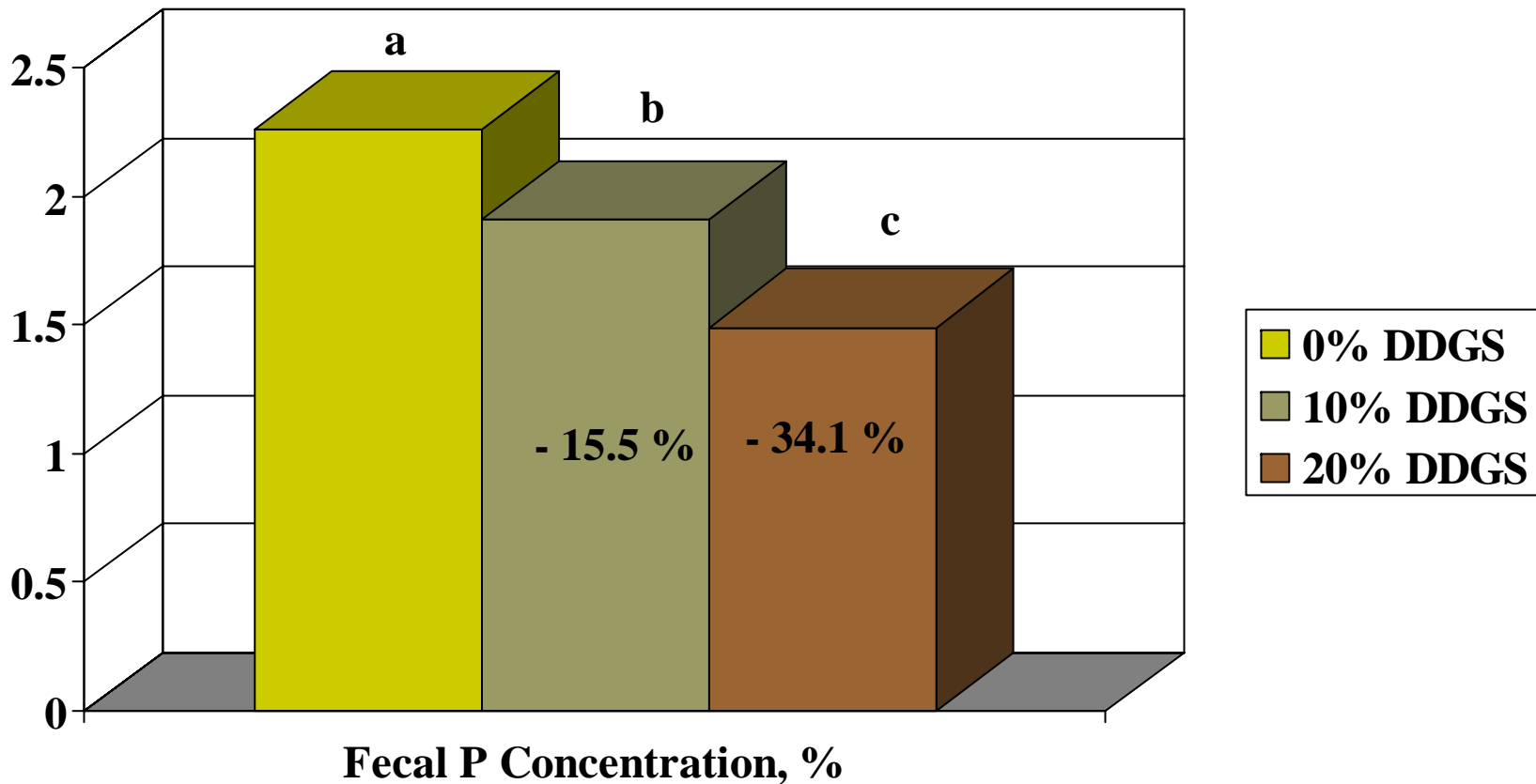
a,b,c Means with different superscripts are significantly different ($P < .05$).

Effect of Dietary Level of DDGS on Dry Matter Digestibility (%)



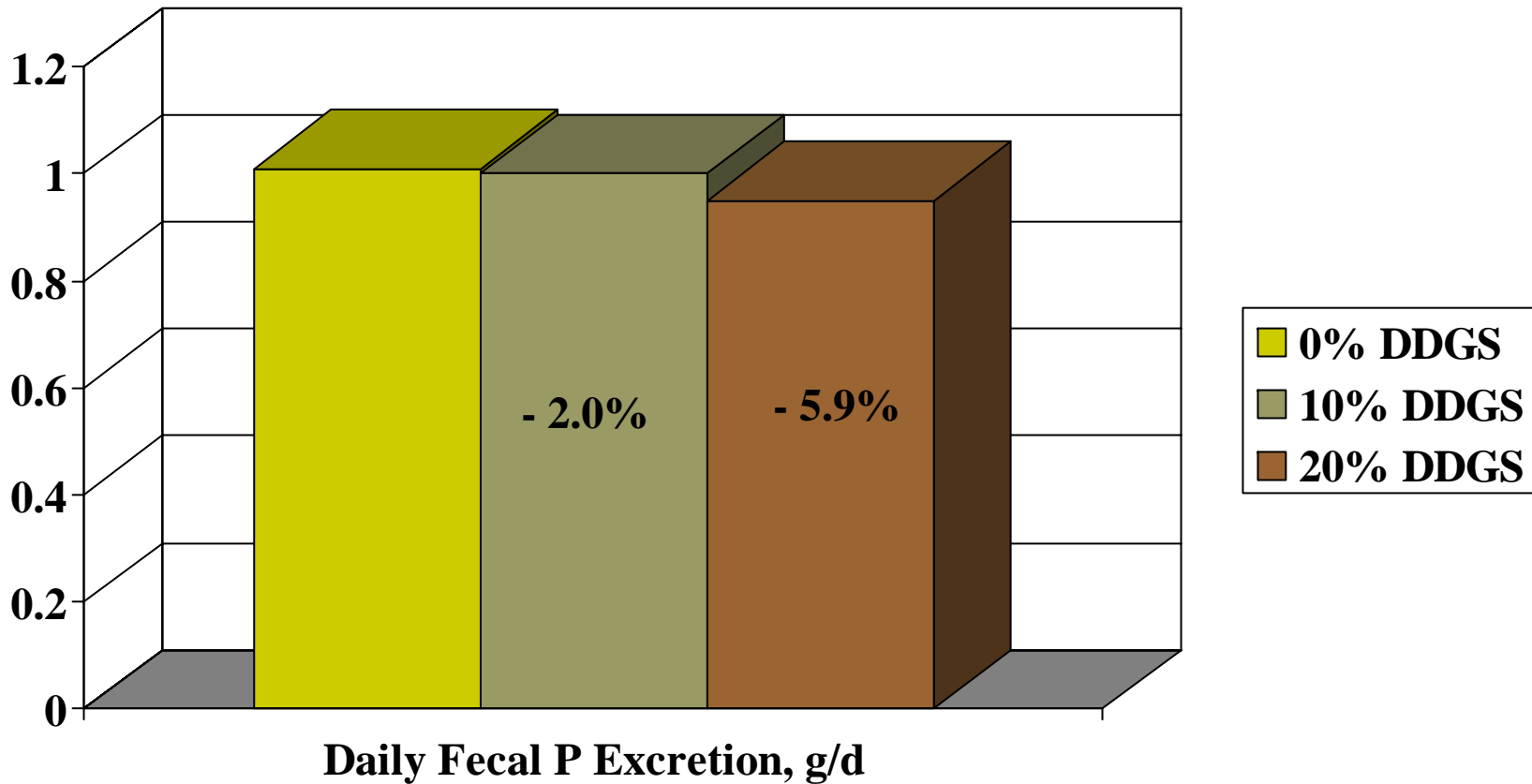
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Effect of Dietary Level of DDGS on Fecal Phosphorus Concentration (%)



a,b,c Means with different superscripts are significantly different ($P < .05$).

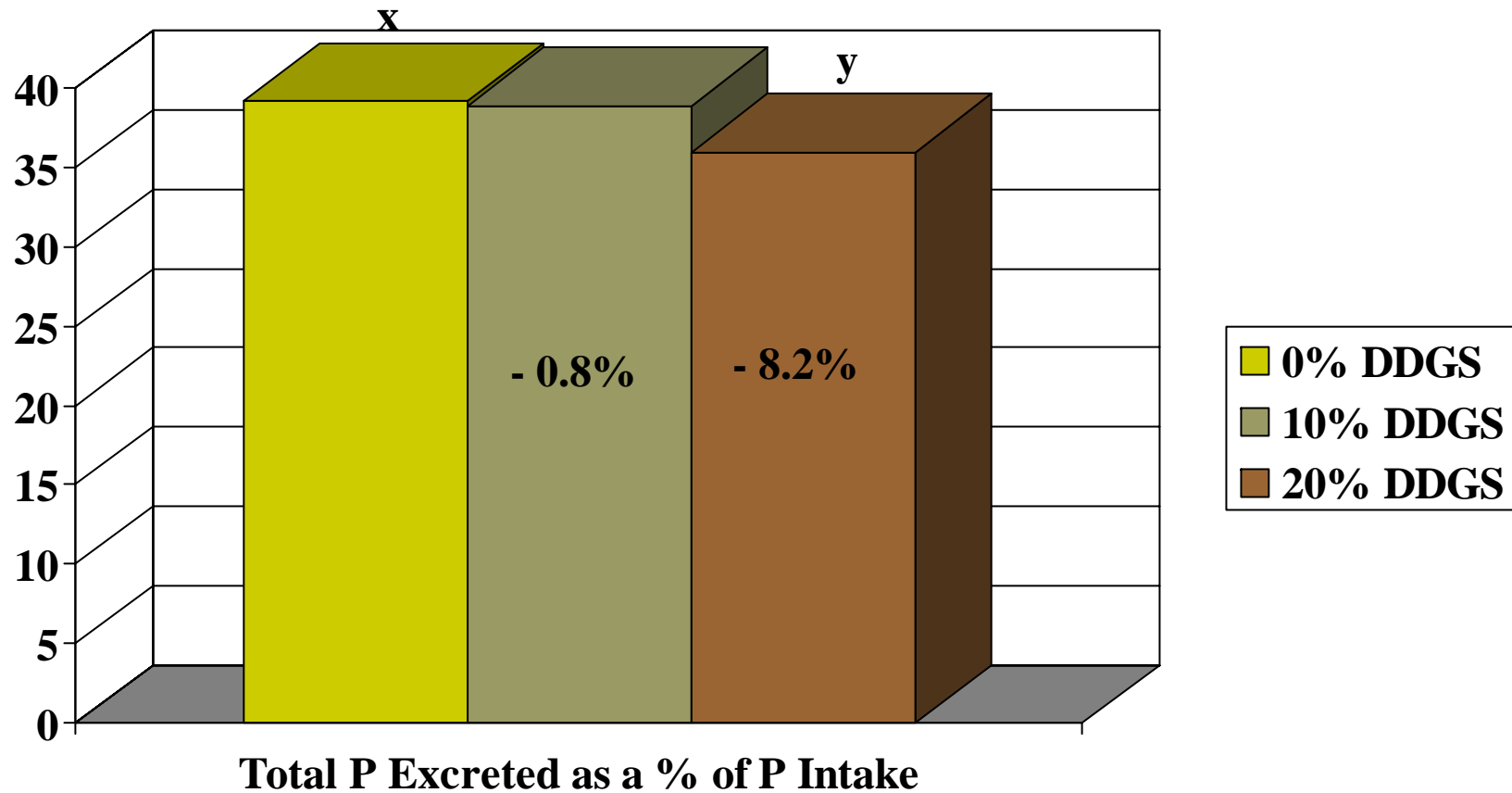
Effect of Dietary Level of DDGS on Daily Fecal Phosphorus Excretion (g/day)



