ABSTRACT: 435

ADJUSTING OVER-PROCESSED SOYBEAN MEAL FOR THE LOSSES OF TOTAL AMINO ACID CONTENTS AND THE REDUCED STANDARDIZED ILEAL AMINO ACID DIGESTIBILTY IN BROILERS

WILTAFSKY M, HELMBRECHT A

Evonik Industries AG, Health & Nutrition, Rodenbacher Chaussee 4, 63457 Hanau
E-mail: markus.wiltafsky@evonik.com

A lot of nutritional criteria of ingredients are considered routinely for successful feed formulation, but detection of heat damage occurring during processing of particular ingredients is still a challenge for the feed industry. Thus, Evonik developed a NIR-based method to identify the degree of heat damage and to adjust the standardized ileal digestibility (SID) coefficients of dietary amino acids (AA) in soybean meal: AMINORED®. This concept has been validated in two trials with broilers and shall be presented.

For the validation of AMINORED®, commercially purchased soybean seeds were used to produce two qualities of soybean meal at a pilot plant for oil extraktion. An aliquot of the soybeans was processed according to best practice in order to receive a good quality soybean meal, while the other aliquot was over-processed. The crude protein content of the two SBM qualities did not differ but total levels of Lys, Met+Cys and Arg were decreased by 8.5, 3.1 and 3.2% in the over-processed SBM, respectively. The total levels of the other amino acids were not affected. The correction of the digestibility coefficients according to AMINORED® showed a more pronunced loss of SID Lys, Met+Cys and Arg of 16.4, 7.1 and 7.2%, respectively. Furthermore, according to AMINORED the overprocessing resulted in a decrease of the other essential SID amino acids between 6.3 and 11.2%.

In the validation trials with 10 to 28 days old broilers 4 treatments were applied. The positive control (PC) was fed a diet using the good quality soybean meal. In the diet of the negative control (NC) the good quality soybean meal was exchanged with the over-processed soybean meal without any further adjustment. In the third treatment (TAA) the over-processed soybean meal was used again but the diet formulation was adapted to the losses of total amino acids. In the last treatment (AMINORED®) the over-processed soybean meal was used but the diet formulation was adapted for the losses of total amino acids and the reduced amino acid digestibility according to AMINORED®.

Feeding the over-processed soybean meal instead of the good quality SBM significantly impaired the final body weight, body weight gain, feed intake, feed conversion ratio, carcass weight and the breast meatl yield in both validation trials. Depending on the parameter and the trial the impairement ranged between 4.8 and 15.2%. Adapting the feed formulation in the TAA and AMINORED® groups resulted in a stepwise recovery of the performance parameter in both trails so that the performance of the AMINORED® groups was statistically not different from the PC. These results are indicating that the AMINORED® concept is able to detect and to correct for the detrimental effects of an over-processing of soybean meal.

It is concluded that it is worthwhile not only to adjust the nutritional matrix of over-processed ingredients in terms of total amino acids but also in terms of standardised ileal digestible amino acids. The detection of heat damage by the rapid NIR technology and adjustment of the amino acid digestibility is possible. Risks of losing animal performance can be minimised if such corrections are applied and offers users a substantial economic benefit compared to existing methods of evaluating quality of soybean meal.

Adjusting over-processed soybean meal for the losses of total amino acid contents and the reduced standardized ileal amino acid digestibility in broilers

