

USE OF DISTILLERS GRAINS AND CO-PRODUCTS IN RUMINANTS DIETS

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DEFINITION-CLASSIFICATION

Grain  **Whole spent stillage**

– Thin stillage

- Condensed distillers' solubles (CDS)
- Dried distillers' solubles (DDS)

– Wet distillers' grains

- Dried distillers' grains (DDG)

– Thin stillage + wet distillers' grains

- Dried distillers' grains with solubles (DDGS)

COMPOSITION OF DISTILLERS PRODUCTS

| Item | WDG | TS | DDG | DS | DDGS |
|---------------------|------|------|------|------|------|
| DM | 27.9 | 4.4 | 92.0 | 42.1 | 92.0 |
| ----- % of DM ----- | | | | | |
| CP | 28.1 | 19.0 | 23.0 | 29.7 | 28.7 |
| NDF | 44.3 | 13.3 | 43.0 | 23.0 | 44.0 |
| EE | 15.4 | 9.2 | 9.8 | 9.2 | 10.3 |
| Ash | 3.1 | 6.7 | 2.4 | 7.8 | 4.8 |

Source: NRC Dairy, 1989; Lee et al., 1991; Dong et al., 1987; Belyea, 1994; Ham et al., 1994.

NUTRIENT COMPOSITION OF DDGS: A SURVEY

Objective:

- To assess the variation in nutrient composition of distillers' dried grains with solubles (DDGS) across and within ethanol production facilities.
- To evaluate commonly used predictors of protein quality of DDGS.

Sample collection:

- ◆ 8 ethanol production facilities were sampled (Location: MN (5), SD (2), and NE (1))
- ◆ Samples from each facility were collected on the first and third Tuesday of each month over a 6-month period (Dec. 96 to May 97)

Measurements:

- ◆ **Nutrients content**
 - DM, CP, NDF, ADF, fat, and ash
- ◆ **Color score:**
 - L (lightness: black to white)
 - a (redness)
 - b (yellowness)

Measurements:

◆ CP fractions:

- Soluble protein (SP).
- Acid detergent insoluble protein (ADIP).
- Rumen degradable protein (RDP).
- Rumen undegraded protein that is available in the intestine (IARUP).

Statistical analysis:

General Linear Model procedure of SAS.

Model: $Y = P + M(P)$

Y = observed measurement

P = effect of ethanol production facility
(fixed effect)

$M(P)$ = effect of month of sampling
nested within production facility
(random effect)

NUTRIENT COMPOSITION OF DDGS¹

| Item | Mean | Range |
|---------------------|-------------|--------------------|
| DM, % | 92.7 | 81.9 – 96.9 |
| CP, % of DM | 30.1 | 25.9 – 36.3 |
| NDF, % of DM | 48.8 | 38.9 – 61.5 |
| ADF, % of DM | 15.5 | 5.4 – 23.1 |
| Fat, % of DM | 10.5 | 4.3 – 18.7 |
| Ash, % of DM | 4.3 | 2.0 – 6.7 |

¹ **Distillers dried grains with solubles**

PROTEIN FRACTIONS IN DDGS¹

| Item | Mean | Range |
|----------------------------|-------------|--------------------|
| CP, % of DM | 30.1 | 25.9 – 36.3 |
| Soluble CP, % of CP | 9.7 | 1.1 – 21.8 |
| ADIP, % of CP | 8.0 | 0.8 – 18.5 |
| RDP, % of CP | 46.5 | 31.5 – 59.8 |
| IARUP, % of RUP | 82.2 | 71.5 – 93.8 |

¹ Distillers dried grains with solubles

VARIATION IN DDGS COMPOSITION WITHIN ETHANOL PRODUCTION FACILITIES¹

| Items with relatively low variability | C.V. range |
|---------------------------------------|--------------|
| DM, % | 0.56 – 3.69 |
| NDF, % of DM | 3.99 – 10.29 |
| CP, % of DM | 2.04 – 5.85 |
| RUP, % of CP | 6.08 – 11.96 |
| IARUP, % | 4.06 – 7.01 |
| Color score L | 2.14 – 6.96 |