Effect of Dietary Level of DDGS on Daily Urine P Excretion (g/day)

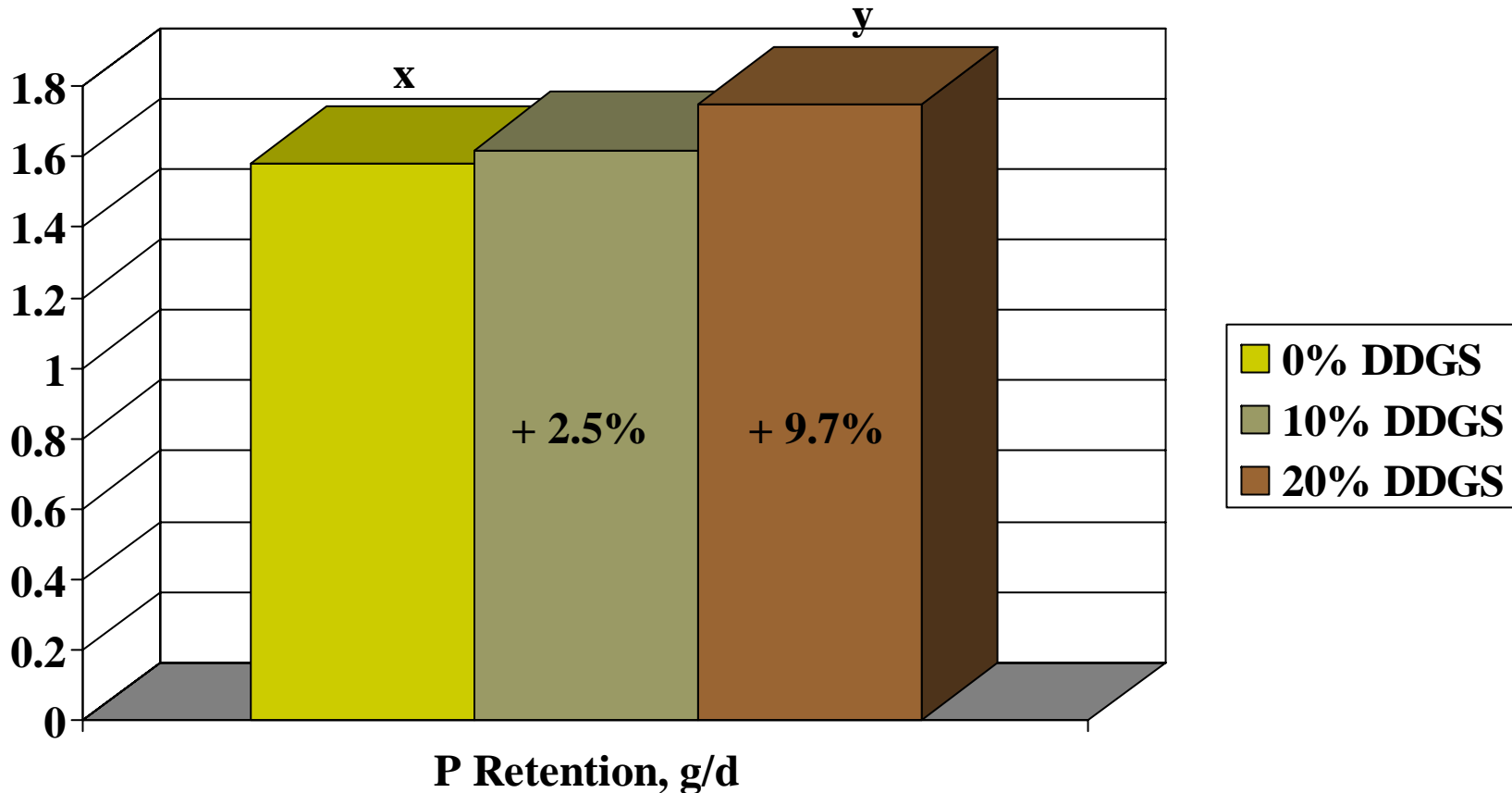


Effect of Dietary Level of DDGS on Total P Excreted as a % of Phosphorus Intake



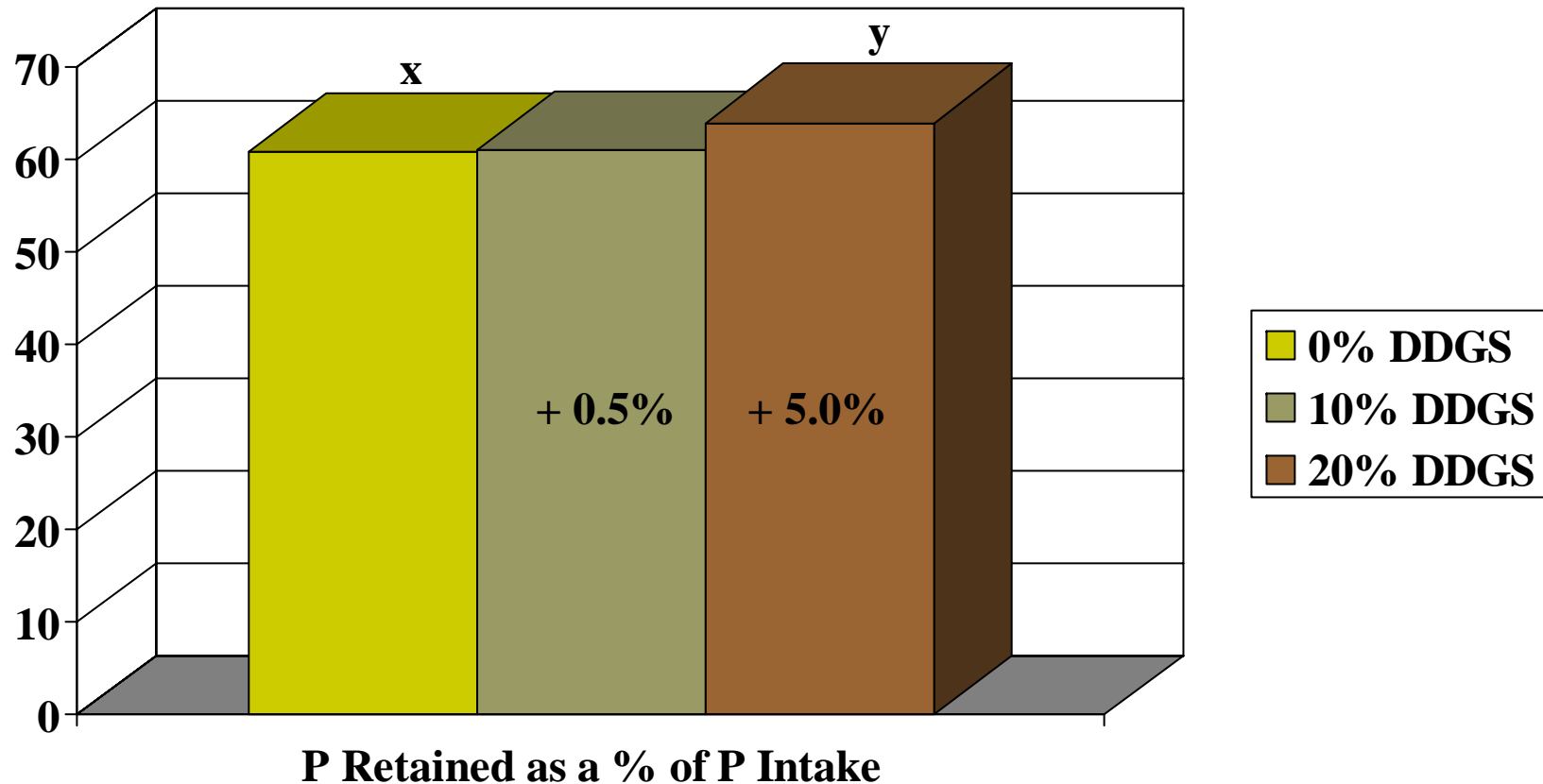
x,y Means with different superscripts are significantly different ($P < .15$).

Effect of Dietary Level of DDGS on Phosphorus Retention (g/day)



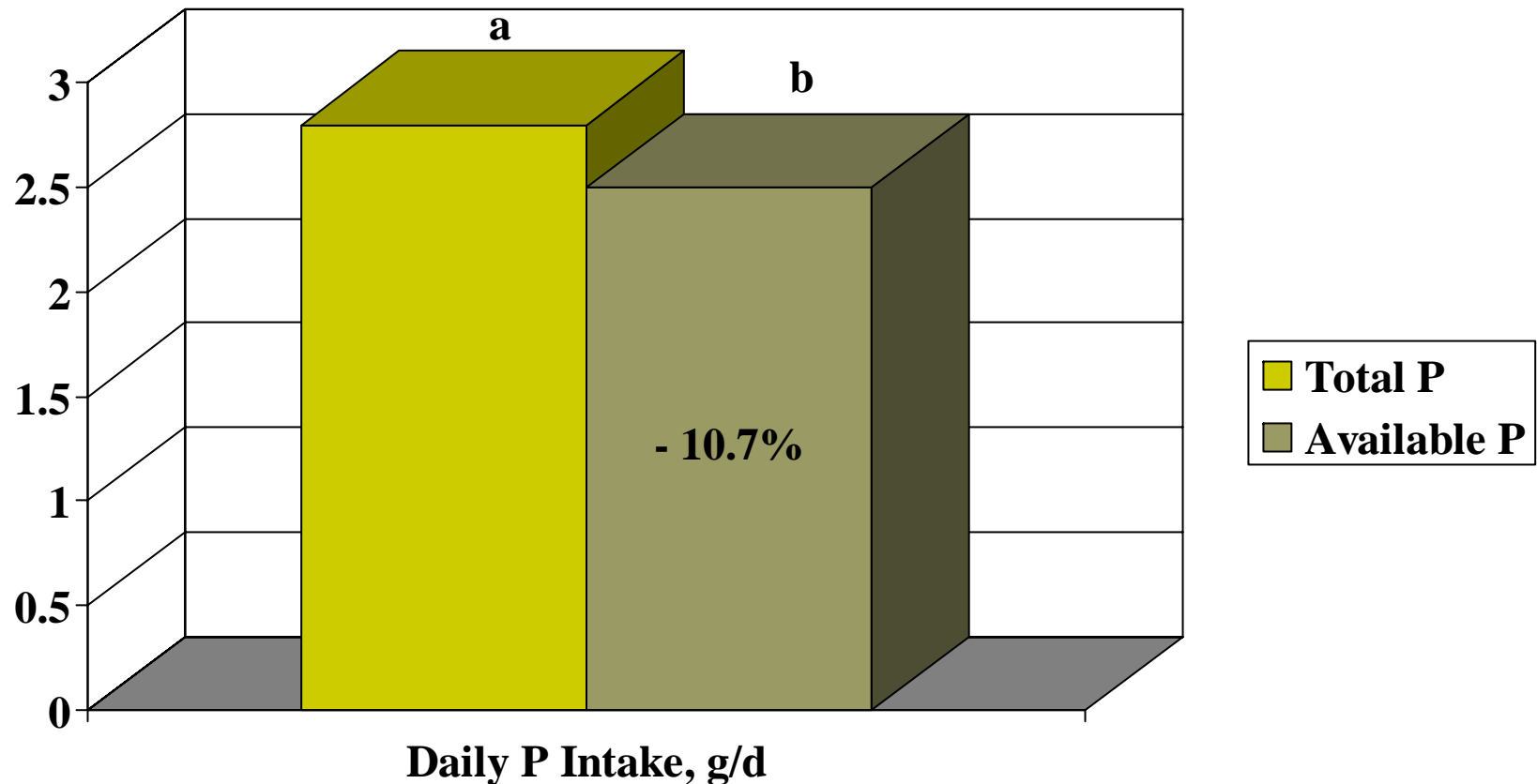
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Effect of Dietary Level of DDGS on P Retained as a % of P Intake