Dr. Markus Wiltafsky and Dr. Ariane Helmbrecht

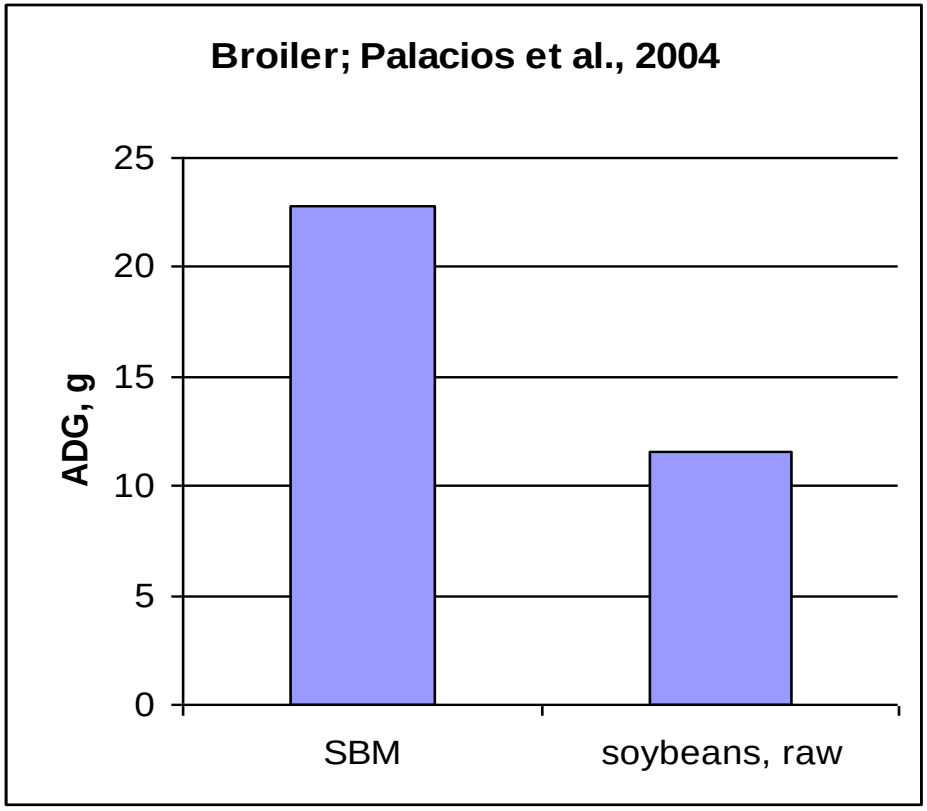
WSRC 2013, Durban, South Africa

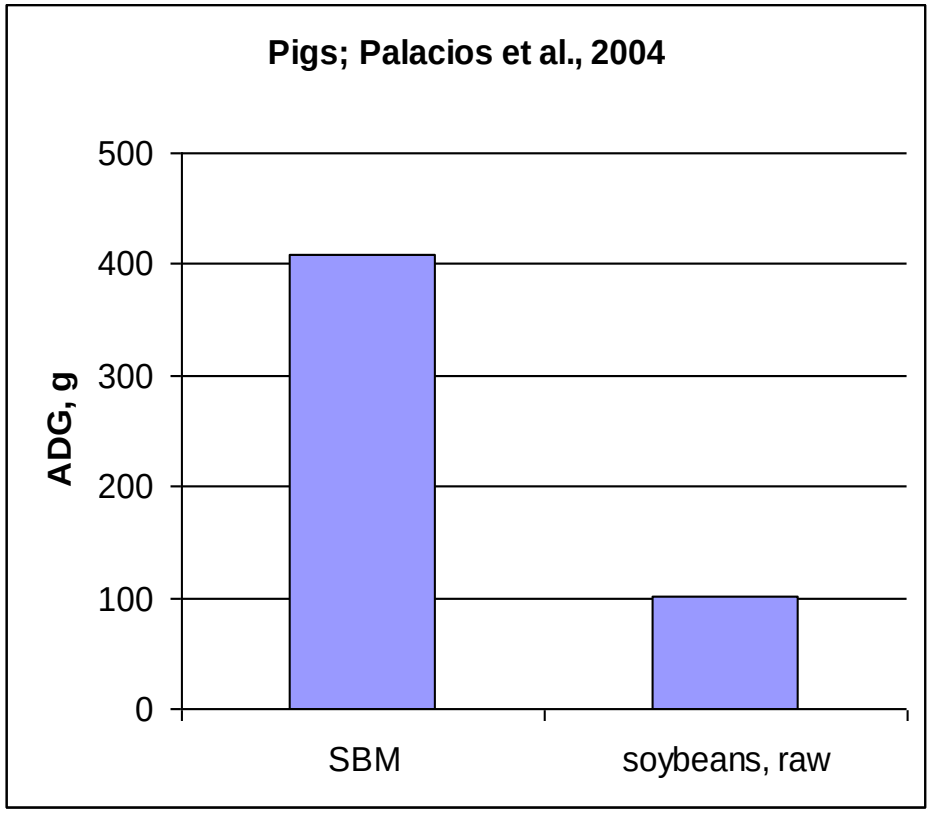
EVONIK INDUSTRIES

Content

- Impact of heat treatment on amino acids and their digestibility in soybean meal
  - Background
  - Research on impact of heat treatment on amino acid content and digestibility
- AMINORED concept
- Validation trials in broilers

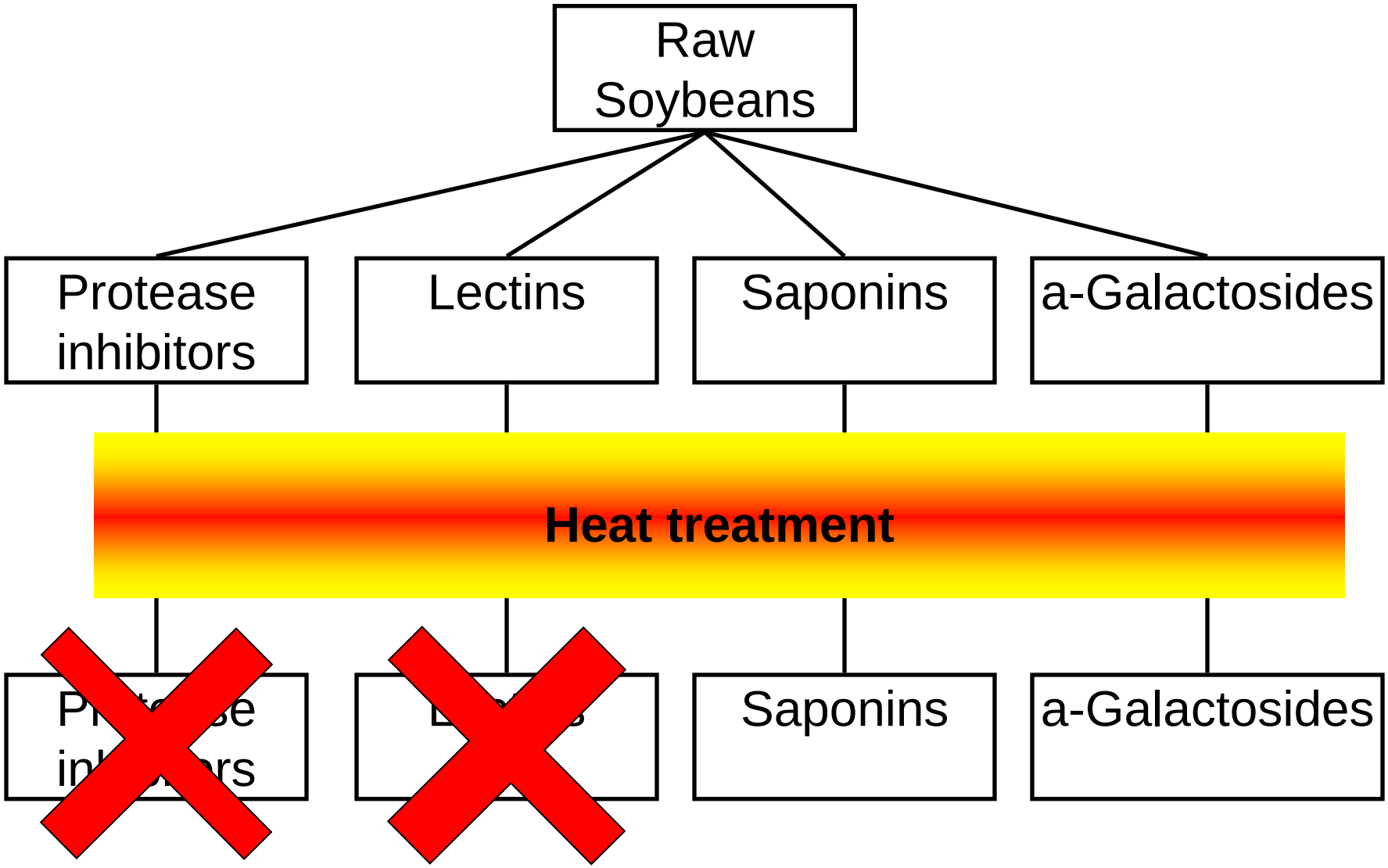
Raw soybeans are performance depressive in poultry and pigs