¹ Distillers dried grains with solubles

VARIATION IN DDGS COMPOSITION WITHIN ETHANOL PRODUCTION FACILITIES¹

| Items with high variability | C.V. range |
|-----------------------------|-------------|
| ADF, % of DM | 12.9 – 28.1 |
| Ether extract, % of DM | 12.9 – 38.5 |
| Ash, % of DM | 6.7 – 19.7 |
| Soluble protein, % of CP | 11.4 – 61.2 |
| ADIN, % of total N | 34.5 – 61.3 |
| Color scores a and b | 8.3 – 68.4 |

¹ Distillers dried grains with solubles

VARIATION IN DDGS COMPOSITION ACROSS PRODUCTION FACILITIES¹

| Item | Mean | C.V. | <i>P</i> |
|--------------|------|------|----------|
| DM, % | 92.7 | 1.7 | < 0.01 |
| NDF, % of DM | 48.8 | 7.2 | < 0.01 |
| ADF, % of DM | 15.5 | 16.9 | 0.04 |
| Fat, % of DM | 10.5 | 16.0 | < 0.01 |
| Ash, % of DM | 4.3 | 12.4 | < 0.01 |

¹ Distillers dried grains with solubles

VARIATION IN DDGS COMPOSITION ACROSS PRODUCTION FACILITIES¹

| Item | Mean | C.V. | <i>P</i> |
|---------------------|------|------|----------|
| CP, % of DM | 30.1 | 3.7 | < 0.01 |
| Soluble CP, % of CP | 9.7 | 28.9 | < 0.01 |
| ADIP, % of CP | 8.0 | 36.1 | < 0.01 |
| RDP, % of CP | 46.5 | 7.7 | < 0.01 |
| IARUP, % of RUP | 82.2 | 4.4 | < 0.01 |

¹ Distillers dried grains with solubles

VARIATION IN PHYSICAL CHARACTERISTICS OF DDGS ACROSS PRODUCTION FACILITIES¹

| Item | Mean | C.V. | <i>P</i> |
|-------------------------|-------------|-------------|------------------|
| Particle size > 2 mm, % | 10.2 | 22.3 | < 0.01 |
| Particle size < 1 mm, % | 58.4 | 20.7 | < 0.01 |
| Color score: | | | |
| L (lightness) | 51.0 | 4.6 | < 0.01 |
| a (redness) | 5.5 | 9.6 | < 0.01 |
| b (yellowness) | 22.5 | 14.2 | < 0.01 |