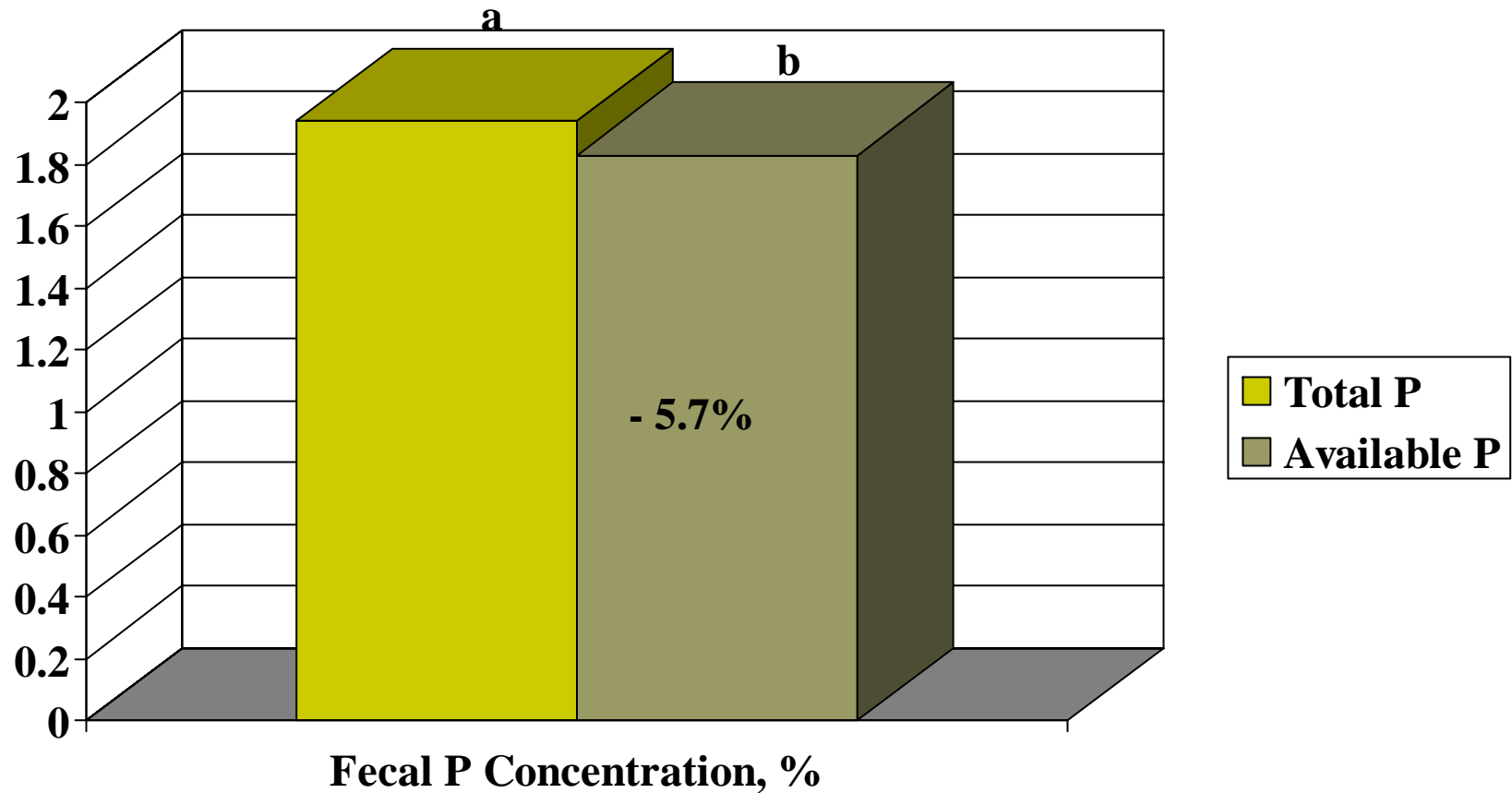
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Effect of Diet Formulation Method on Daily Phosphorus Intake (g/day)



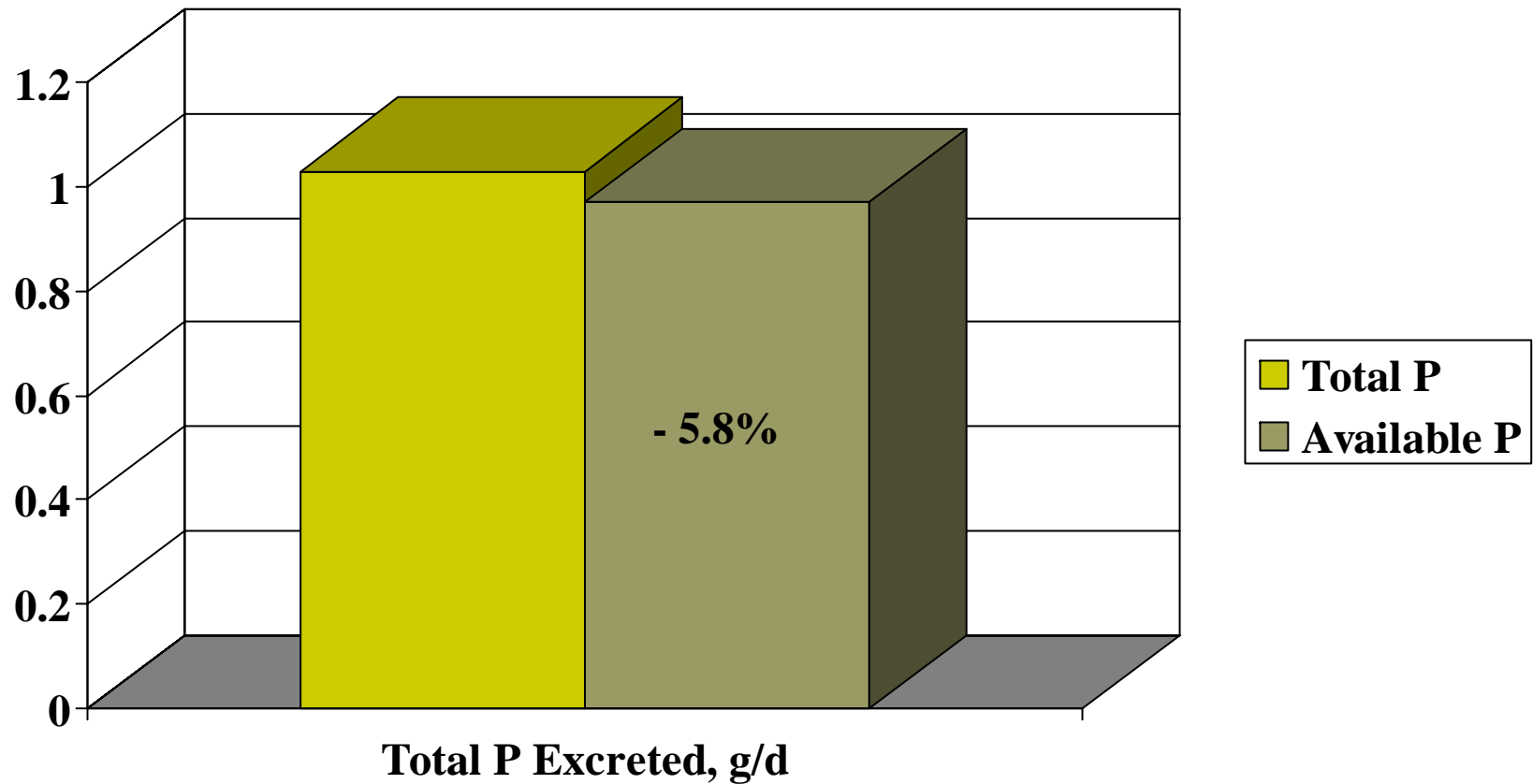
a,b Means with different superscripts are significantly different ($P < .05$).

Effect of Diet Formulation Method on Fecal Phosphorus Concentration (%)

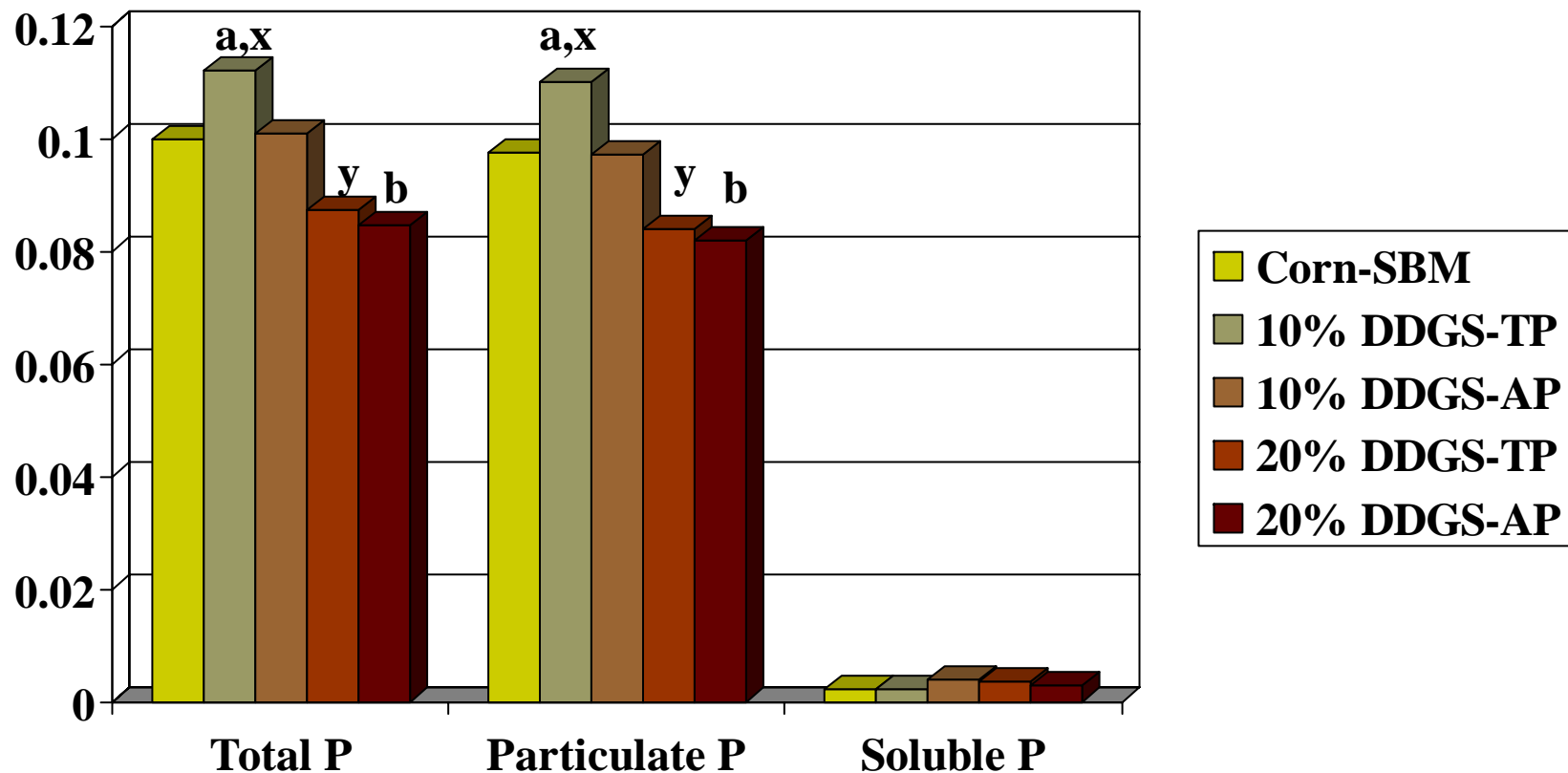


a,b,c Means with different superscripts are significantly different ($P < .05$).

