LATEST DEVELOPMENTS ON SOYA PROTEIN PRODUCTS & LOCAL SOYBEAN MEAL QUALITY

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• AFMA Forum
• Sun City South Africa
• March 2016

• Sponsorship by:

PROTEINEERZORGSTIGTING
PROTEIN RESEARCH FOUNDATION
THE MIRACLE BEAN
• SHAPE
• SIZE
• COLOUR
• CHARACTERISTICS
SOYBEAN GROWN FOR DIFFERENT PURPOSES

• HIGH PROTEIN AND OIL

• LOW PHYTATE

• HIGH OLEIC OIL

• LARGE SEED FOR TOFU & SOYMILK

• SMALL SEEDS FOR NATTO PRODUCTION
42 Million tons Oil or 233 Million tons beans

High Oleic Soybean Oil Availability*
(in billions of pounds)

Projection of 9.3 Billion pounds of high oleic soybean oil available by 2024

*QUALISOY high oleic soybean oil projections - subject to fluctuate.
CARBOHYDRATE 3 MAJOR SUGARS IN SOYBEAN MEAL

- RAFFINOSE: 5 to 15%
- STACHYOSE: 12 to 35%
- SUCROSE: 41 to 67%

It is possible to disrupt the activity of rafﬁnose synthase to reduce the levels of rafﬁnose and stachyose.

Interdisciplinary Plant Group University of Missouri (2014)
ANTIGENS

• 65 TO 85% OF RAW SOYBEAN PROTEIN IS MADE UP OF B CONGLYCICIN AND GLYCININ WHICH ARE THE MAIN STORAGE PROTEINS OF SOYA BEAN

• A SUBUNIT OF B CONGLYCICIN CAUSES ALLERGIC RESPONSE IN THE GUT EPITHELIA. GLYCININ CAUSES ANTIBODY FORMATION. ANTIGENS CAUSE AN ALLERGIC RESPONSE IN THE GUT AND DECREASE DIGESTIVE CAPACITY OF PROTEIN
PHYTIC ACID

• PHYTIC ACID IS A PHOSPHORUS CONTAINING ACID WHICH CHELATES WITH MINERALS

• ITS BREAKDOWN INCREASES PROTEIN DIGESTIBILITY. THE DEGRADATION OF PHYTATE BY PHYTASE ENZYME INCREASES PHOSPHORUS AVAILIBILITY

• PHYTASE PRODUCERS ARE INCREASING THE DOSAGE ADVICE TO REDUCE THE ANF OF PHYTIC ACID
LECTINS

- Lectins are glycoproteins that are resistant to proteolysis. They bind to the small intestine epithelium and cause disruption of the brush border and villi ulceration.

- Increased endogenic nitrogen losses.

- Using lectin-free soy beans improved TME protein digestibility and feed conversion by 10%.

- Heat treatment is effective and necessary in the inactivation of lectins.
• NEGATIVE CORRELATION BETWEEN ADF AND AMINO ACID DIGESTIBILITY