¹ Distillers dried grains with solubles

CAUSES OF VARIATION IN DISTILLERS GRAINS COMPOSITION

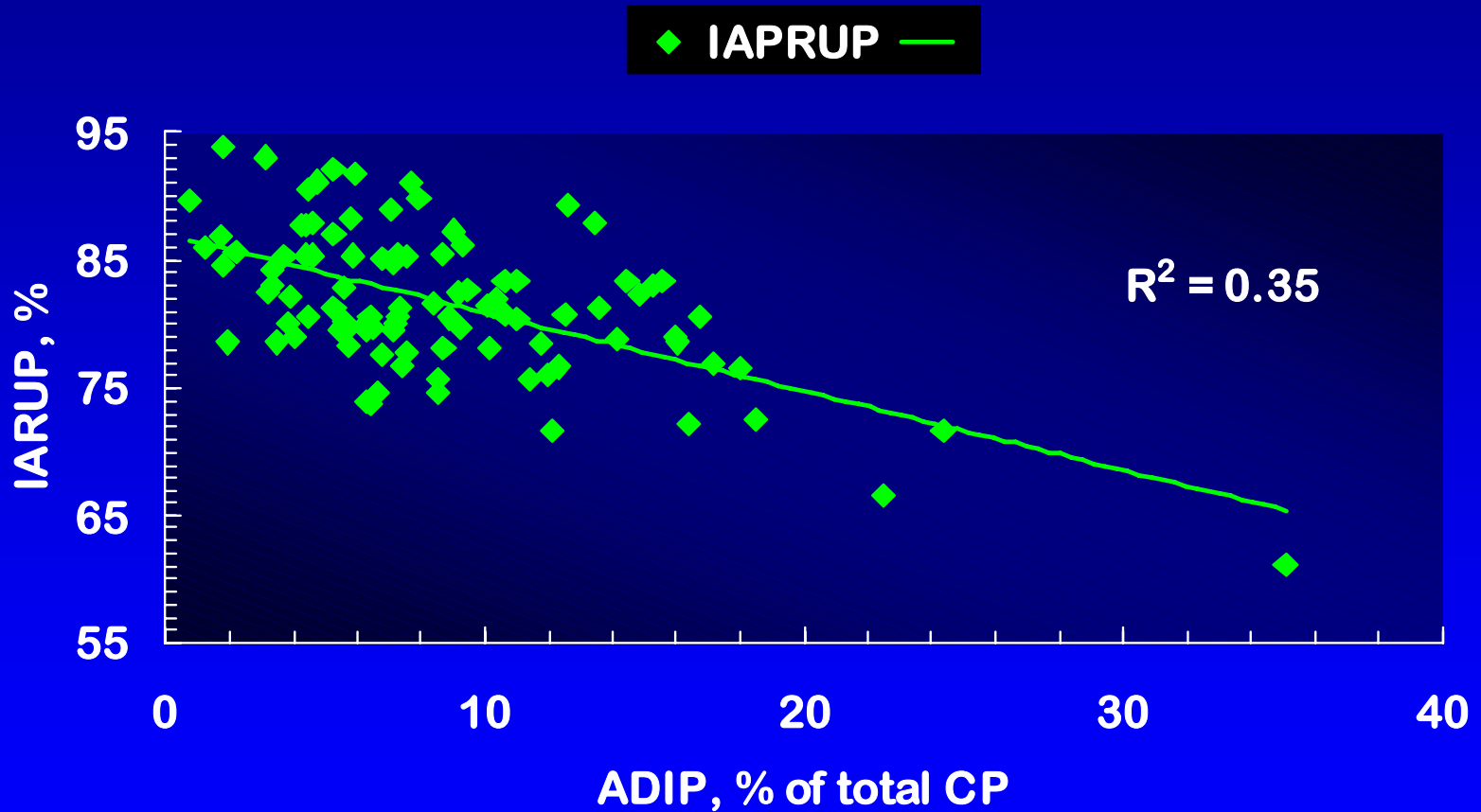
- Grain used

CORRELATION BETWEEN PROTEIN FRACTIONS AND ADIN OR COLOR OF DDGS¹

| Item | SP | ADIN | RDP | IARUP |
|-------------|--------------------|----------------------|--------------------|----------------------|
| ADIN | - 0.06 | 1.00 | 0.04 | - 0.28 ^{**} |
| L | - 0.19 | - 0.27 ^{**} | - 0.03 | 0.17 |
| a | 0.38 ^{**} | - 0.16 | 0.33 ^{**} | 0.11 |
| b | - 0.10 | - 0.23 [*] | 0.02 | 0.09 |