Effect of Diet Formulation Method on Daily Total Phosphorus Excretion (g/day)



Effects of Adding 10 or 20% DDGS to Nursery Diets on % Total, Soluble and Particulate P in Swine Manure



a,b Means with different superscripts are significantly different ($P < .05$).

x,y Means with different superscripts are significantly different ($P < .15$).

Summary

- For every 10% DDGS added to the nursery diet:
 - dry matter digestibility ↓ 2.2%
 - daily fecal excretion ↑ 15%
 - fecal P concentration ↓ 16%
 - daily P excretion ↓ 2 to 4% ??
 - theoretical maximum is 6%

Summary

- Formulating nursery diets on an available P basis vs. total P basis:
 - ↓ daily total P intake by 11%
 - ↓ fecal P concentration by 6%
 - May ↓ daily fecal excretion by 6%



Conclusions

- Adding DDGS to nursery diets has a small effect on reducing manure P excretion
 - not as much as mathematically possible because of reduced DM digestibility

- Adding 20% DDGS to a nursery diet and formulating on an available P basis will result in the greatest reduction in manure P.



Conclusions

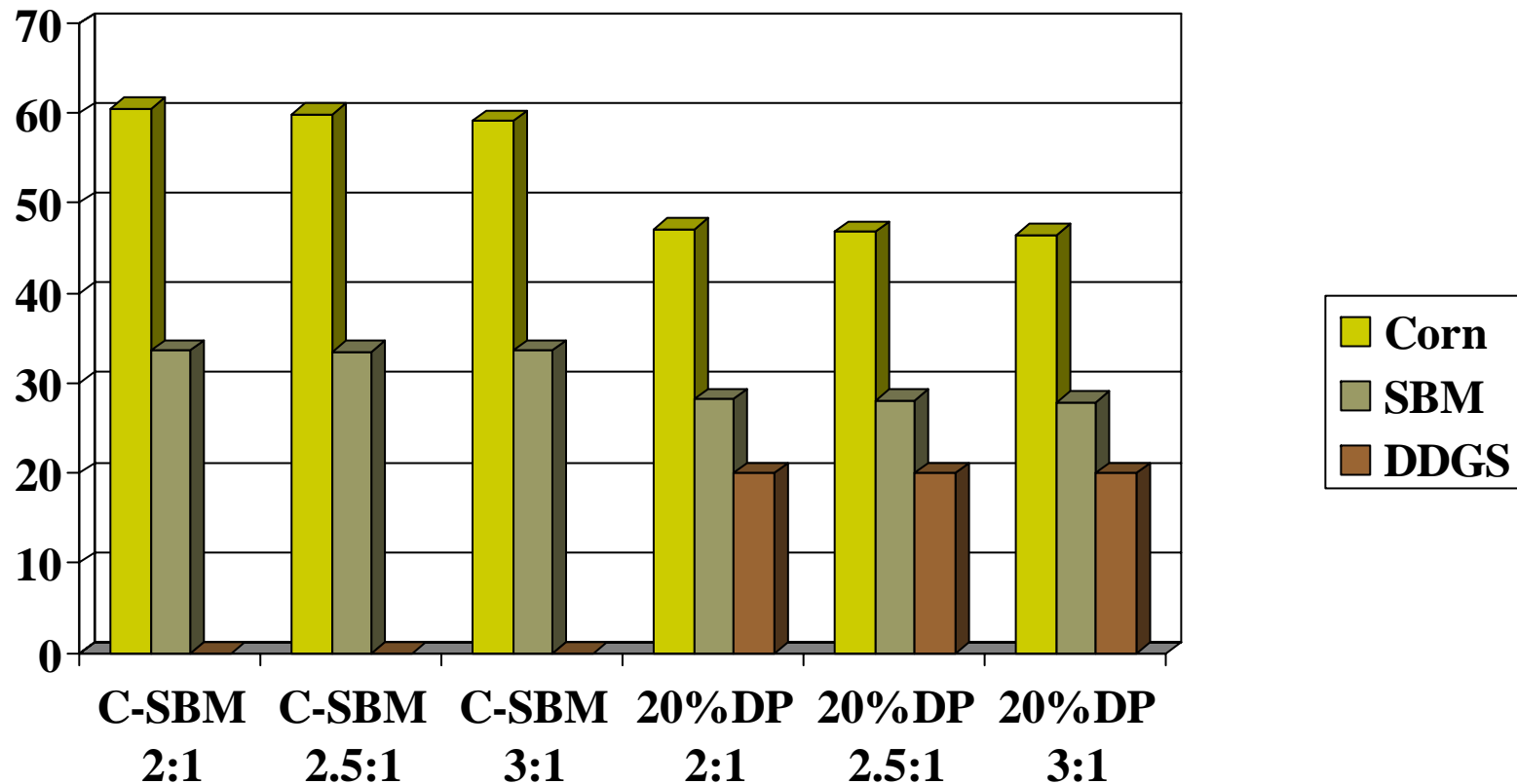
- Using a P bioavailability coefficient of 90% for DDGS appears to be reasonable when formulating DDGS diets for swine.
- Adding DDGS to nursery diets and formulating on an available P basis has minimal effects on the amount of soluble and particulate P excreted.



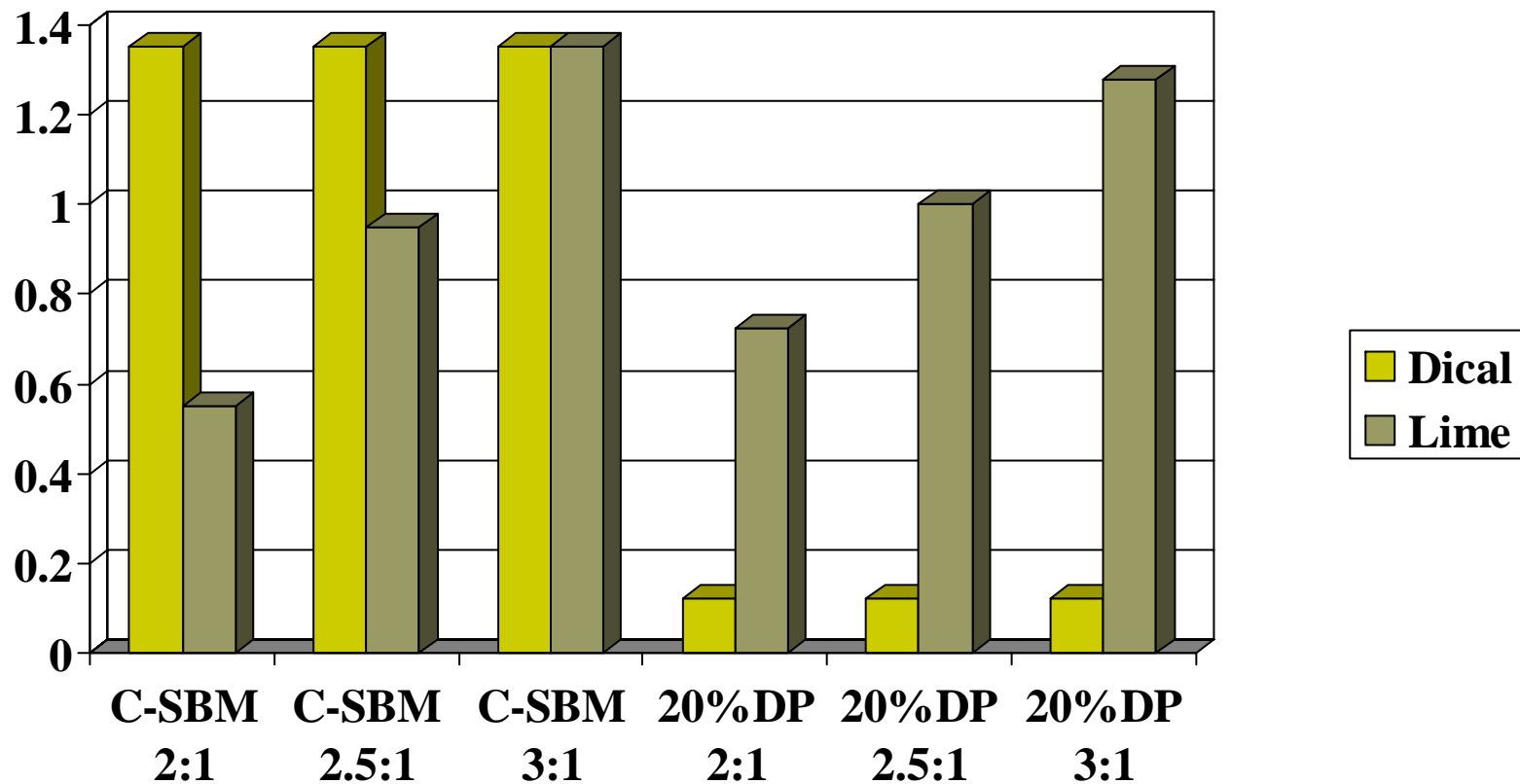
Effect of Adding 20% DDGS and Phytase, at Different Ca:Available P Ratios on Manure Phosphorus Excretion in Nursery Pigs.

Diet Composition	Ca:Available P ratio
1. Corn-SBM	2:1
2. Corn-SBM	2.5:1
3. Corn-SBM	3:1
4. 20% DDGS + phytase	2:1
5. 20% DDGS + phytase	2.5:1
6. 20% DDGS + phytase	3:1

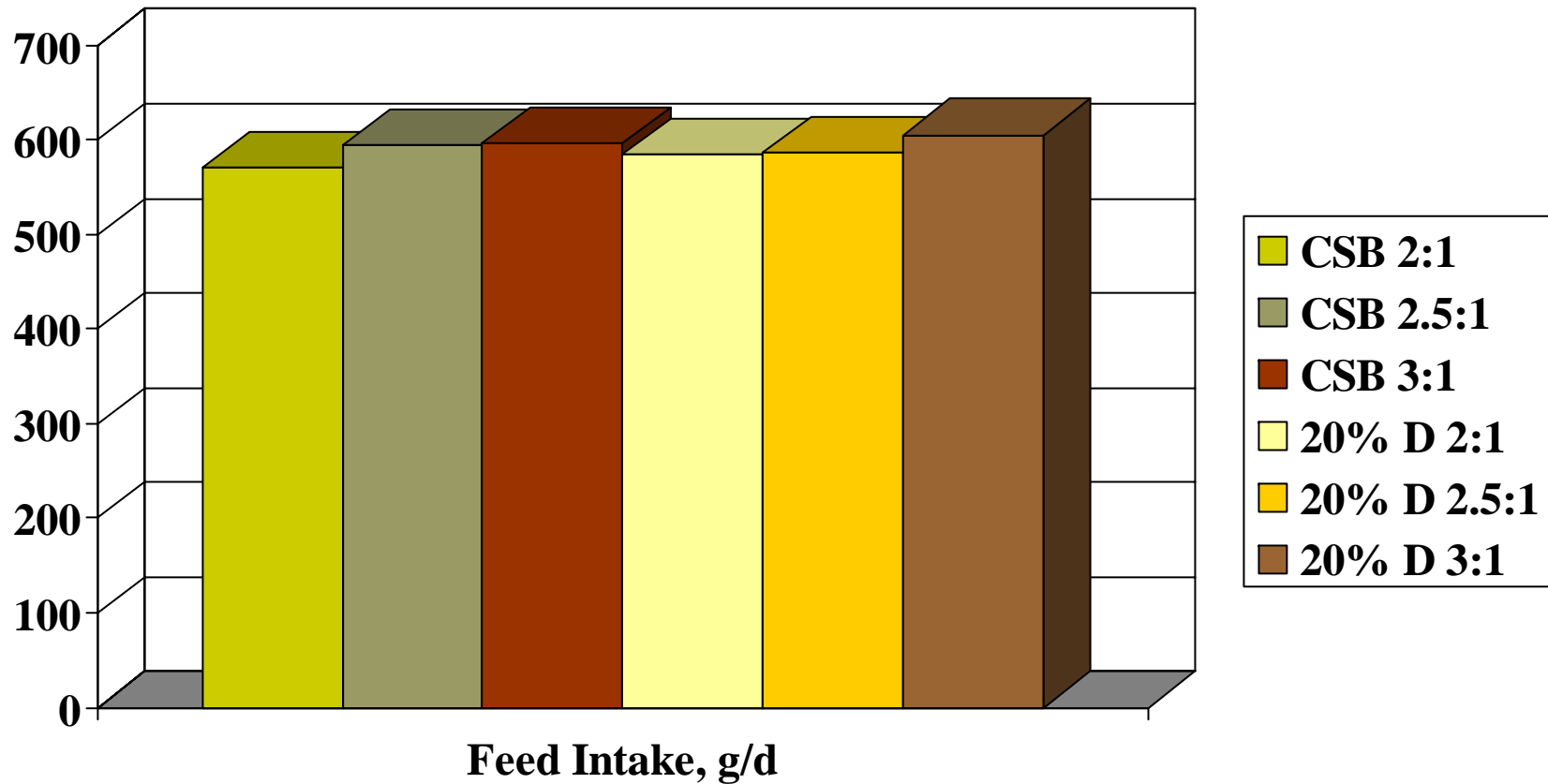
Percentage of Corn, Soybean Meal, and DDGS in Experimental Diets



