WHEAT IS NOT A STANDARD RAW MATERIAL

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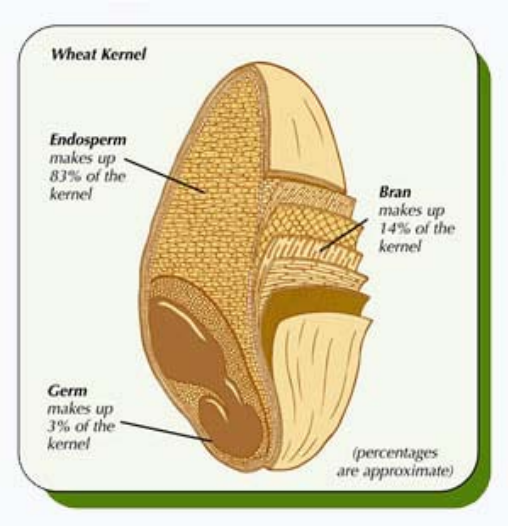
DEFINING WHEAT

Graphic 1 and 2. Different components of the wheat grain (%) (graphic 1) and Chemical composition of the wheat grain (10 % moisture) (graphic 2)

1



2

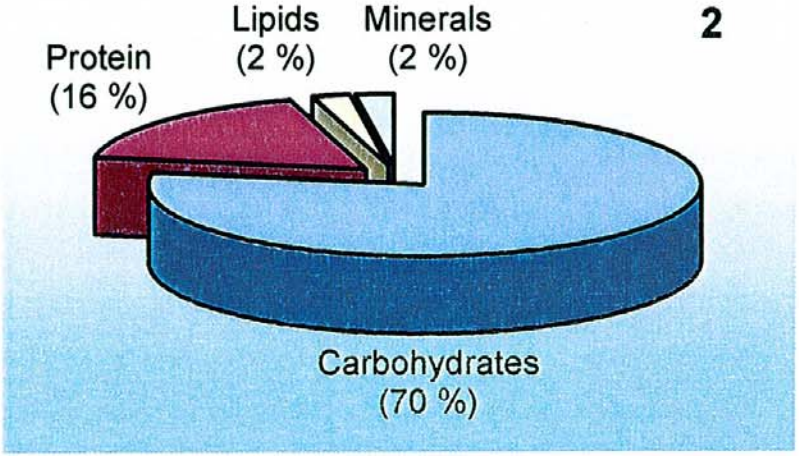


Table 1. Concentration of the nutrients of the wheat in the different components (%).

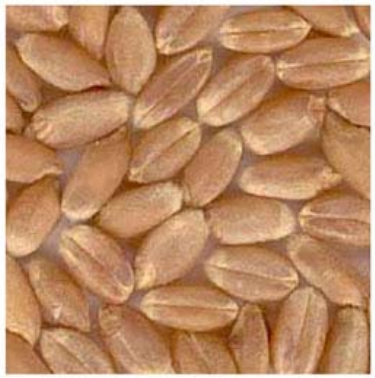
	Starch	Crude Protein	Crude Fibre	Lipids	Minerals
Bran (including aleurone)	-	20	93	30	67
Endosperm	100	72	4	50	23
Germ	-	8	3	20	10