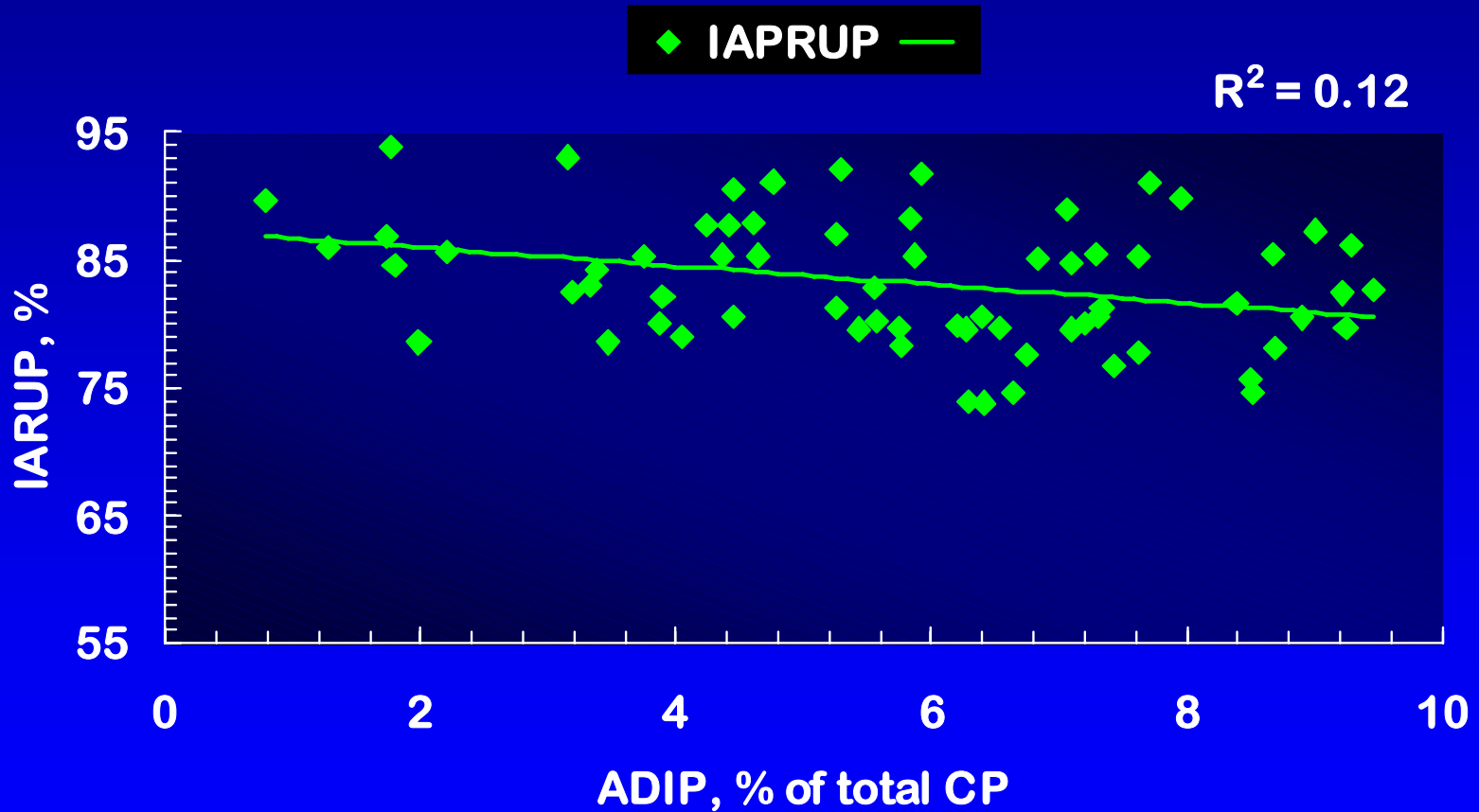
¹ Distillers dried grains with solubles.