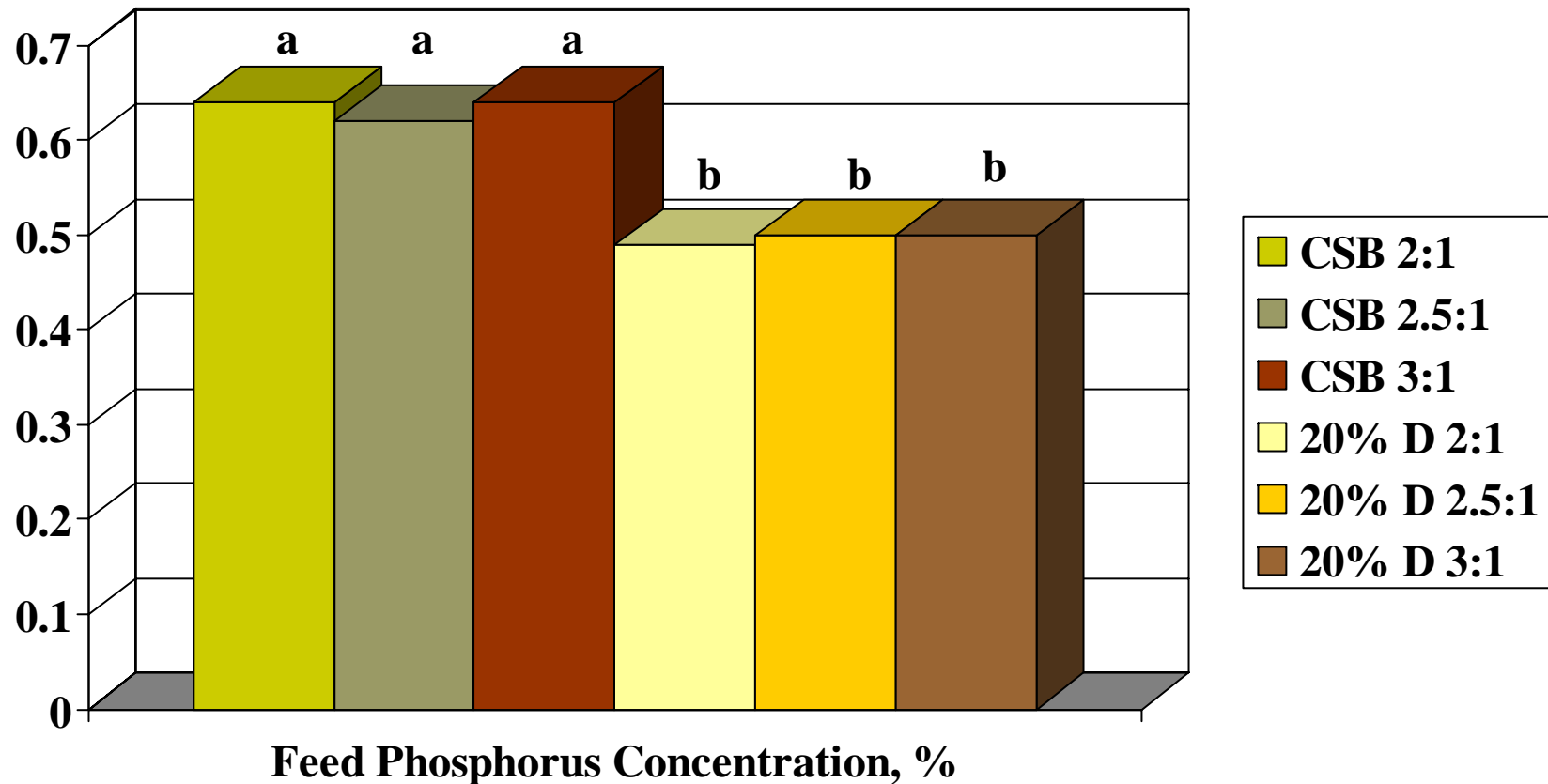
Percentage of Dicalcium Phosphate and Limestone in Experimental Diets



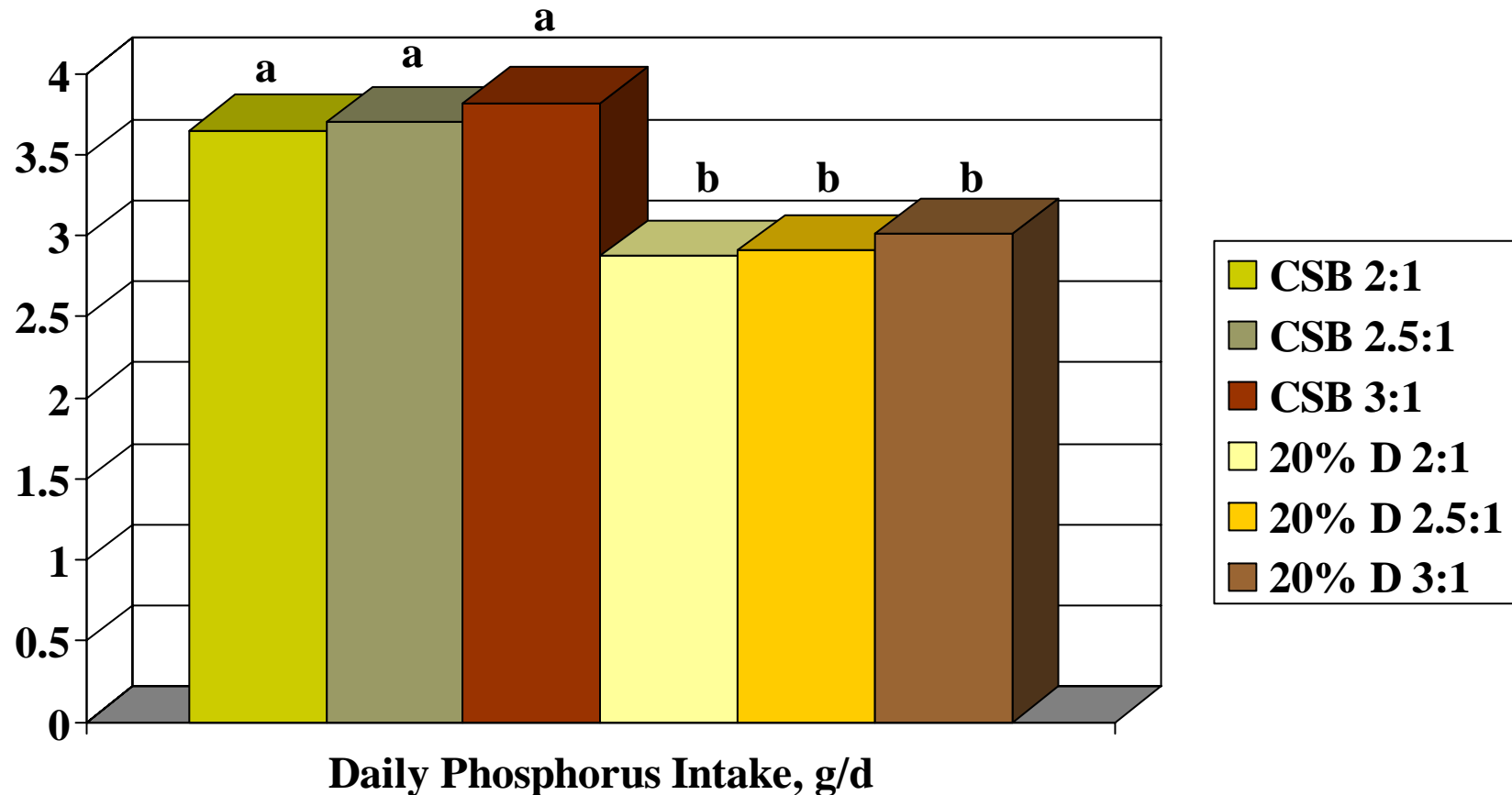
Effect of Feeding Corn-SBM Diets Without Phytase vs. Corn-SBM-20% DDGS Diets With Phytase at Different Ca:Avail P Ratios on Feed Intake of Nursery Pigs (g/day)



Effect of Feeding Corn-SBM Diets Without Phytase vs. Corn-SBM-20% DDGS Diets With Phytase at Different Ca:Avail P Ratios on **Dietary Phosphorus Concentration (%)**