Gutiérrez del Álamo, 2007

WHEAT

- *Wheat is unique raw material*

WHEAT CLASSES



Hard Red Spring wheat

Durum wheat

Hard Red Winter wheat

Soft Red Winter wheat

Soft White Winter wheat

Mixed wheat

WHEAT SHAPES

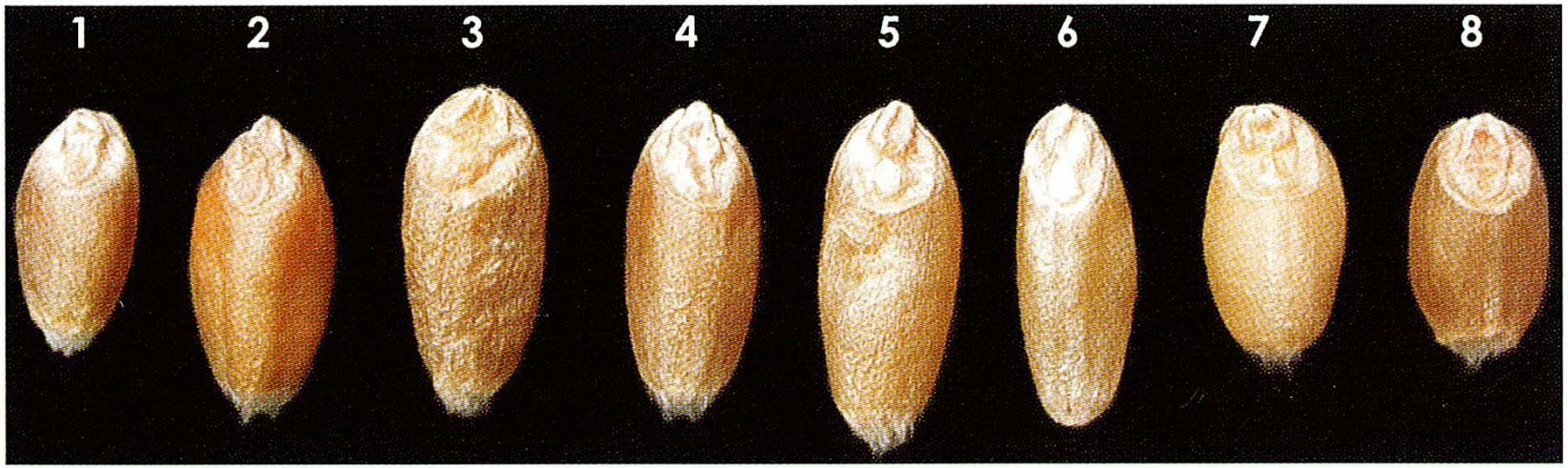


Fig. 4.5. Kernel visual distinguishability of Canada Western wheat classes.

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AACC, 2009

WHEAT QUALITY (FOOD)

- Wheat grade characteristics (test weight, damaged kernels, foreign material, shrunken/broken kernels)
- Wheat non-grade data (dockage, moisture, protein, kernel hardness, kernel hardness, kernel weight, kernel diameter)
- Milling quality characteristics (flour yield, falling number, wet gluten, gluten index)
- Flour properties (protein, ash content, moisture)
- Dough properties determined via alveograph testing (tenacity, extensibility, strength, configuration ratio)
- Baking evaluation (internal characteristics, loaf volume)

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CHOPIN ALVEOGRAPH

How does the Chopin Alveograph work?

What the graph means

W = baking strength of dough (the area under the curve)

L = extensibility of dough (time taken for bubble to burst)

P/L = dough strength and extensibility (ratio of curve height to length)

High W = strong flour

P = maximum pressure required

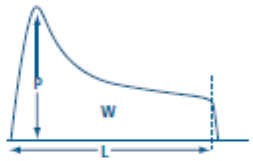
Low P/L = very extensible and low strength

Typical characteristics of different wheat varieties

nabim Group 1

Suitable for bread flour – makes strong elastic dough and has excellent bread-making potential.

- high pressure (P)
- long time (L) to burst

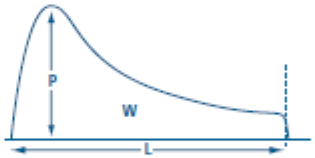


Typical range	
Alveograph P/L	0.5 - 0.9
Alveograph W	>200

nabim Group 2

Suitable for bread and baking flours – most varieties having bread-making potential.