• ADF RISES FROM 4.8% TO 11% CAN RESULT IN A 6% DECREASE IN AMINO ACID DIGESTIBILITY

• Van Eys (2015)
REDUCTION OF ANF PROCESSING

• HEAT TREATMENT

• SOLVENT EXTRACTION

• ENZYMATIC DEGRADATION

• FERMENTATION

• HEAT TREATMENT ONLY AFFECTS HEAT SENSITIVE MOLECULES LIKE TIA BUT NOT HEAT STABLE ANF LIKE OLIGOSACCHARIDES
<table>
<thead>
<tr>
<th>Product type</th>
<th>Unit</th>
<th>Soybean seeds, raw</th>
<th>SBM</th>
<th>Enzyme treated SPC</th>
<th>Alcohol extracted SPC</th>
<th>SPI</th>
</tr>
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<tbody>
<tr>
<td>Humidity</td>
<td>%</td>
<td>10 - 12</td>
<td>10 - 12</td>
<td>6 - 7</td>
<td>6 - 7</td>
<td>6 - 7</td>
</tr>
<tr>
<td>Crude protein</td>
<td>%</td>
<td>33 - 37</td>
<td>42 - 50</td>
<td>55 - 60</td>
<td>63 - 67</td>
<td>&gt;85</td>
</tr>
<tr>
<td>Fat</td>
<td>%</td>
<td>17 - 20</td>
<td>0.9 - 3.5</td>
<td>2.5</td>
<td>0.5 - 3.0</td>
<td>0.1 - 1.5</td>
</tr>
<tr>
<td>Ash</td>
<td>%</td>
<td>4.5 - 5.5</td>
<td>4.5 - 6.5</td>
<td>6.2 - 6.8</td>
<td>4.8 - 6.0</td>
<td>2.0 - 3.5</td>
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<tr>
<td>Oligosacharides</td>
<td>%</td>
<td>14</td>
<td>15</td>
<td>&lt;1.0</td>
<td>&lt;3.5</td>
<td>&lt;0.4</td>
</tr>
<tr>
<td>Stachyose</td>
<td>%</td>
<td>4 - 4.5</td>
<td>4.5 - 5</td>
<td>&lt;0.3</td>
<td>1 - 3</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td>Raffinose</td>
<td>%</td>
<td>0.8 - 1</td>
<td>1 - 1.5</td>
<td>&lt;0.2</td>
<td>&lt;0.2</td>
<td>&lt;0.1</td>
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<tr>
<td>Verbasacose</td>
<td>%</td>
<td>-</td>
<td>0.3 - 0.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Trypsin inhibitors</td>
<td>mg/g</td>
<td>25 - 50</td>
<td>1.6 - 5.0</td>
<td>1 - 2</td>
<td>2 - 3</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Glysinin</td>
<td>mg/g</td>
<td>150 - 200</td>
<td>20 - 70</td>
<td>&lt;0.01</td>
<td>&lt;0.1</td>
<td>&lt;0.01</td>
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<tr>
<td>B-conglycinin</td>
<td>mg/g</td>
<td>50 - 100</td>
<td>3 - 40</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Lectins</td>
<td>ppm</td>
<td>2100 - 3500</td>
<td>20 - 600</td>
<td>&lt;1.0</td>
<td>&lt;1.0</td>
<td>&lt;1.0</td>
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<tr>
<td>Saponins</td>
<td>%</td>
<td>0.5</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Phytic acid bound</td>
<td>%</td>
<td>0.38</td>
<td>0.42 - 0.49</td>
<td>0.6</td>
<td>0.6</td>
<td>-</td>
</tr>
</tbody>
</table>

van Eys (2015)
FERMENTED SOYBEAN MEAL

• DUE TO ITS PROCESSING METHOD HAS LOST SIGNIFICANT Oligosacharides AND ANTIGENS
• CAN SUCCESSFULLY REPLACE FISHMEAL AND ANIMAL PROTEIN IN PIG WEANER DIETS
• POULTRY DIETS
  (LACTOBACILLUS ACIDOPHILUS)

Zoot & Stein (2013)
Silva et al (2014)
• ACCELERATE AVAILABILITY OF ADVANCED COMPOSITIONAL TRAITS

• FOCUS ON THE NEEDS OF MEAL AND OIL USERS

• ENHANCE DEMAND FOR QUALITY SOYBEANS

• INCREASING LEVELS OF SELECTED ESSENTIAL AMINO ACIDS

• IMPROVING BALANCE AND AMINO ACID DIGESTIBILITY

• REDUCING SELECTED CARBOHYDRATES

• IMPROVING PHOSPHORUS AVAILABILITY
PRIMARY TARGET

• INCREASE METHIONINE AND CYSTINE BY 50%
• REDUCE PHYTATE BOUND PHOSPHORUS BY 50%
• INCREASE METABOLIZABLE ENERGY BY 10%
• INCREASE DIGESTIBILITY OF PROTEIN BY 5%
• INCREASE LYSINE THREONINE AND TRYPTOPHAN BY 20%

United Soybean Board (2015)
REDUCED OLIGOSACCHARIDE SOYBEAN MEAL

• SOYBEAN MEAL PRODUCED WITH HIGH PROTEIN AND LOW OLIGOSACCHARIDE SOYBEANS ARE REQUIRED AT LOWER INCLUSION LEVELS TO DELIVER THE SAME BROILER PERFORMANCE DUE TO HIGHER NUTRIENT CONTENT
• TME VALUES SIGNIFICANTLY HIGHER FOR LOW OLIGOSACCHARIDE SOYBEAN MEAL IN POULTRY
• FEED EFFICIENCY CAN BE IMPROVED
• AMINO ACID DIGESTIBILITY IS SIMILAR

Baker et al (2011); Chen X (2013)
ENZYMES

- PROTEASE CAN IMPROVE THE NUTRITIVE VAUE OF COMMERCIAL SOLVENT EXTRACTED SOYBEAN MEAL

- PROTEASE ISOLATED FROM DIFFERENT SPECIES DETERMINE THE IMPROVED PERFORMANCE OF THE SOYBEAN MEAL

- ALPHA-GALACTOSIDASE
  
  Ghazi (2002); Ghazi (2003)

- COMBINATION OF PROTEASE AND PHYTASE IMPROVES ADDITIVELY THE PERFORMANCE OF MAIZE SOYA DIETS
  

- MULTIENZYMES
ENZYMES

• MONO COMPONENT PROTEASE IMPROVED ILEAL DIGESTIBILITY OF SOYBEAN MEAL IN COMMERCIAL LAYING HENS
  Angel et al (2015)