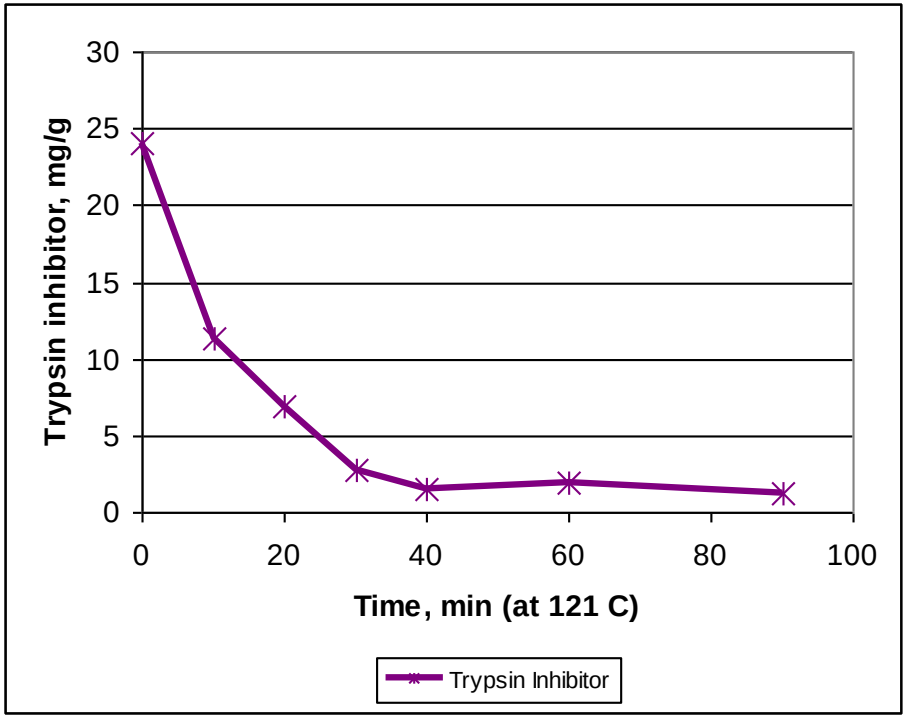


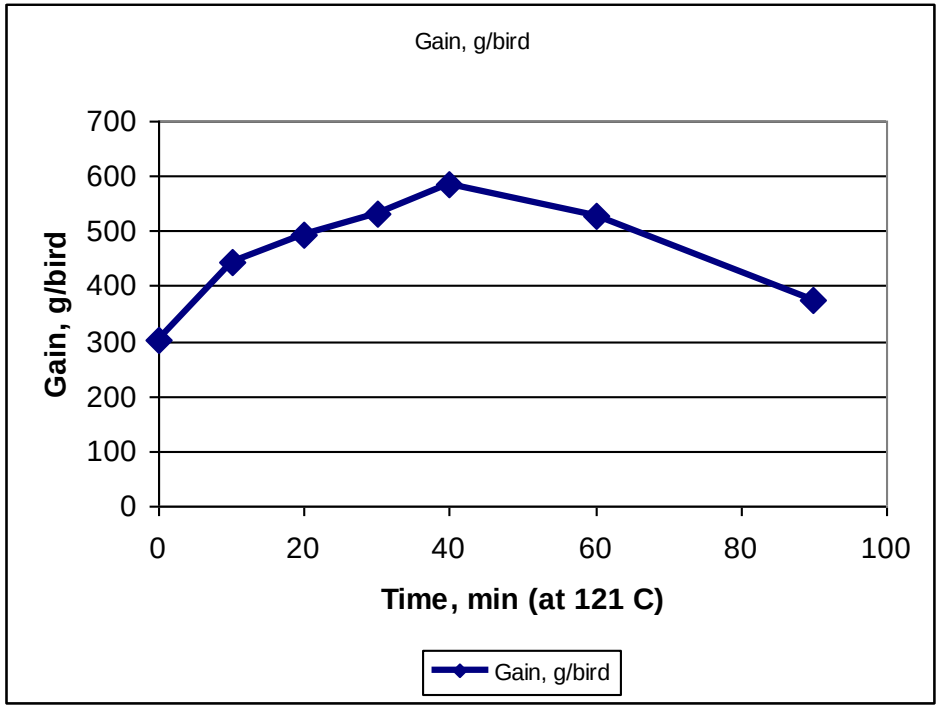
- Raw soybeans contain some ingredients that are negative for the animal: **Antinutritional factors!**

Protease inhibitors and Lectins can be deactivated by heat treatment



TIA is suitable to detect under processing but not over processing





Herkelman et al., 1991

Full fat soybeans, autoclaved at 121 C

Male broilers, d 0 to 21, corn-soybean diet

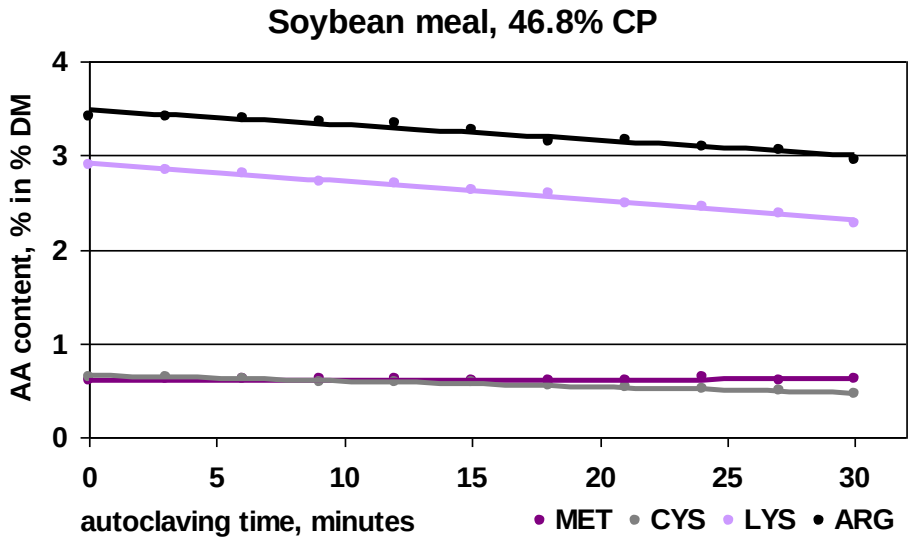
Fontaine et al. (2007)

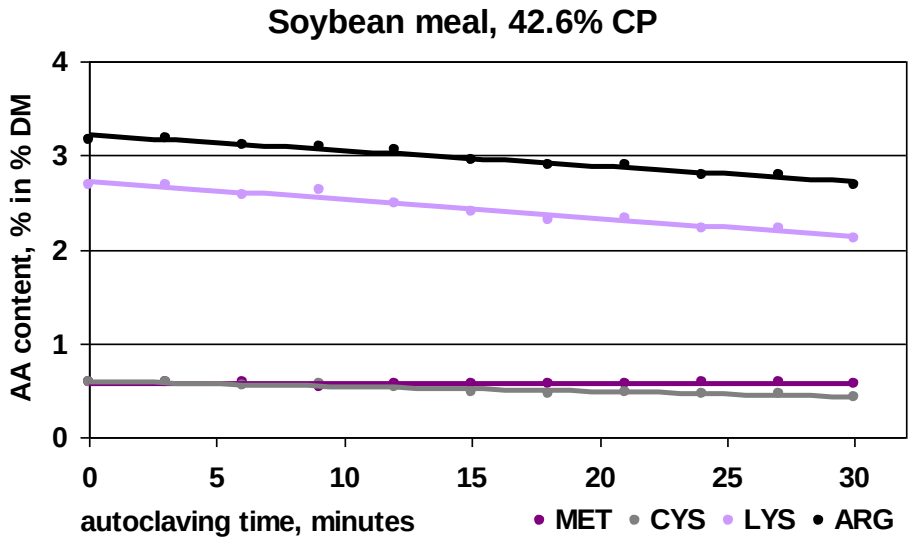
- 3 soybean and 2 DDGS corn product samples were systematically heat damaged at DIL (Deutsches Institut für Lebensmitteltechnik)

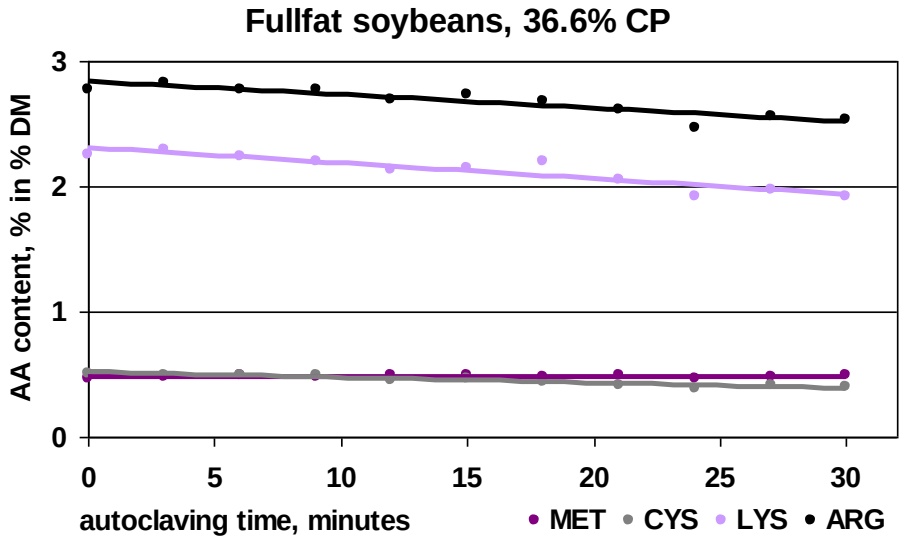
- Soybean meal – 46.8% CP
  Soybean meal – 42.6% CP
  Full fat soybeans – 36.6% CP

  - Heat treatment in autoclave at 135 C
  - Samples were taken in 3 min intervals
    (starting at 0 until 30 min resulting in 10 samples)
  - Sample analyses
    - total amino acids

Some amino acids decreased with heat treatment







Heat damage can be measured

- The previous slides demonstrate that we can measure heat damage in raw materials.
  - ➢ It is possible to detect heat damage by NIRS analysis of amino acids through changes in their contents.
- This leads to the next question:
  - ➢ What happens in the animal?