Relationship Between ADIP and RUP Availability

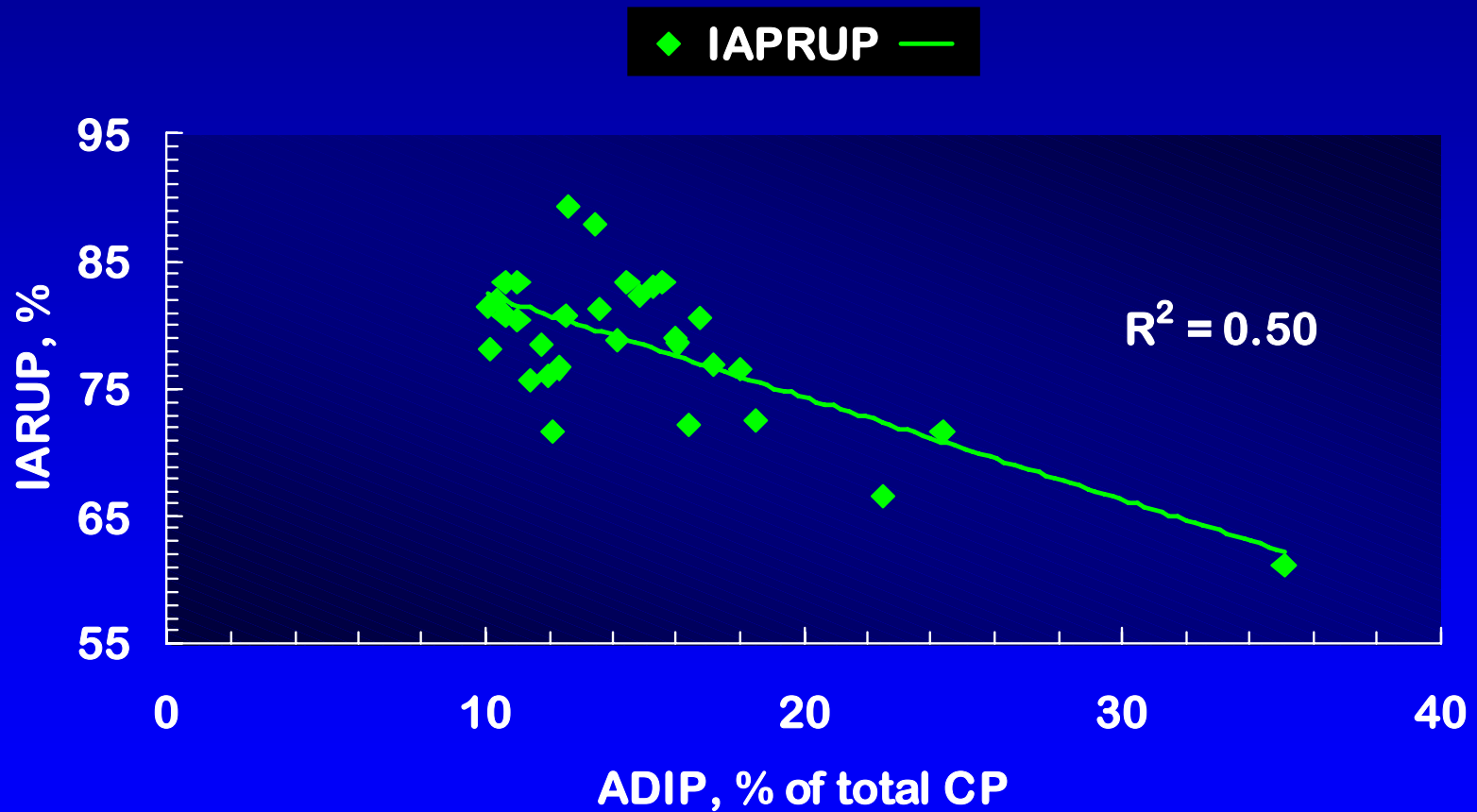


Relationship Between ADIP and RUP

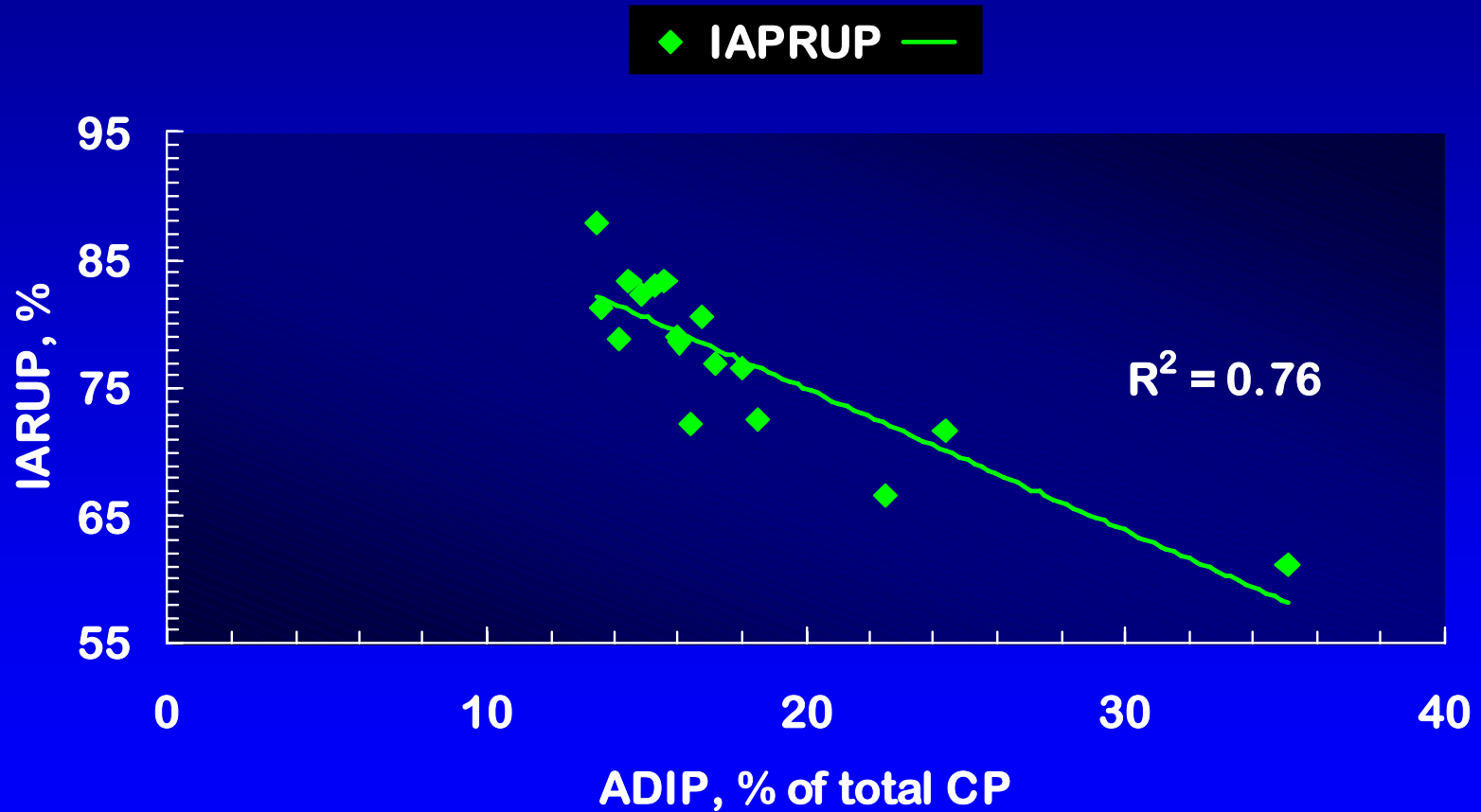
Availability for ADIP < 10% of CP



Relationship Between ADIP and RUP Availability for ADIP > 10% of CP



Relationship Between ADIP and RUP Availability for ADIP > 13% of CP



SUMMARY

- **Production facility had a significant effect on all nutrient values.**
- **Within production facility, variation in DDGS composition was considerable except for NDF, CP, soluble CP, RDP, IARUP, and measurement of color lightness.**

SUMMARY

(continued)

Over the range of the data collected, the correlation between protein quality measurements and ADIP or DDGS color score was:

- ✓ poor for ADIP values $< 10\%$ of CP,
- ✓ moderate for ADIP values $>10\%$ of CP,
- ✓ strong for ADIP values $>13\%$ of CP.

CONCLUSION

DDGS appears to be a good source of both RDP and intestinally available RUP for ruminants; but

- **Routine sampling and analysis of DDGS is recommended.**
- **Sample darkness associated with ADIP values >13% of CP is a good indication of heat damage and low availability of protein.**
- **Further investigations should determine individual amino acid availability.**