- low P/L ratio important

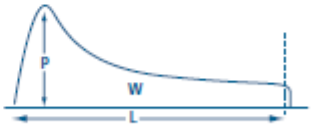


Typical range	
Alveograph P/L	0.4 - 0.9
Alveograph W	170 - 310

nabim Group 3

Suitable for biscuit and blending flours – makes extensible dough, good for biscuits and blending with strong wheats.

- low pressure (P)
- long time (L)
- area under the curve (W) less critical

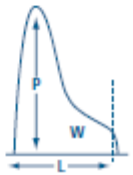


Typical range	
Alveograph P/L	0.2 - 0.4
Alveograph W	70 - 100

nabim Group 4

Suitable for animal feed only – makes tough, inelastic dough

- high pressure (P)
- short time (L) to burst



Typical range	
Alveograph P/L	0.3 - 1.5
Alveograph W	60 - 140

Five stages of the Alveograph test take place over three days

Stage 1
Wheat conditioned to standard moisture

Stage 2
Wheat milled and left to rest

Stage 3 & 4
Dough produced and formed into a disc

Stage 5
Air is pumped into dough to test resistance and elasticity

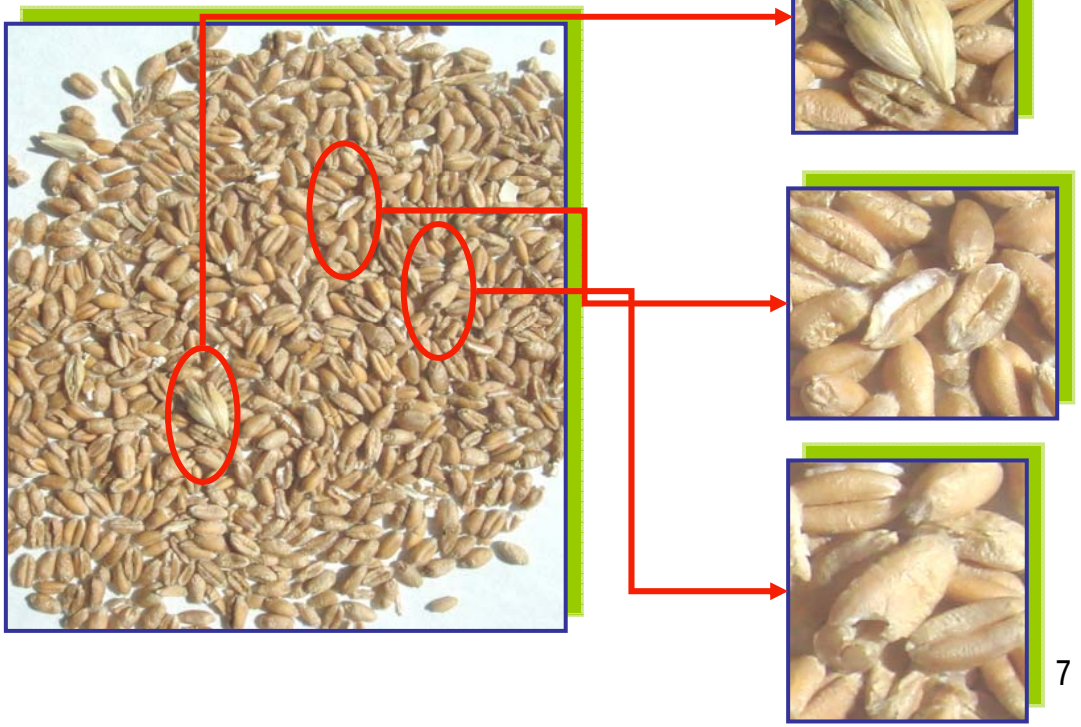
Chopin Alveograph showing stage 5 - air being pumped into dough

British Cereal Exports is the Export Promotion Department of the Home Grown Cereals Authority

HGCA

WHEAT QUALITY DEFINITION

"IT MUST BE CLEAN AND BRIGHT WITH NO BAD SMELL, INJURIOUS WEEDSEEDS AND ERGOTS MUST BE AT LOW LEVEL AND IT MUST NOT BE DISCOLOURED. THE DENSITY OF THE BULK GRAINS (SPECIFIC OR BUSHEL WEIGHT) MUST BE AT LEAST 720 kg/m^3"