What happens in the animal

- Standardized ileal digestibility (SID) is currently our best measurement to approximate the availability of amino acids in the animal.

  - Availability being the product of both digestibility & utilization

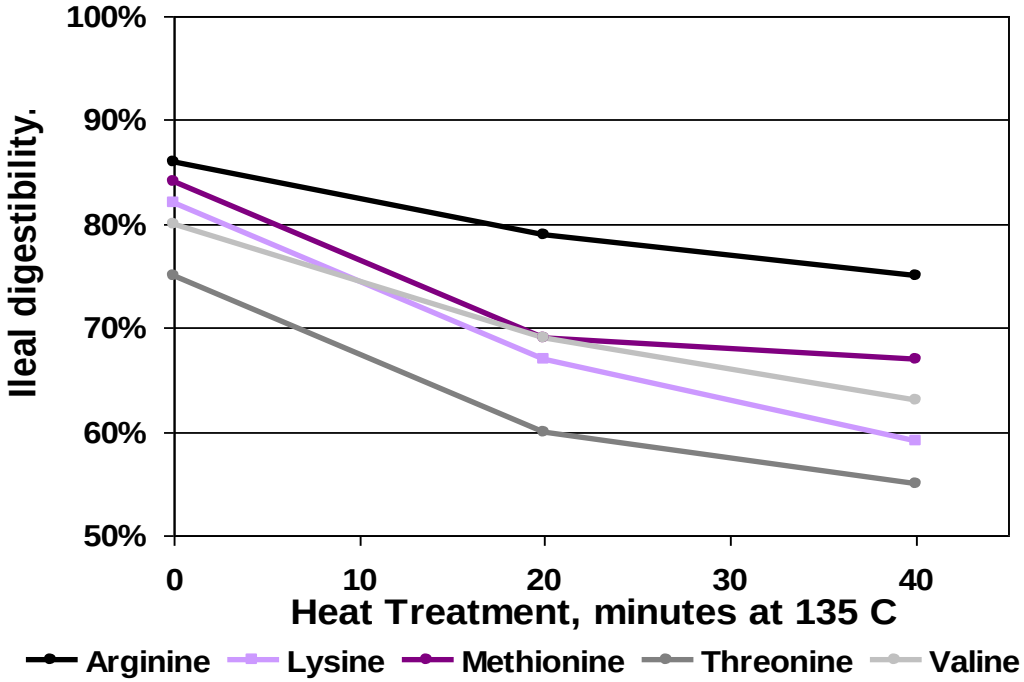
- We therefore decided to investigate and measure the digestibility of heat damaged soybean meal, corn based DDGS and rapeseed meal

Ileal digestibility of heat treated soybean

- Best available quality of soybean meal (47% CP) was heat treated at DIL (Deutsches Institut für Lebensmitteltechnik)
  - autoclaving at 135 C for
    - 0, 20, 40 minutes – soybean meal

- A digestibility assay was conducted at Universities of Halle, Germany
  - Ross 308 broilers at 14 days
  - Experimental feed for 5 days
  - Digesta of two last thirds of the ileum were collected (Kluth et al., 2005)
  - Inert marker: TiO_2
  - Regression methodology was applied (Rodehutscord et al., 2004)

Ileal digestibility of amino acids is reduced in broilers if soybean meal is over-processed



Amino acid (%)	0	20 min	40 min
Arg	86[a]	79[b]	75[b]
Lys	82[a]	67[b]	59[b]
Met	84[a]	69[b]	67[b]
Thr	75[a]	60[b]	55[b]
Val	80[a]	69[b]	63[b]

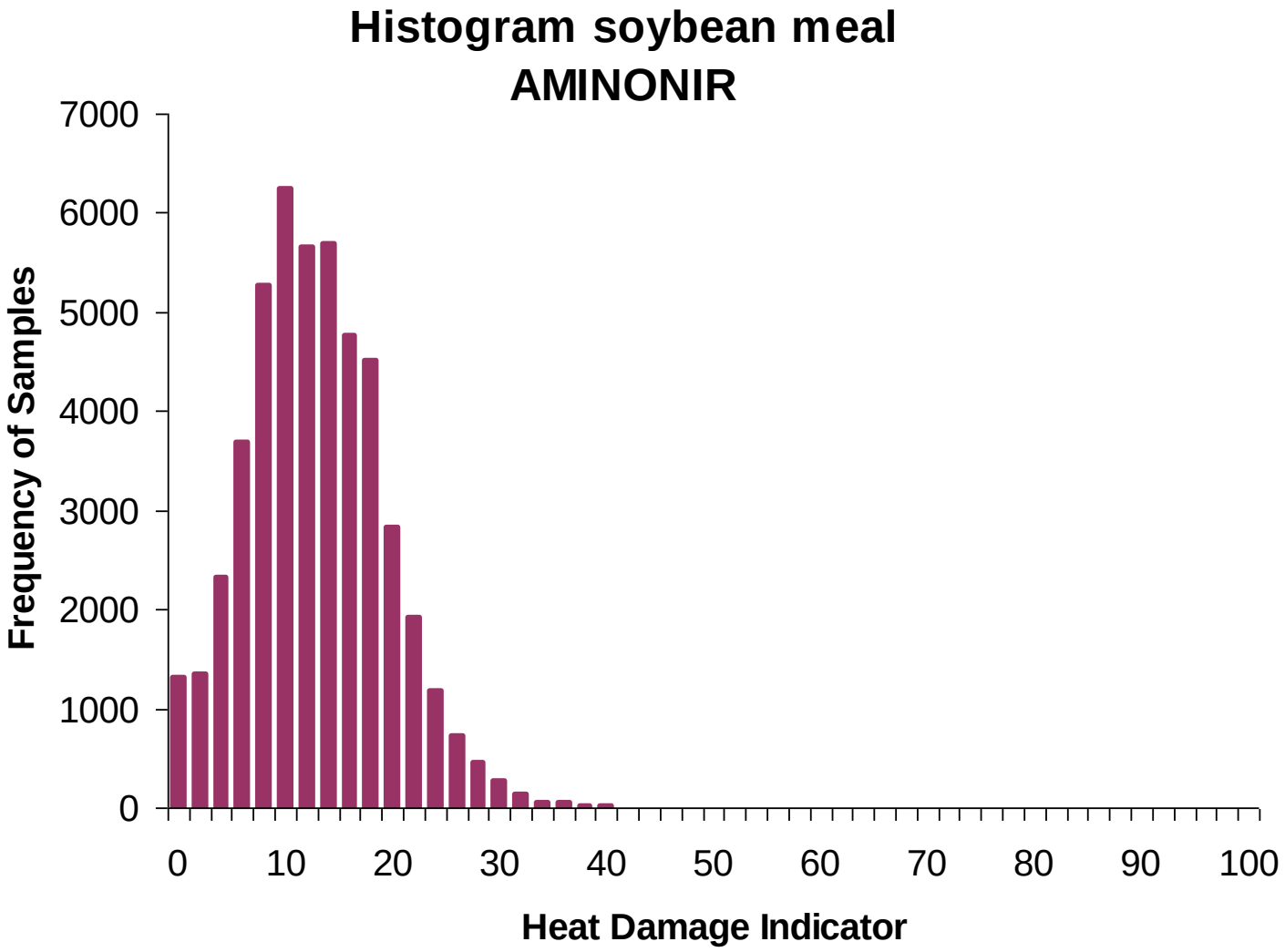
Results demonstrate

- Over-processing of soybeans leads to :
  - a reduction in the total levels of **some** amino acids, this is most pronounced for lysine.
  - a reduction in the standardized ileal digestibility coefficients of **all** amino acids.