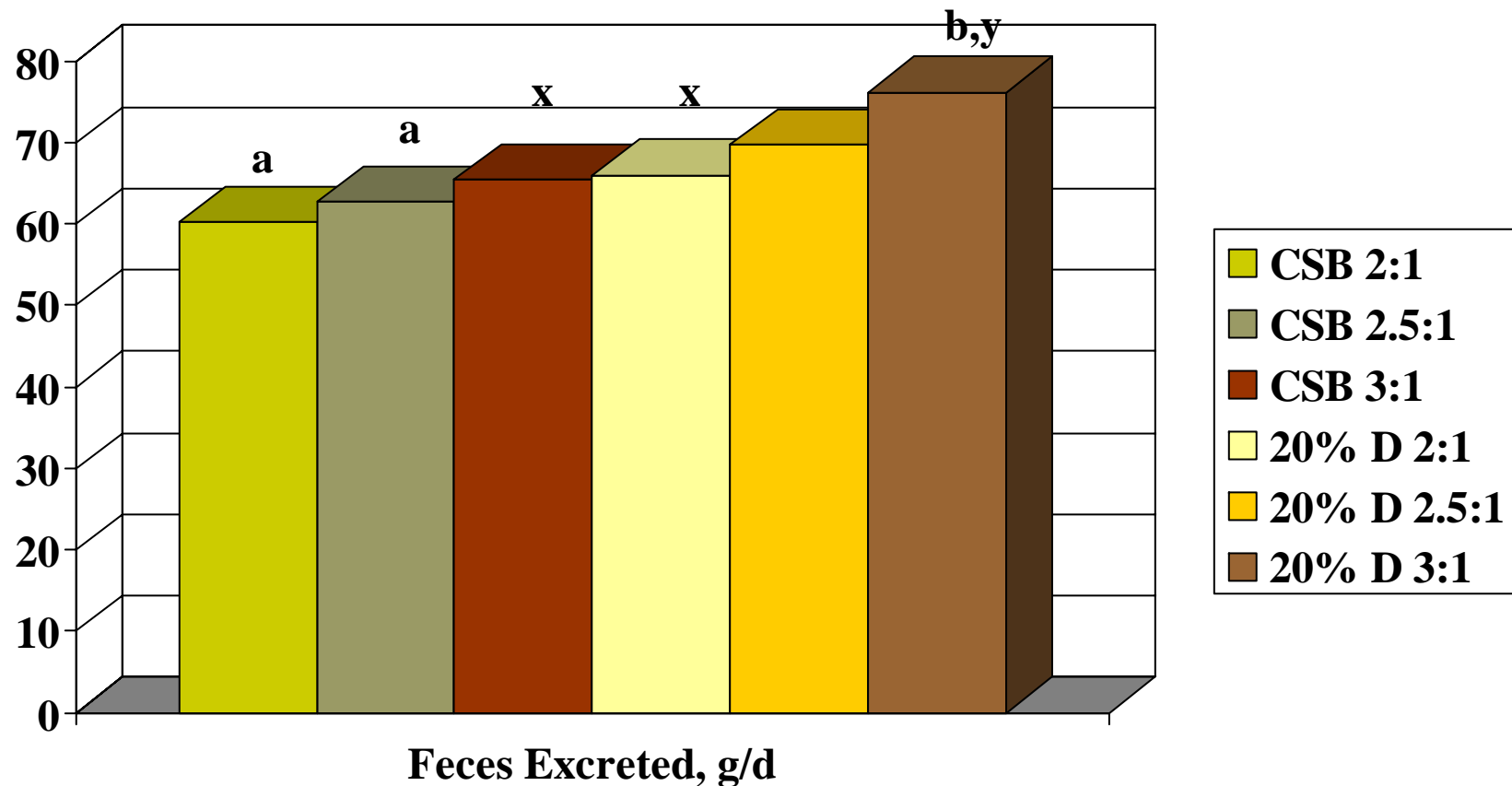


Effect of Feeding Corn-SBM Diets Without Phytase vs. Corn-SBM-20% DDGS Diets With Phytase at Different Ca:Avail P Ratios on **Daily Phosphorus Intake (g/d)**



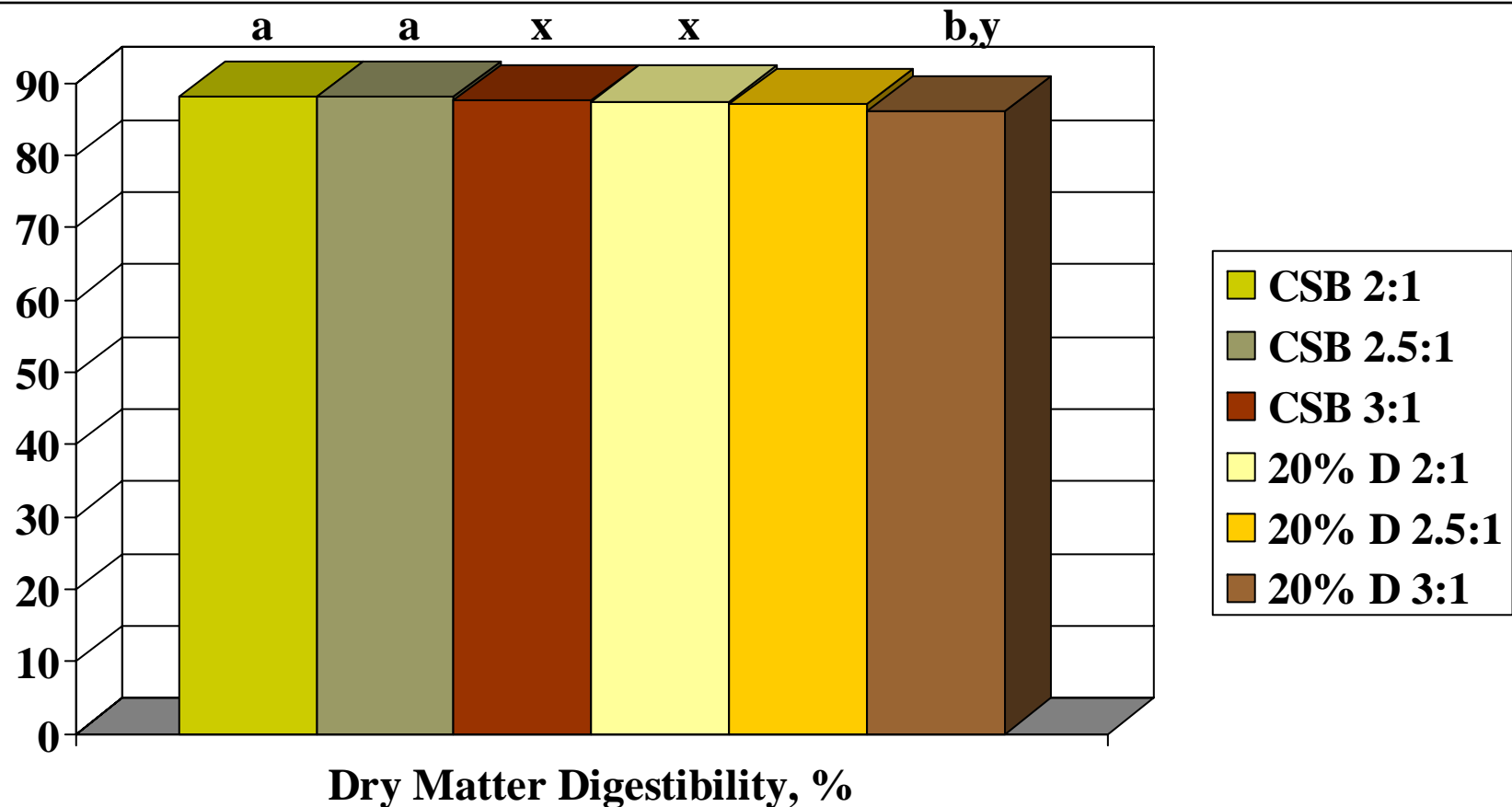
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Effect of Feeding Corn-SBM Diets Without Phytase vs. Corn-SBM-20% DDGS Diets With Phytase at Different Ca:Avail P Ratios on **Daily Fecal Excretion (g/d)**



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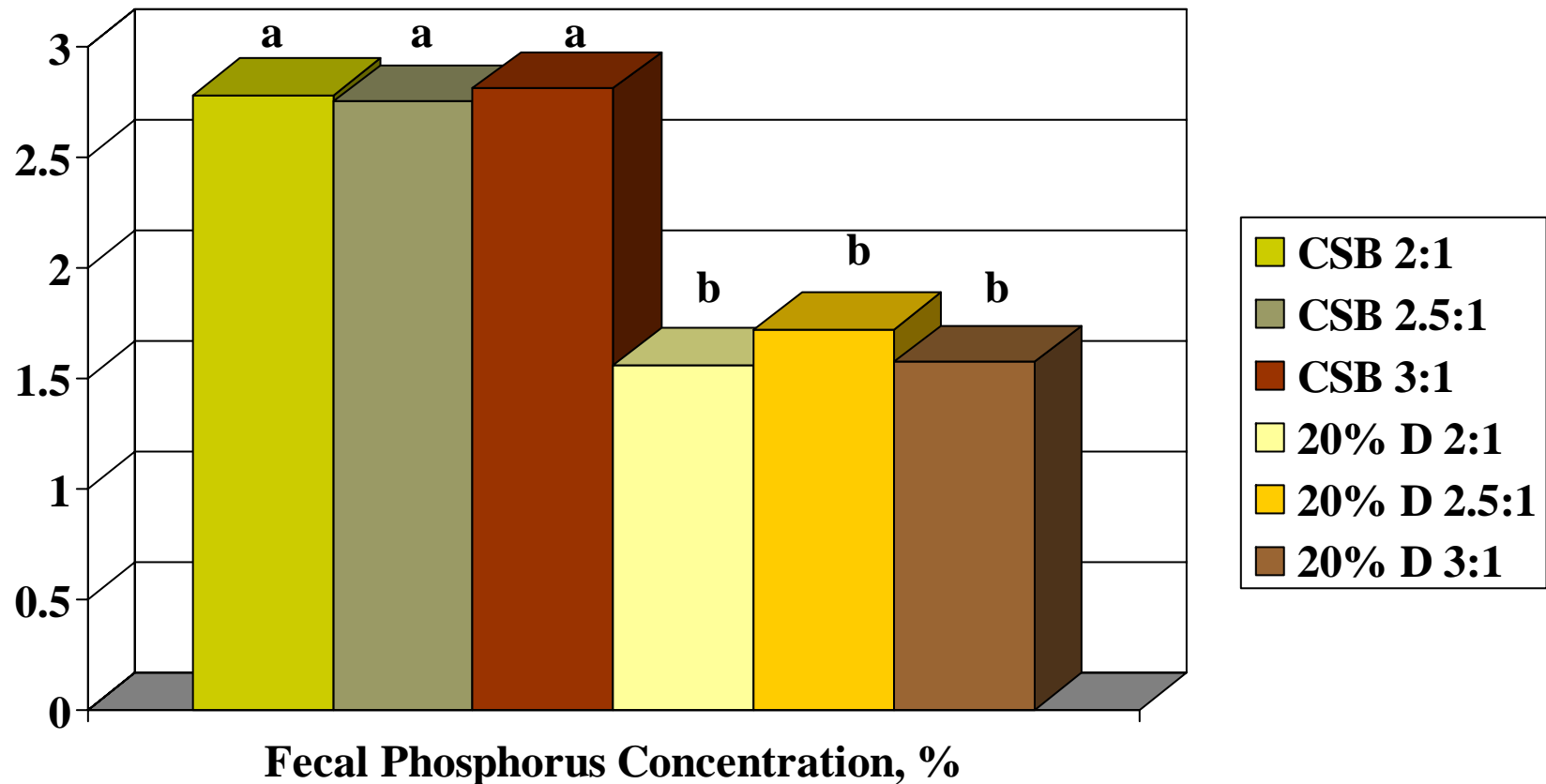
Effect of Feeding Corn-SBM Diets Without Phytase vs. Corn-SBM-20% DDGS Diets With Phytase at Different Ca:Avail P Ratios on **Dry Matter Digestibility (%)**