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COARSE GRAIN EXPORTS

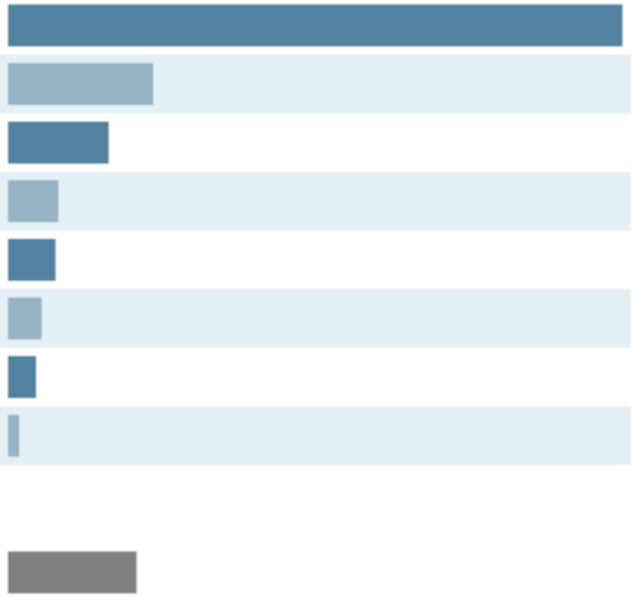
Agriculture Statistics > Grains > Coarse grain exports (most recent) by country

VIEW DATA: Totals | Per capita | Definition | Source | Printable version

Bar Graph | Pie Chart | Map

Showing latest available data.

Rank	Countries	Amount
# 1	United States:	51,455 thousand metric tons
# 2	Argentina:	12,215 thousand metric tons
# 3	China:	8,525 thousand metric tons
# 4	Australia:	4,250 thousand metric tons
# 5	Canada:	3,925 thousand metric tons
# 6	Ukraine:	2,835 thousand metric tons
# 7	Russia:	2,400 thousand metric tons
# 8	South Africa:	1,025 thousand metric tons
	Total:	86,630 thousand metric tons
	Weighted average:	10,828.8 thousand metric tons



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WHEAT IN BROILER NUTRITION

"So, cereals will be expensive and some experts believe they will be actually VERY expensive. There is nothing really to replace cereals, as any potential candidates have already been priced accordingly (one of the perils of globalization!) In other words, we must learn to survive and even turn a profit even with high cereal prices. This might be the time to actually start saving on feed cost for many poultry producers."

Ioannis Mavromichalis
World Poultry News
August, 2010

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TODAY POINTS TO DISCUSS

- *Towards the definition of wheat quality*
  - *Specific weight*
- *The use of enzymes in wheat based diets*
- *Estimation of AMEn of wheat and its use in broiler nutrition*
  - *Tables*
  - *Equations*
  - *Near-Infrared Spectroscopy (NIRS)*