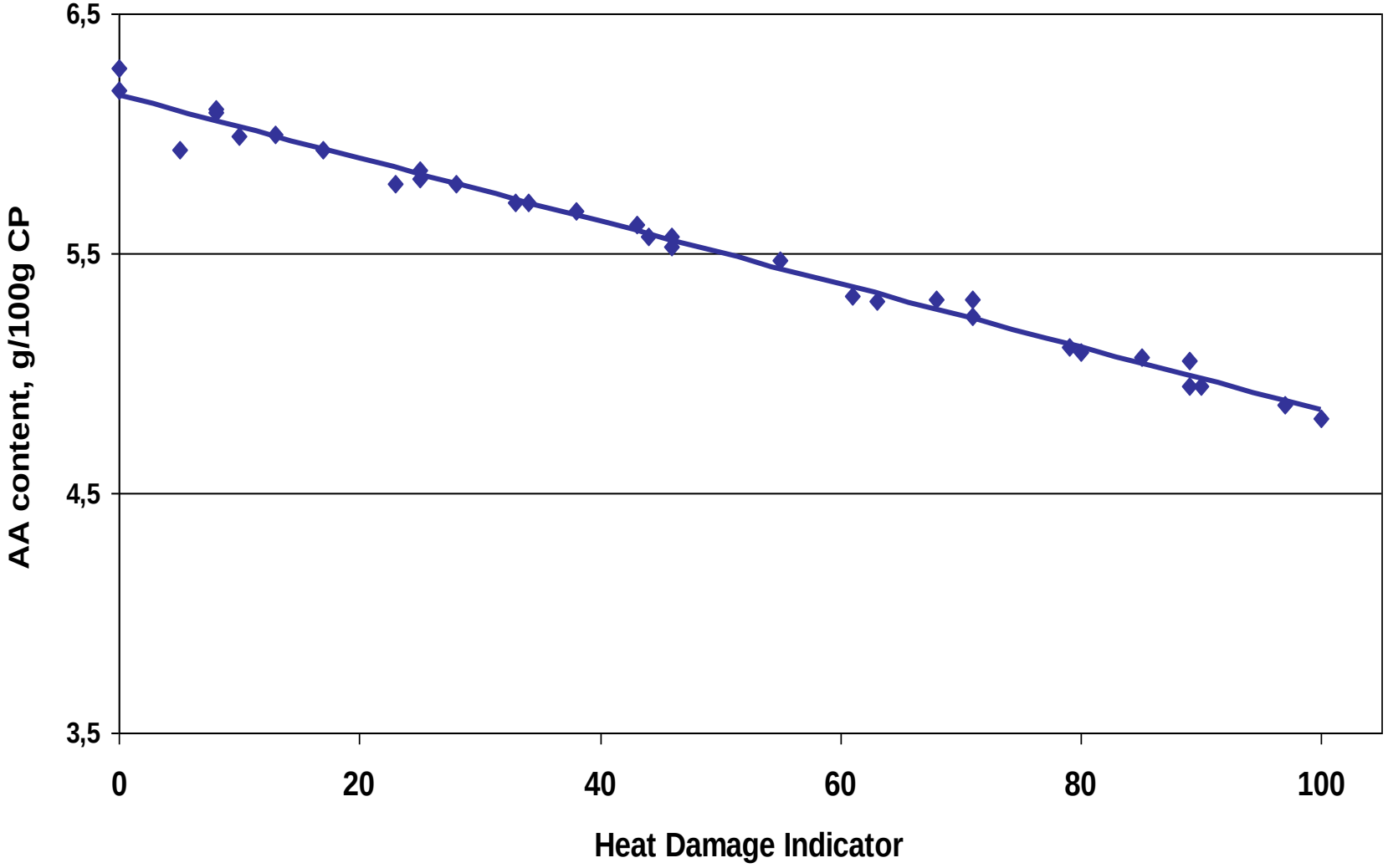
Digestibility values of heat processed raw materials in practice: AMINORED service

- Indication of heat damage via NIR
  - Classification of raw material quality
  - Relationship to digestibility
  - Change of values used in feed formulation