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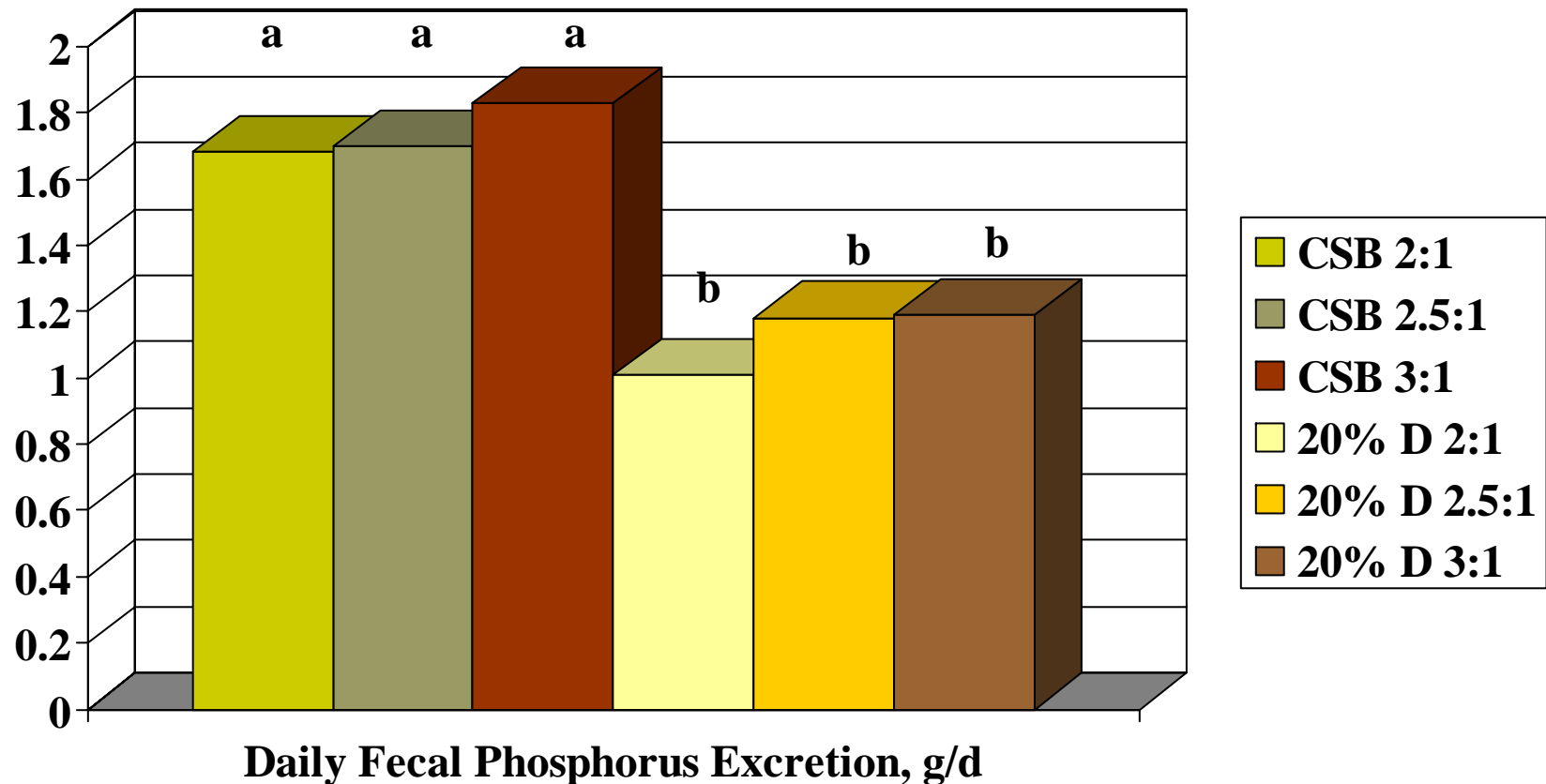
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Effect of Feeding Corn-SBM Diets Without Phytase vs. Corn-SBM-20% DDGS Diets With Phytase at Different Ca:Avail P Ratios on **Fecal Phosphorus Concentration (%)**



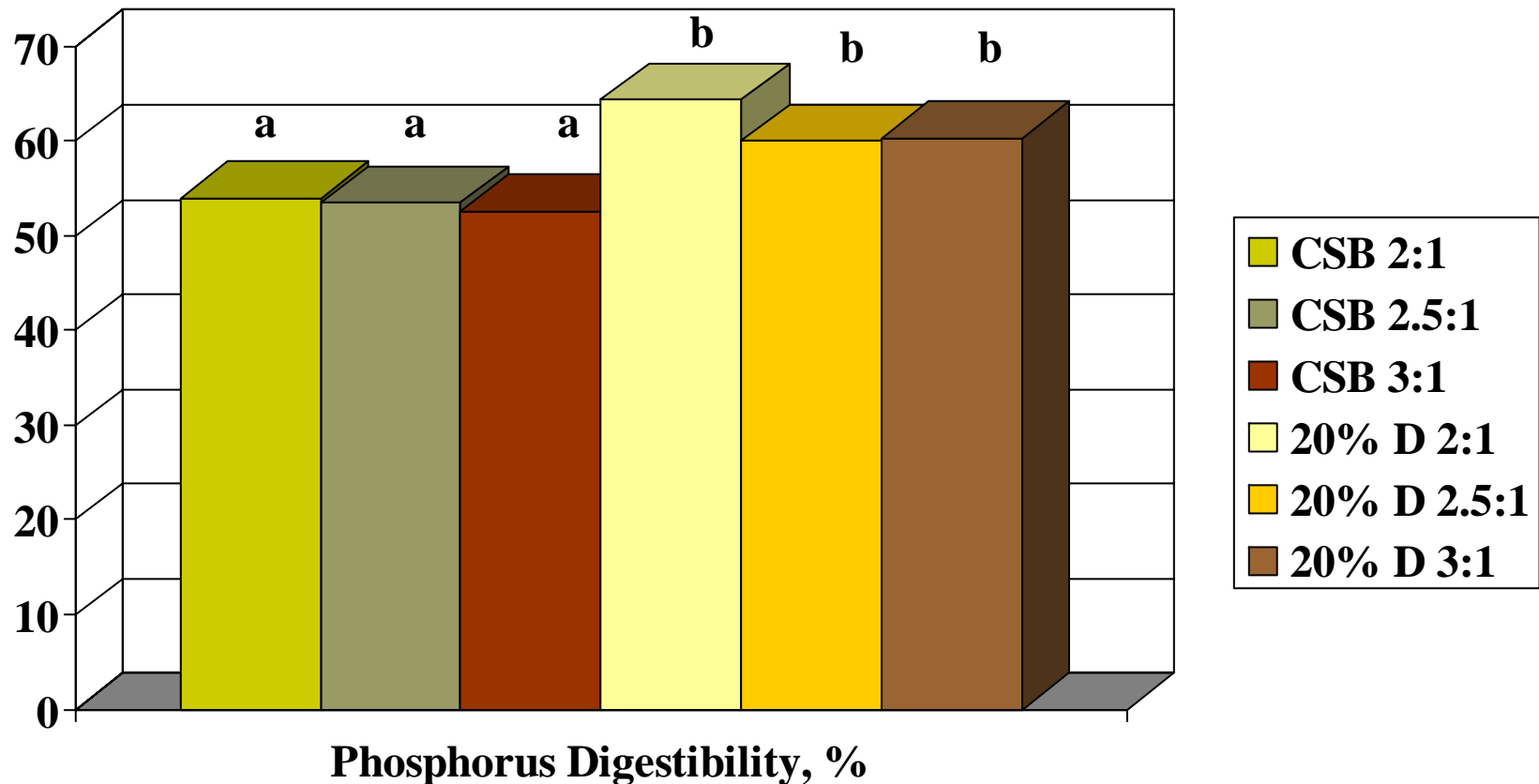
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Effect of Feeding Corn-SBM Diets Without Phytase vs. Corn-SBM-20% DDGS Diets With Phytase at Different Ca:Avail P Ratios on **Daily Fecal Phosphorus Excretion (g/d)**



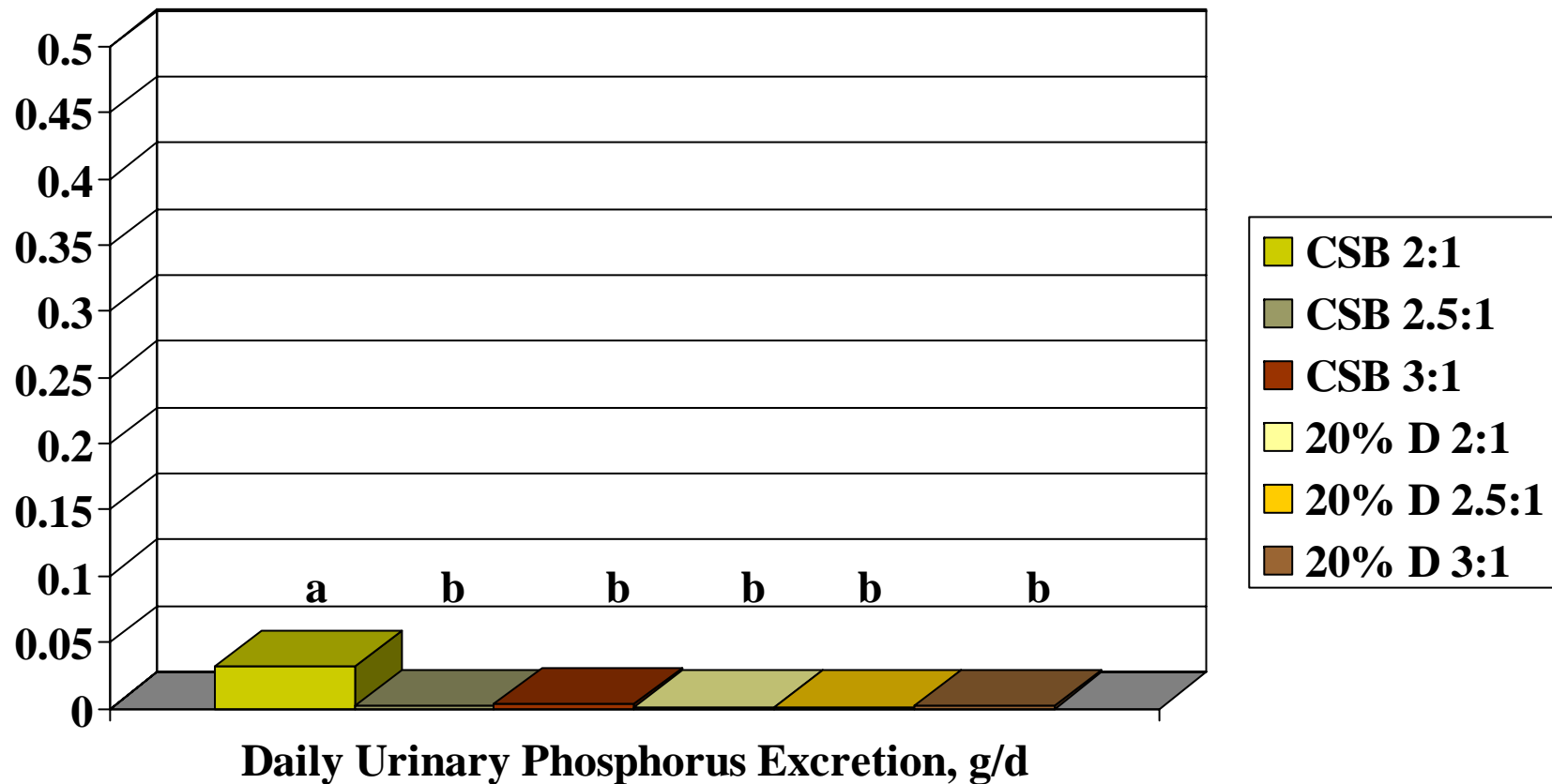
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Effect of Feeding Corn-SBM Diets Without Phytase vs. Corn-SBM-20% DDGS Diets With Phytase at Different Ca:Avail P Ratios on Phosphorus Digestibility (%)