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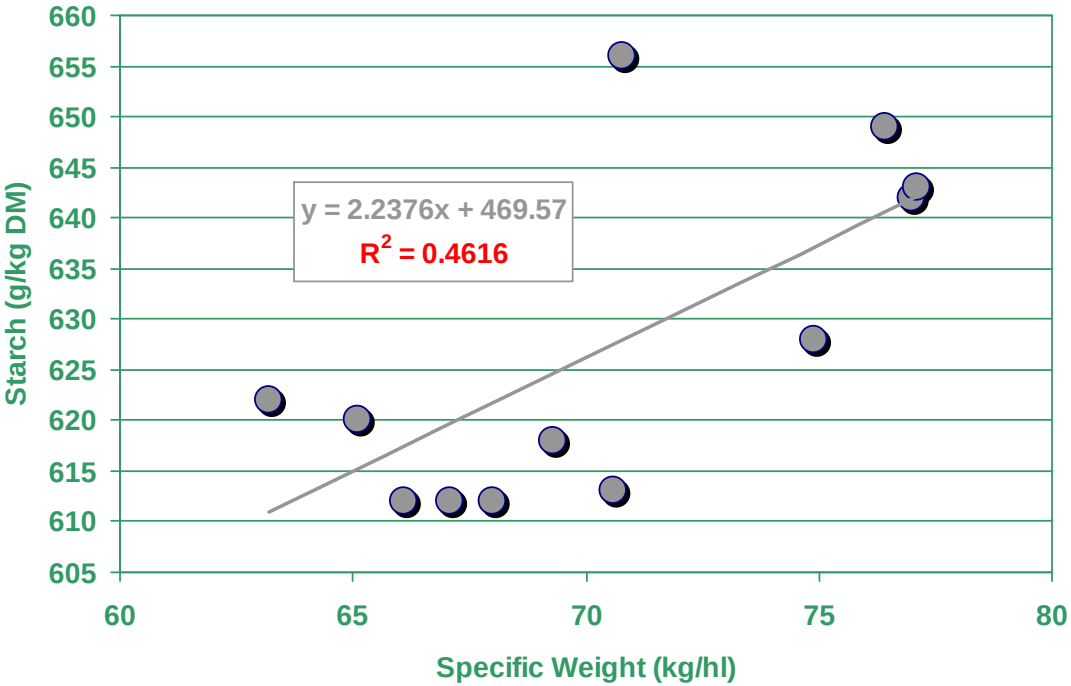