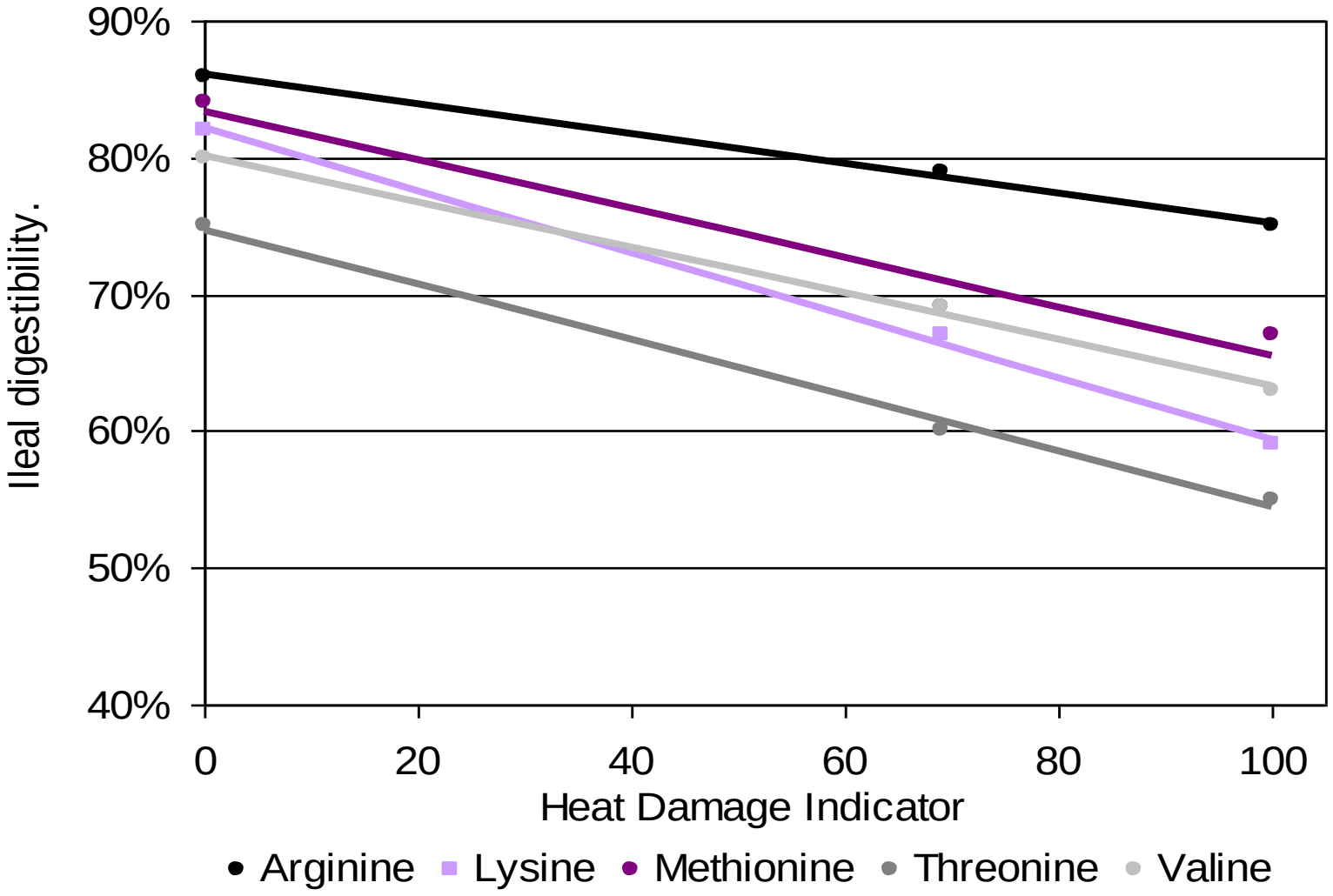
Heat Damage Indicator
AMINONIR® samples



AMINORED® - Rapid Evaluation of Digestibility

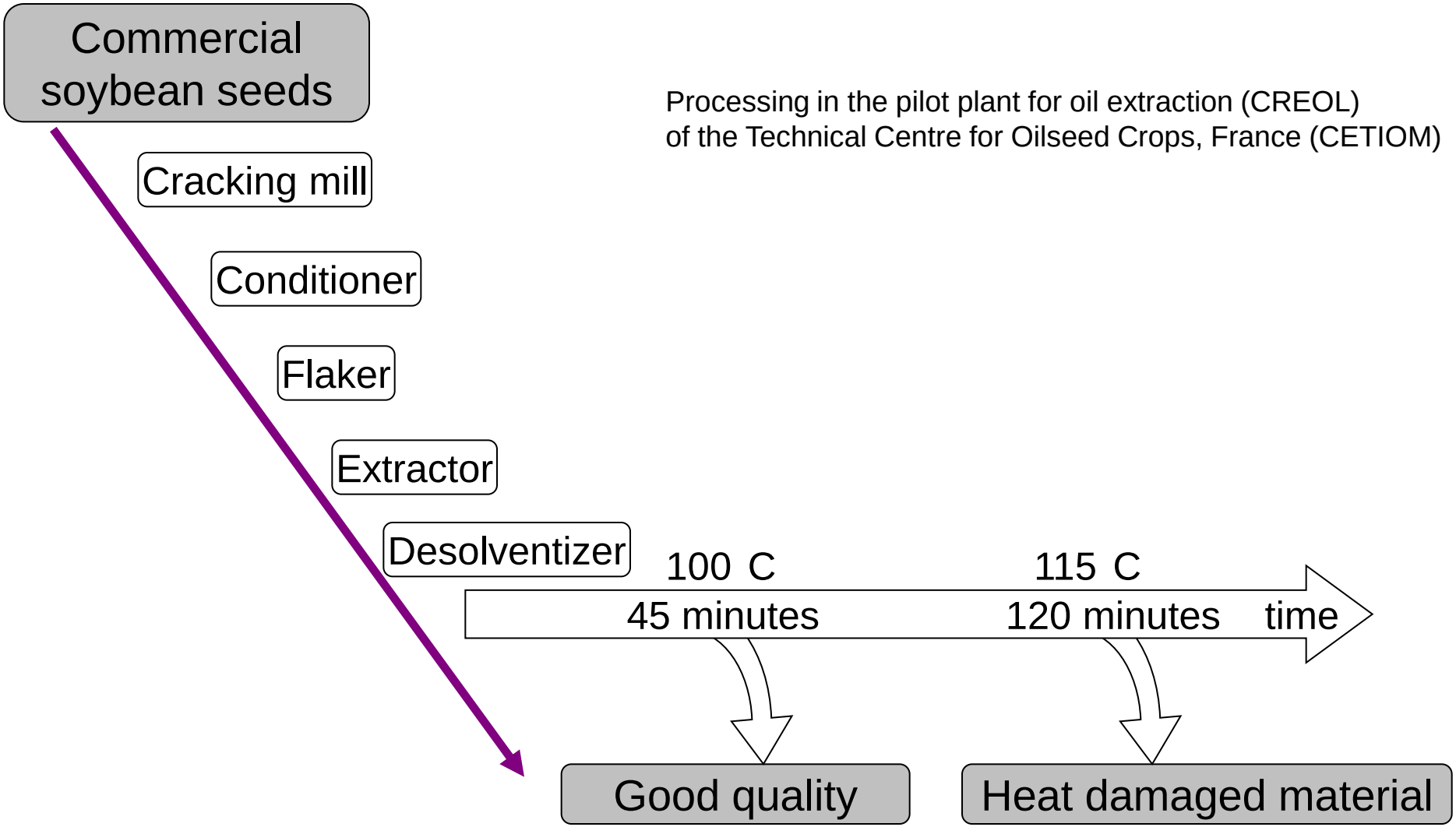


AMINORED® - Rapid Evaluation of Digestibility



Validation trials in broilers

Processing of soybean meal



Processing in the pilot plant for oil extraction (CREOL)
of the Technical Centre for Oilseed Crops, France (CETIOM)

Experimental design

Treatment	Good Quality SBM
Basis of formulation	AMINONIR analysis + SID coefficient published by Evonik

SBM = soybean meal; SID = standardized ileal digestibility;
AA = amino acids; CP = crude protein

Experimental design

Treatment	Good Quality SBM	HD SBM
Basis of formulation	AMINONIR analysis + SID coefficient published by Evonik	Replacement of the good quality SBM to reach the same CP Level

SBM = soybean meal; SID = standardized ileal digestibility;
AA = amino acids; CP = crude protein

Experimental design

Treatment	Good Quality SBM	HD SBM	HD SBM + Analyzed AA
Basis of formulation	AMINONIR analysis + SID coefficient published by Evonik	Replacement of the good quality SBM to reach the same CP Level	Analyzed total AA + SID coefficient published by Evonik

SBM = soybean meal; SID = standardized ileal digestibility;
AA = amino acids; CP = crude protein

Experimental design

Treatment	Good Quality SBM	HD SBM	HD SBM + Analyzed AA	HD SBM + AMINORED®
Basis of formulation	AMINONIR analysis + SID coefficient published by Evonik	Replacement of the good quality SBM to reach the same CP Level	Analyzed total AA + SID coefficient published by Evonik	Analyzed total AA + SID coefficient according to AMINORED®

SBM = soybean meal; SID = standardized ileal digestibility;
AA = amino acids; CP = crude protein

Total amino acids and standardized ileal digestibility (SID)

Soybean meal quality	Good		Heat damaged	
	Total	SID	Total	SID
Crude protein	47.28		47.33	
Lysine	2.84	2.56	2.60	2.14
Methionine	0.63	0.57	0.62	0.53
Methionine + Cystine	1.30	1.12	1.26	1.04
Threonine	1.83	1.56	1.82	1.42
Tryptophan	0.64	0.56	0.64	0.50
Arginine	3.44	3.20	3.33	2.97
Isoleucine	2.06	1.83	2.06	1.69
Leucine	3.52	3.13	3.51	2.86
Valine	2.17	1.91	2.18	1.79
Histidine	1.26	1.16	1.24	1.03
Phenylalanine	2.32	2.07	2.32	1.93
Heat Damage Indicator (HDI)	12		48	