• IT HAS BEEN DEMONSTRATED THAT PROTEASES CAN DEGRADE KUNITZ AND BOWMAN BIRK INHIBITORS AS WELL AS LECTIN

• PROTEASE CAN DEGRADE PROTEIN IN SOYBEAN MEALS WITH VARIOUS LEVELS OF ANTI-NUTRITIONAL FACTORS IMPROVEMENT IS HIGHER FOR LESS DIGESTIBLE SOURCES
  Nasser-Odetallah (2015)
EFFECT OF PARTICLE SIZE

PREVIOUS STUDIES HAVE INDICATED THAT PARTICLE SIZE CAN INFLUENCE GIZZARD DEVELOPMENT AND RETENTION TIME OF FEED

Ferket (2000)
DIGESTION COULD BE IMPROVED

Bjerrum (2005)
EFFECT OF TRYPSIN INHIBITOR & PARTICLE SIZE EXPELLER SOYBEAN MEAL BODY WEIGHT GAIN

Pacheco et al (2014)
EFFECT OF TRYPsin INHIBITOR & PARTICLE SIZE EXPELLER SOYBEAN MEAL FEED CONVERSION

Pacheco et al (2014)
THE BEST WAY TO DETERMINE SOYBEAN MEAL QUALITY ARE ANIMAL GROWTH STUDIES & AMINO ACID DIGESTIBILITY

• EXPENSIVE AND TIME CONSUMING
• NEED TO BE STATISTICALLY CORRECT
• CORRELATION BETWEEN ILEAL DIGESTIBILITY AND CHEMICAL ANALYSIS MAY ALLOW IMPROVEMENT IN THE EVALUATION OF NUTRITIVE VALUE OF COMMERCIAL SOYBEAN MEAL
TRYPSIN INHIBITORS

• 60% OF GROWTH INHIBITION OF RAW SOYBEANS CAN BE ASCRIBED TO ANTINUTRITIVE FACTORS OTHER THAN TRYPsin INHIBITORS
• Kakade et al (1974)

• LIPASE INHIBITORS; GOITROGENS; HEMAGGLUTINS
TYPSIN INHIBITORS

• TRYSIN INHIBITORY ACTIVITY EXPRESSED AS TRYSIN UNITS INHIBITED PER GRAM (TIU/g)
  (AOCS METHOD 2011b)

• TRYSIN INHIBITOR ACTIVITY EXPRESSED AS mg/g
  (HAMERSTAND ET AL 1981) (ISO 2001)
RAPID FOOD PASSAGE

TIA MAX 3.5 MG/g
AVOID RAPID FOOD PASSAGE

LOWER TIA MAX 2.5 MG/g
OPTIMAL

Trypsin inhibitors vs. Urease activity
(Belalcázar and Otálora, 2012)

\[ y = 0.0738x - 0.1224 \]

\[ R^2 = 0.9748 \]

\( n = 104 \)
## PROTEIN QUALITY

<table>
<thead>
<tr>
<th></th>
<th>ARGENTINE</th>
<th>BRAZIL</th>
<th>USA</th>
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<td>PDI</td>
<td>13.2</td>
<td>15.8</td>
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<tr>
<td>KOH</td>
<td>75</td>
<td>77.7</td>
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<tr>
<td>HDI</td>
<td>8.9</td>
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<tr>
<td>TIA mg/g</td>
<td>2.3</td>
<td>2.7</td>
<td>2.7</td>
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(88% DM)  
Mateos (2015)
SOYBEAN MEAL ORIGIN STANDARDIZED ILEAL DIGESTIBILITY OF AA IN PIGLETS

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<tr>
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<th>Brazil</th>
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<th>USA</th>
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<tbody>
<tr>
<td>CP</td>
<td>449</td>
<td>458</td>
<td>461</td>
</tr>
<tr>
<td>NDF</td>
<td>117</td>
<td>88</td>
<td>86</td>
</tr>
<tr>
<td>ADF</td>
<td>77</td>
<td>44</td>
<td>51</td>
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<tr>
<td>TIA mg/g</td>
<td>3.3</td>
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</tr>
<tr>
<td>Arg</td>
<td>91</td>
<td>91</td>
<td>90</td>
</tr>
<tr>
<td>Lys</td>
<td>86</td>
<td>87</td>
<td>85</td>
</tr>
<tr>
<td>Met</td>
<td>85</td>
<td>86</td>
<td>84</td>
</tr>
<tr>
<td>Cys</td>
<td>65</td>
<td>65</td>
<td>67</td>
</tr>
<tr>
<td>Thr</td>
<td>77</td>
<td>80</td>
<td>78</td>
</tr>
<tr>
<td>Trp</td>
<td>74</td>
<td>75</td>
<td>75</td>
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Eklund et al (2012)
INFLUENCE OF SOURCE OF SOYBEAN MEAL ON BROILER PERFORMANCE