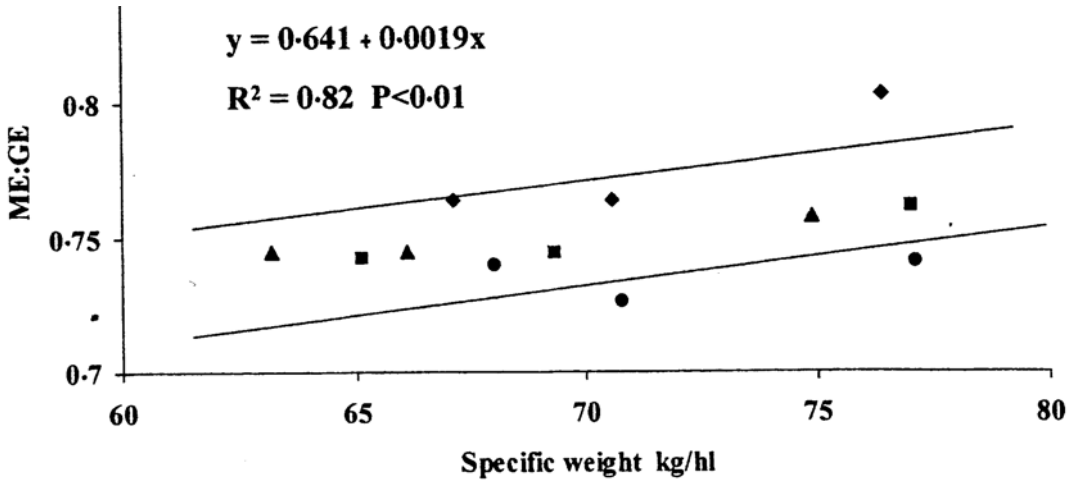
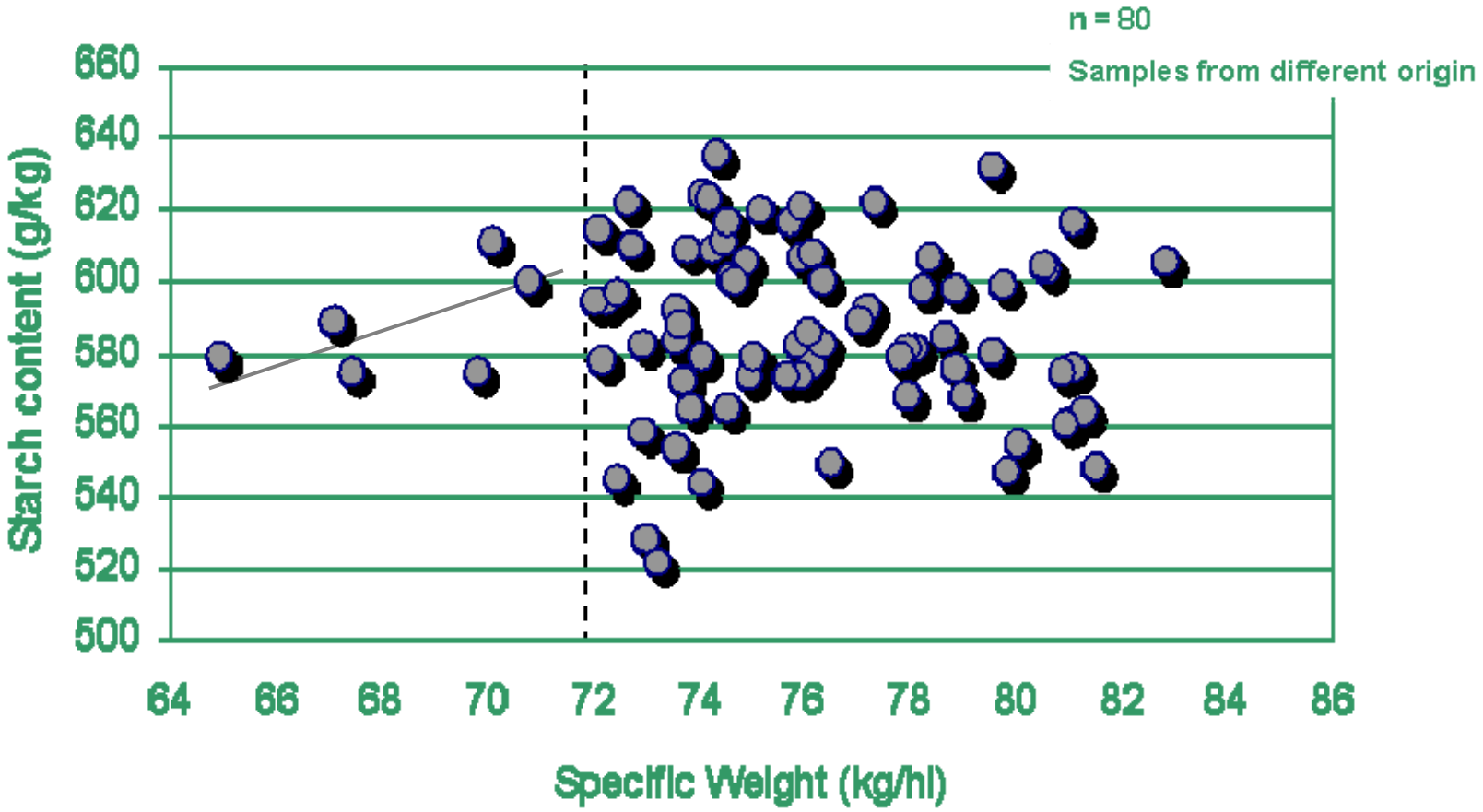
RELATIONSHIP STARCH-AMEn AND SW