Values in % standardized to 88% dry matter; Dry matter was 85,3% for good quality SBM and 93,7% for heat damaged SBM

Diet composition, g/kg

	Validation trial 1			
Treatment	**PC**	**NC**	**TAA**	**adSID**
Good SBM	311.8			
HD SBM		284.1	284.1	284.1
Corn	306.0	324.9	324.9	324.9
Wheat	250.0	250.0	250.0	250.0
Soy oil	68.7	68.7	68.7	68.7
Corn starch	20.0	28.7	28.0	25.8
Minerals	34.8	34.9	34.9	34.9
Premix	5.0	5.0	5.0	5.0
DL-Met	2.2	2.2	2.2	2.5
L-Lys•HCl	1.1	1.1	1.9	2.9
L-Thr	0.3	0.3	0.3	0.8
L-Val				0.4
L-Arg				

Diet composition, g/kg

	Validation trial 1				Validation trial 2			
Treatment	**PC**	**NC**	**TAA**	**adSID**	**PC**	**NC**	**TAA**	**adSID**
Good SBM	311.8				316.3			
HD SBM		284.1	284.1	284.1		292.9	292.9	292.9
Corn	306.0	324.9	324.9	324.9	299.3	299.3	299.3	299.3
Wheat	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
Soy oil	68.7	68.7	68.7	68.7	69.3	75.3	74.9	74.1
Corn starch	20.0	28.7	28.0	25.8	20.0	37.0	36.3	35.2
Minerals	34.8	34.9	34.9	34.9	34.9	35.3	35.4	35.4
Premix	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
DL-Met	2.2	2.2	2.2	2.5	2.4	2.4	2.5	2.7
L-Lys•HCl	1.1	1.1	1.9	2.9	1.9	1.9	2.6	3.0
L-Thr	0.3	0.3	0.3	0.8	0.6	0.6	0.7	1.0
L-Val				0.4	0.4	0.4	0.4	0.8
L-Arg								0.5

Nutrients, %

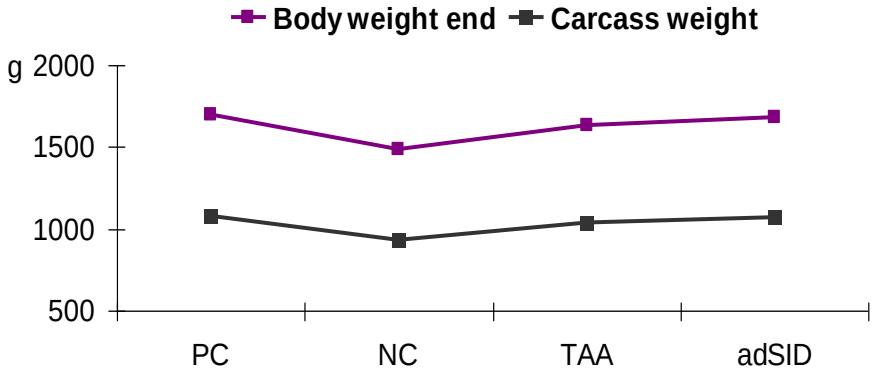
	Validation trial 1				Validation trial 2			
Treatment	**PC**	**NC**	**TAA**	**adSID**	**PC**	**NC**	**TAA**	**adSID**
ME MJ or kcal/kg	13.2/3155				13.2/3155			
CP	20.1	20.3	20.4	20.5	19.1	19.1	19.2	19.4
SID Lys	1.00	0.90	0.96	1.00	1.00	0.91	0.96	1.00
SID Met	0.47	0.46	0.47	0.49	0.48	0.47	0.48	0.50
SID M+C	0.74	0.71	0.72	0.74	0.74	0.71	0.72	0.74
SID Thr	0.65	0.62	0.62	0.65	0.64	0.60	0.61	0.64
SID Trp	0.22	0.23	0.23	0.23	0.21	0.21	0.21	0.21
SID Arg	1.20	1.06	1.06	1.06	1.12	0.99	0.99	1.04
SID Ile	0.74	0.70	0.70	0.70	0.69	0.66	0.66	0.66
SID Leu	1.41	1.37	1.37	1.37	1.32	1.27	1.27	1.27
SID Val	0.80	0.76	0.76	0.80	0.80	0.76	0.76	0.80

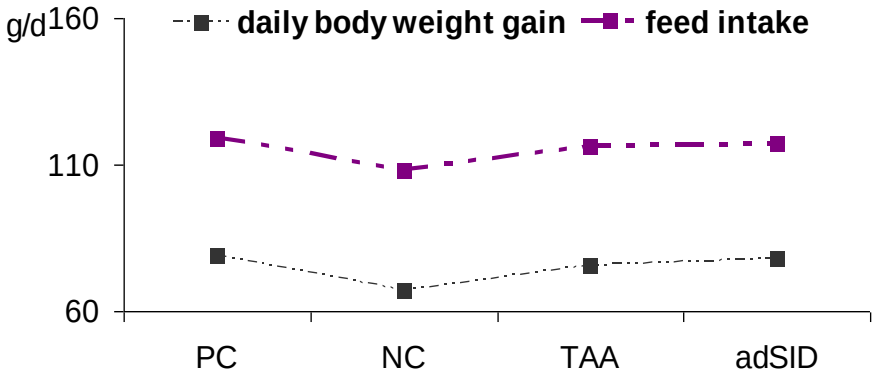
ME = Metabolizable energy, CP = Crude protein, SID = standardized ileal digestibility

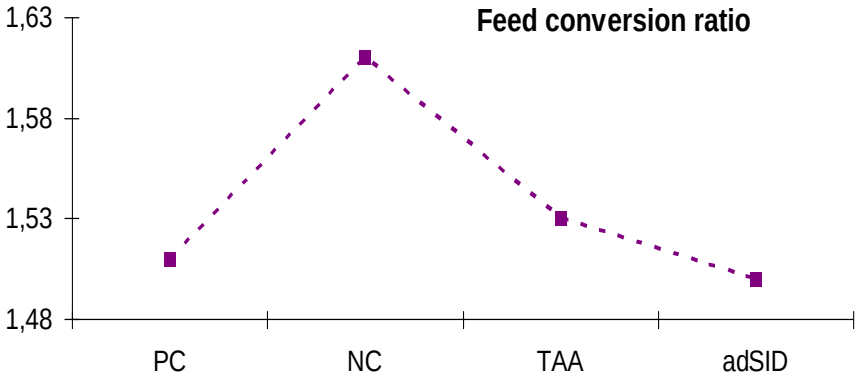
Validation trials

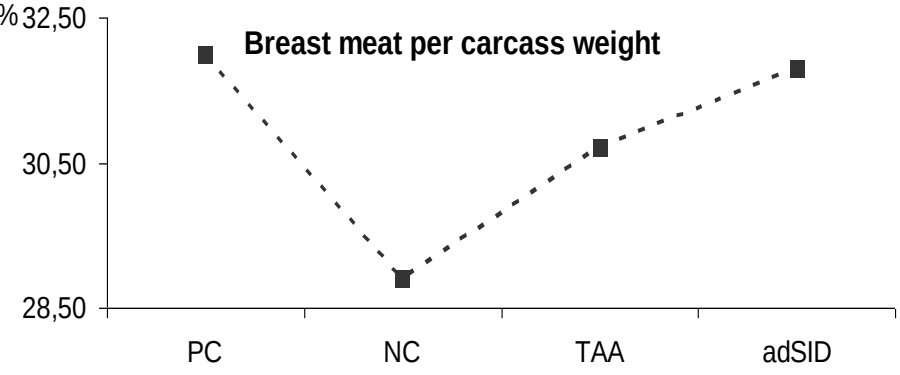
	feedtest, Germany	Wageningen UR Livestock Research, The Netherlands
Birds	1200 male Ross 308	960 male Ross 308
Replicates	15, 20 birds per rep.	12, 20 birds per rep.
Pen	Floor pens covered with wood shavings	
	bell drinker, feeding trough	drinking nipples, storage bin
Temperature	After breeders recommendations (Aviagen, 2007)	
Diet first 9 days	Commercial starter diet, adequate in nutrients and energy	
Weighing	Days 10 and 28 individually	
Feed consumption	Recorded per pen	
Slaughter parameters	7 birds per pen, body weight close to pen average	