<table>
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<tr>
<th></th>
<th>USA 1</th>
<th>USA 2</th>
<th>BRAZILIAN</th>
<th>ARGENTINE</th>
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<tbody>
<tr>
<td>PROTEIN</td>
<td>48.1</td>
<td>46.2</td>
<td>47.6</td>
<td>46.3</td>
</tr>
<tr>
<td>KOH</td>
<td>84</td>
<td>79.6</td>
<td>68</td>
<td>77</td>
</tr>
<tr>
<td>TIA mg/g</td>
<td>2.7</td>
<td>2.0</td>
<td>2.2</td>
<td>1.8</td>
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<tr>
<td>ADG</td>
<td>65.7</td>
<td>66.6</td>
<td>64.3</td>
<td>64.4</td>
</tr>
<tr>
<td>FEED GAIN</td>
<td>1.68</td>
<td>1.67</td>
<td>1.72</td>
<td>1.68</td>
</tr>
</tbody>
</table>

SERRANO (2015)
SOYBEAN MEAL ILEAL AMINO ACID DIGESTIBILITY USA BRAZIL ARGENTINE

• ILEAL DIGESTIBILITY OF AMINO ACIDS LOWER FOR ARGENTINE VERSUS USA AND BRAZILIAN MEAL (BROILERS)

• ARGENTINE MEALS WERE PROCESSED UNDER MORE SEVERE CONDITIONS LOWER TIA CONTENT BUT POSSIBLY HIGHER INCIDENCE OF MAILLARD REACTION

• LOWER KOH SOLUBILITY VALUES OBSERVED FOR ARGENTINE MEALS

• HIGHER CRUDE PROTEIN CONTENT OF USA AND BRAZIL COULD HAVE A POSITIVE EFFECT ON AMINO ACID DIGESTIBILITY

• KOH SOLUBILITY WAS THE BEST PREDICTOR OF ILEAL DIGESTIBILITY

• DIFFERENCES IN NUTRITIVE VALUE AMONG COMMERCIAL SOURCES OF SOYBEAN MEAL

Frikha et al (2012)
UNDER AND OVER PROCESSING SOYBEAN MEAL

• HEAT DAMAGE AFFECTS AMINO ACID DIGESTIBILITY

• NIR METHODOLOGY COULD BE USED TO DETECT OVERPROCESSING EFFECT ON AMINO ACID DIGESTIBILITY (HDI)

• SUPPLEMENTATION OF AMINO ACIDS CAN RESTORE PERFORMANCE OF OVER PROCESSED SOYBEAN MEAL

Wiltafsky (2013)
PDI AS A MEASURE

• WIDELY USED IN THE FOOD INDUSTRY FOR OVER 30 YEARS

• THIS TEST WILL FURTHER DISTINGUISH THE QUALITY OF SOYBEAN MEAL THAT ARE CONSIDERED OF HIGH QUALITY BASED ON UREASE KOH AND TIA

• “HIGH PERFORMANCE SOYBEAN MEALS” WITH PDI VALUES OF 30-50%; LOW UREASE VALUES pH BELOW 0.05 AND KOH ABOVE 90% ARE GLOBALLY MARKETED
## TIA VERSUS COLOUR

<table>
<thead>
<tr>
<th></th>
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<th>BRAZIL</th>
<th>USA</th>
<th>ALL</th>
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<tbody>
<tr>
<td>LIGHTNESS</td>
<td>58</td>
<td>27</td>
<td>55</td>
<td>56</td>
</tr>
<tr>
<td>REDNESS</td>
<td>-49</td>
<td>-26</td>
<td>-65</td>
<td>-56</td>
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(Minolta ground 1mm)

LOCAL SOYBEAN MEAL QUALITY
DEALING WITH VARIATION

• GEOGRAPHIC LOCATION OF SOYBEAN PRODUCTION
• SOYBEAN VARIETY
• PROCESSING METHOD
# PROXIMATE ANALYSIS (NIR)

<table>
<thead>
<tr>
<th></th>
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<th>LOC 2</th>
<th>LOC 3</th>
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<td>47.1</td>
<td>47.6</td>
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<td>FAT</td>
<td>0.72</td>
<td>2.5</td>
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<td>1.35</td>
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<td>FIBER</td>
<td>3.2</td>
<td>3.2</td>
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<tr>
<td>MOISTURE</td>
<td>11.93</td>
<td>9.42</td>
<td>10.53</td>
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<td>10</td>
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<tr>
<td>ASH</td>
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<td>6.24</td>
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<td>7.1</td>
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<tr>
<td>SUGAR</td>
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<td>10.29</td>
<td>8.65</td>
<td>11.17</td>
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</table>
FEED CONVERSION

ARGENTINE

BEST LOCAL
THANK YOU FOR YOUR ATTENTION