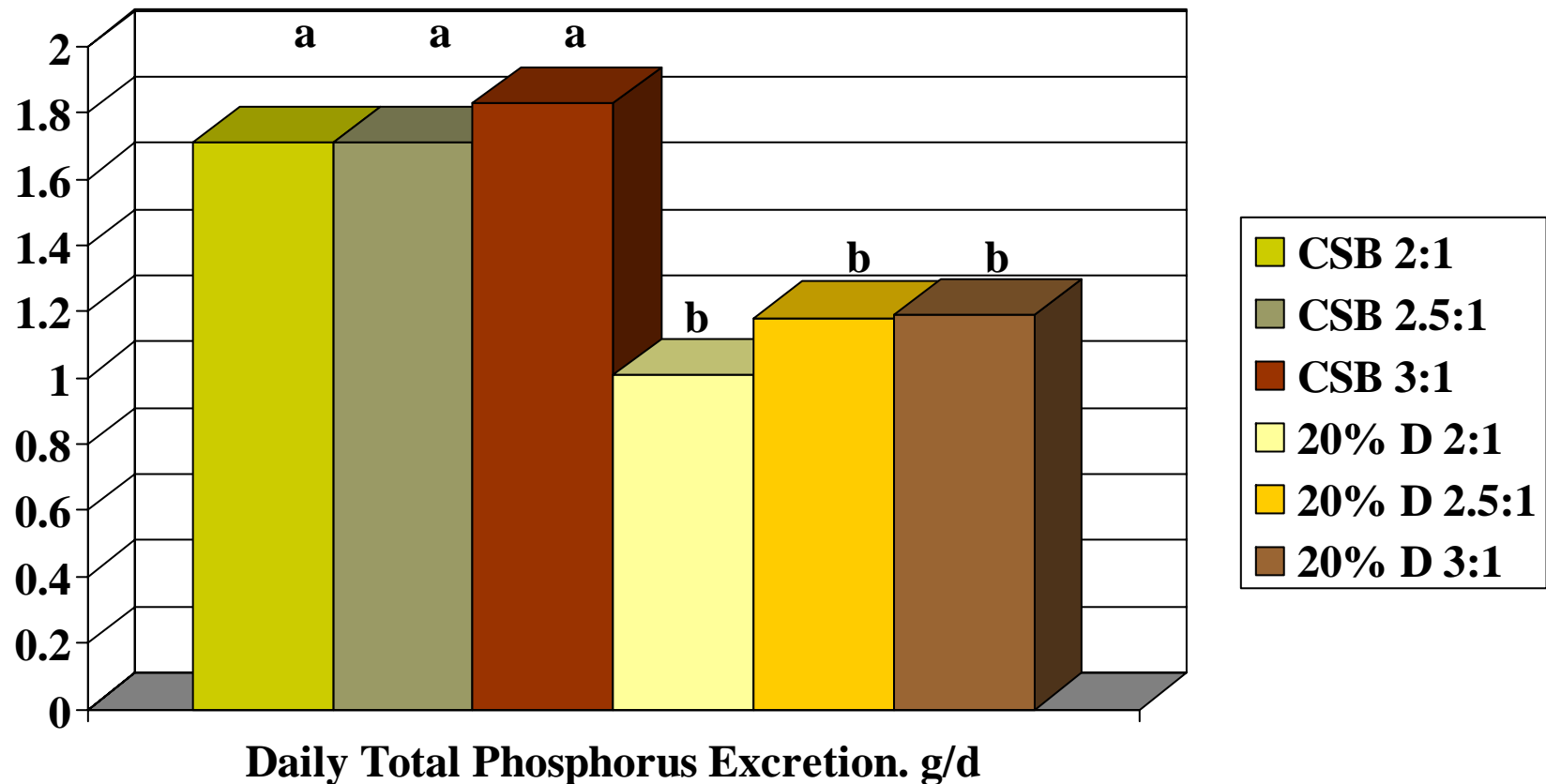
a,b Means with different superscripts are significantly different ($P < .05$).

Effect of Feeding Corn-SBM Diets Without Phytase vs. Corn-SBM-20% DDGS Diets With Phytase at Different Ca:Avail P Ratios on **Daily Urinary Phosphorus Excretion (g/d)**



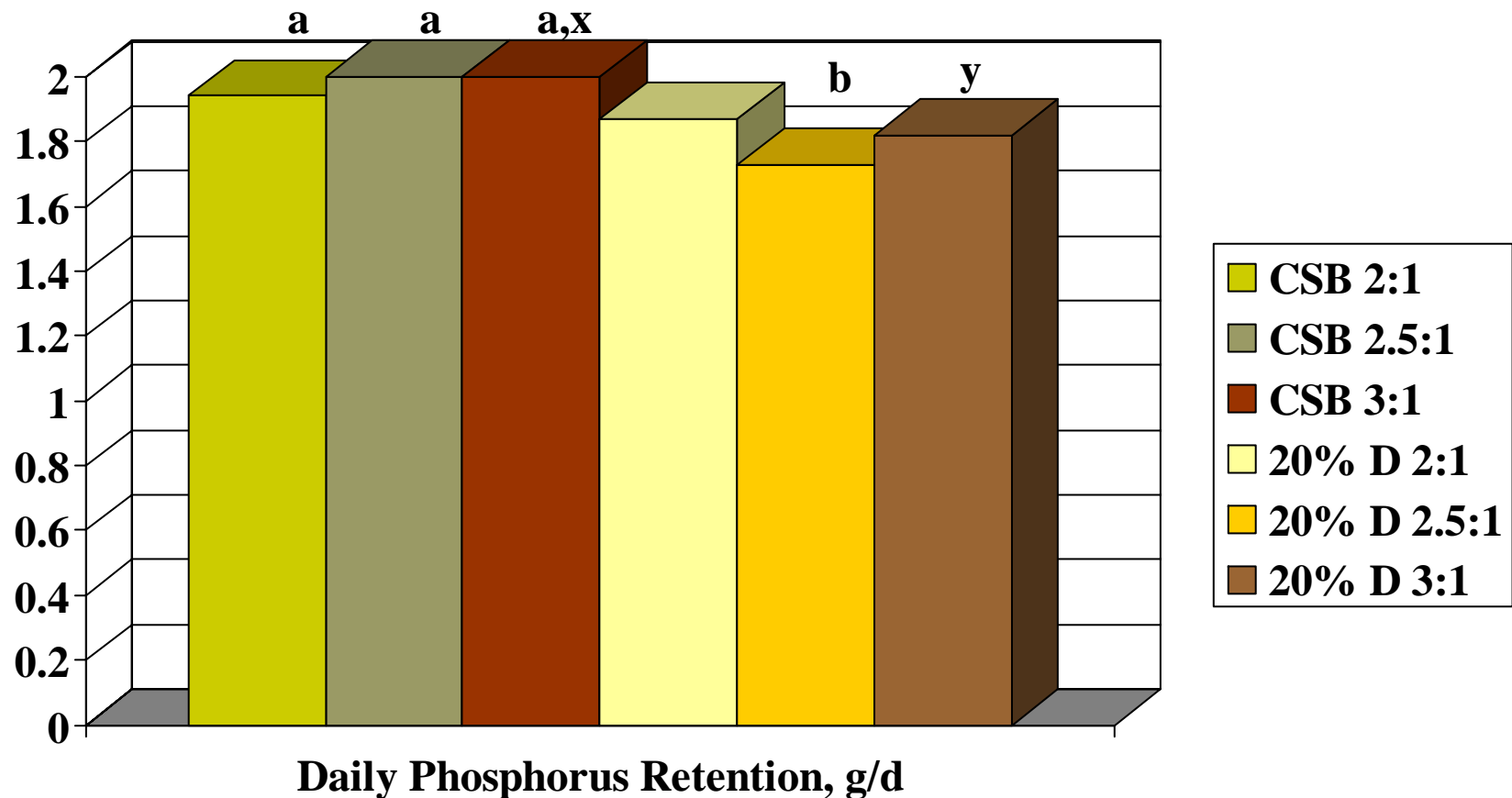
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Effect of Feeding Corn-SBM Diets Without Phytase vs. Corn-SBM-20% DDGS Diets With Phytase at Different Ca:Avail P Ratios on **Daily Total Phosphorus Excretion (g/d)**



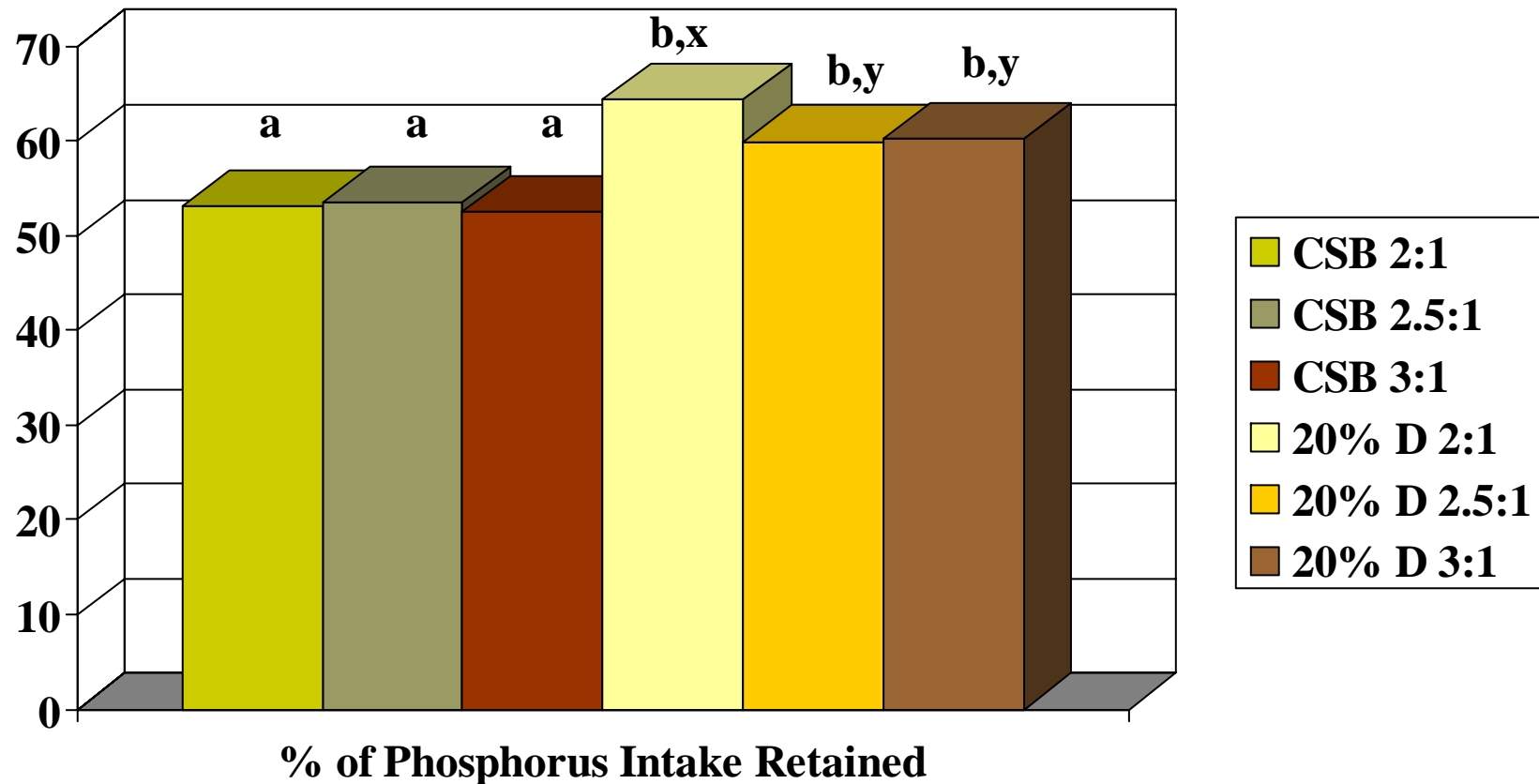
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Effect of Feeding Corn-SBM Diets Without Phytase vs. Corn-SBM-20% DDGS Diets With Phytase at Different Ca:Avail P Ratios on **Daily Phosphorus Retention (g/d)**



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Effect of Feeding Corn-SBM Diets Without Phytase vs. Corn-SBM-20% DDGS Diets With Phytase at Different Ca:Avail P Ratios on **Percentage of P Intake Retained (%)**



a,b Means with different superscripts are significantly different ($P < .05$).
x,y Means with different superscripts are significantly different ($P < .15$).

Summary

- Adding 20% DDGS and phytase to swine diets:
 - ↓ diet P concentration
 - ↓ daily P intake
 - ↓ fecal P concentration
 - ↓ fecal and total P excretion
 - ↑ P digestibility
 - ↑ % of P intake retained by the pig

Summary

- Calcium:Available P ratio:
 - No effect on DM digestibility
 - 3:1 tended to have ↑ fecal P excreted than 2:1
 - No effect on fecal P concentration
 - P digestibility tended to be ↑ for 2:1 vs. 2.5:1 and 3:1
 - No effect on P retention



Conclusion

- Adding 20% DDGS + phytase to nursery pig diets:
 - reduces manure P excretion by 36%
 - improves P retention

compared to feeding a corn-soybean meal diet
without DDGS and phytase

- Ca:Available P ratio is of little concern as long as it is between 2:1 to 3:1

Acknowledgements

- This study was funded by the:

Iowa Corn Growers Association