Results – validation trial 1





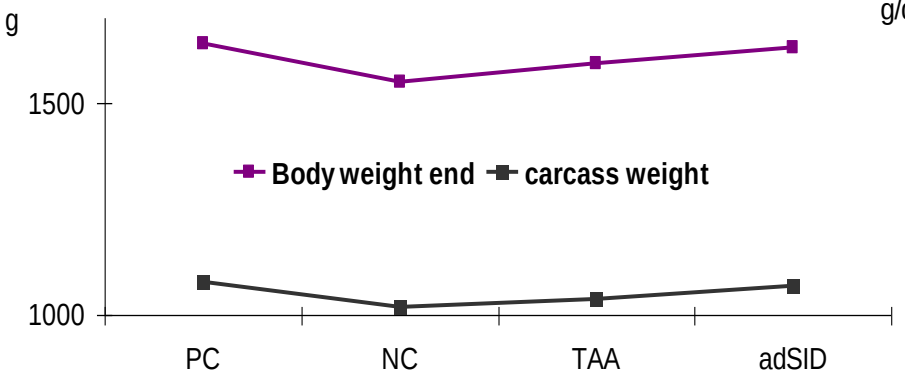


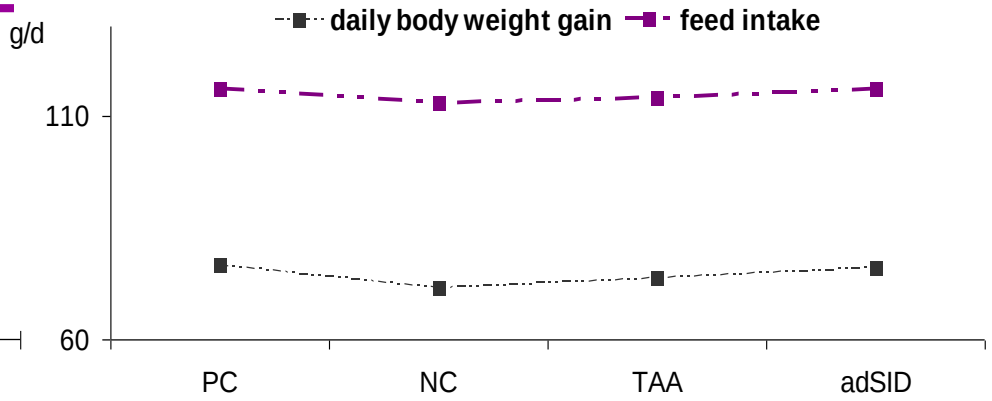


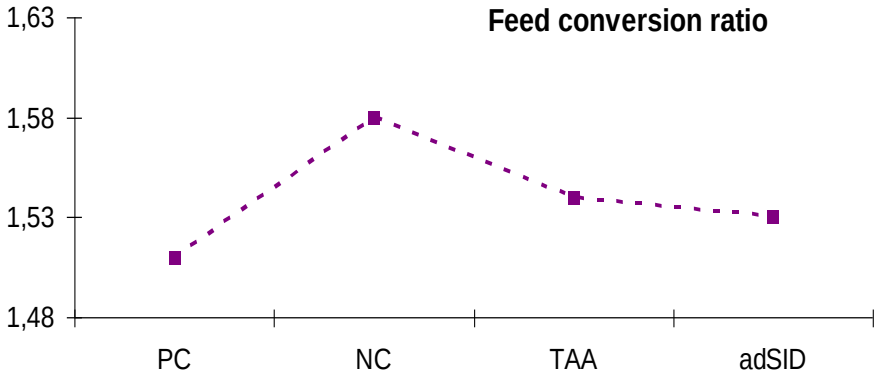
Treatment	PC	NC	TAA	adSID
BW end, g	1695^{a}	1483^{c}	1635^{b}	1680^{a}
d BWG, g/d	78.9^{a}	66.9^{c}	75.4^{b}	77.9^{ab}
FI, g/d	119^{a}	108^{b}	116^{a}	117^{a}
FCR	1.51^{ab}	1.61^{c}	1.53^{b}	1.50^{a}
CW, g	1082^{a}	930^{c}	1038^{b}	1068^{a}
Breast/CW, %	32.0^{a}	28.9^{c}	30.7^{b}	31.8^{a}

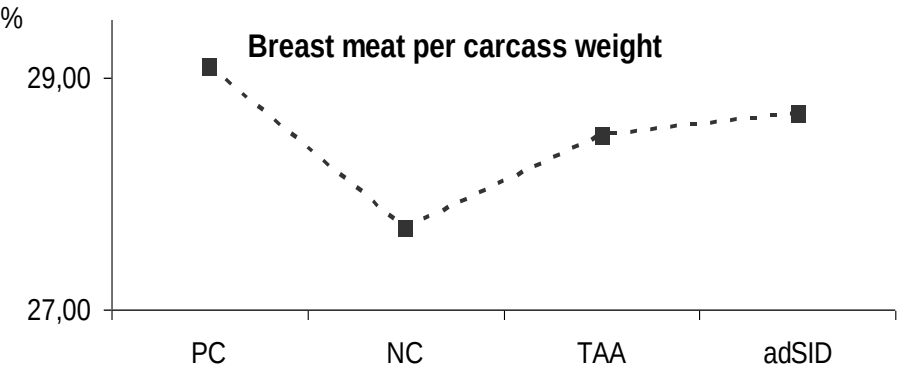
Different superscripts (a-c) within a row indicate significant differences ($p<0.05$).

Results – validation trial 2









Treatment	PC	NC	TAA	adSID
BW end, g	1641^{a}	1551^{c}	1593^{b}	1630^{a}
d BWG, g/d	76.5^{a}	71.4^{c}	73.7^{b}	75.9^{ab}
FI, g/d	116^{a}	113^{b}	114^{a}	116^{a}
FCR	1.51^{ab}	1.58^{c}	1.54^{b}	1.53^{a}
CW, g	1079^{a}	1019^{c}	1039^{b}	1069^{a}
Breast/CW, %	29.1^{a}	27.7^{b}	28.5^{a}	28.7^{a}

Different superscripts (a-c) within a row indicate significant differences ($p<0.05$).

Conclusion over all

- Body weight gain, feed conversion ratio, carcass weight, and breast meat yield improved significantly after adjustment for total amino acids and SID in heat damaged soybean meal.
- After these adjustments the performance level was statistically not different form the performance of the positive control.
  - ➢ It is worthwhile to adjust the nutritional matrix of heat damaged ingredients in terms of total amino acids but also in terms of standardised ileal digestible amino acids in order to maintain the bird performance.

Thank you for your attention!