McCracken et al., 2002



CURRENT RELATIONSHIP STARCH AND SPECIFIC WEIGHT



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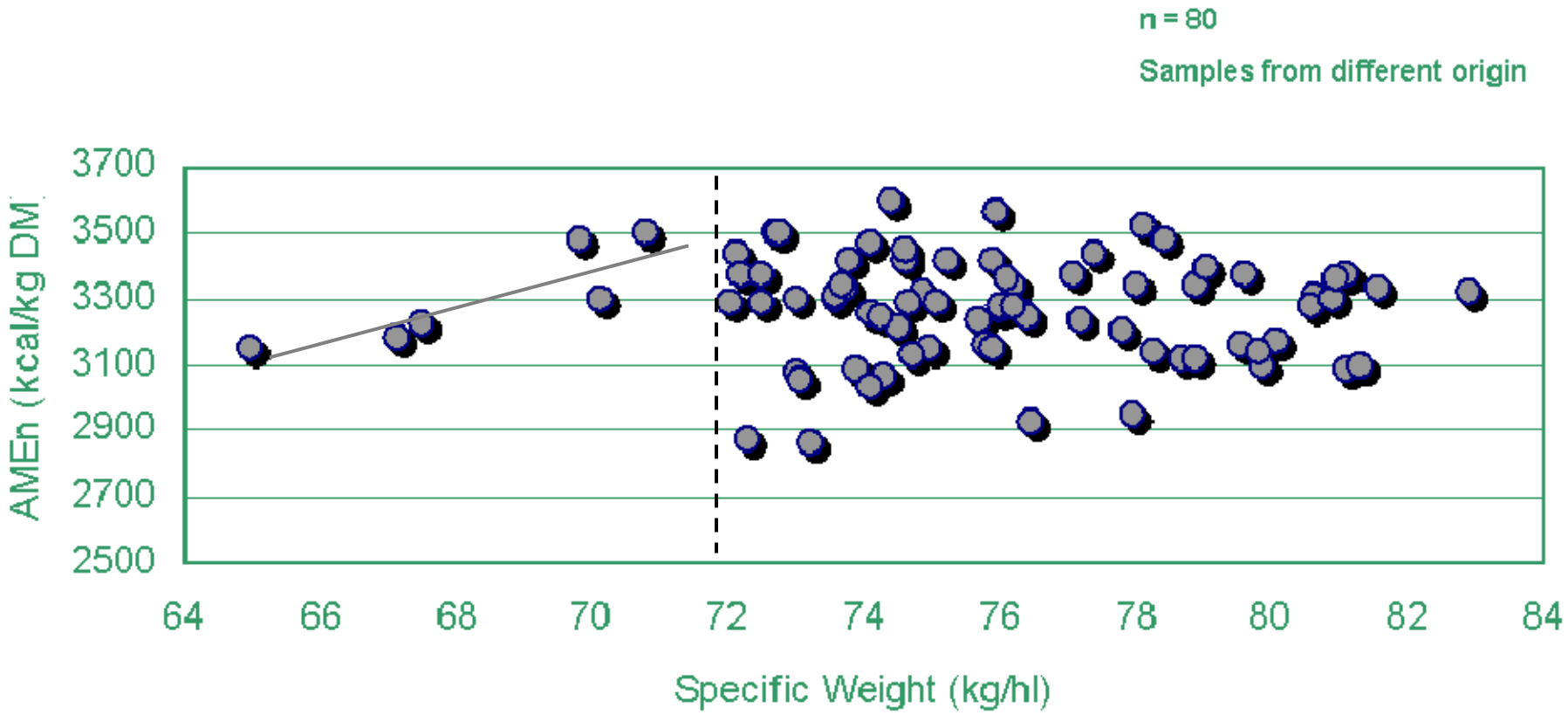
Gutiérrez del Álamo et al., 2008

CURRENT RELATIONSHIP SPECIFIC WEIGHT AND AMEn



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Gutiérrez del Álamo et al., 2008

RELATIONSHIP SW AND BROILER "ANSWER"

Paerson correlations

n = 80

Samples from different origin

ITEM	r
AMEn	0.070
Ileal digestibility Dry Matter	0.202
Ileal digestibility Starch	0.228
Ileal digestibility Crude Protein	0.209
Excreta digestibility Dry Matter	0.012
Excreta digestibility Crude Protein	0.087
Retained Crude Protein	-0.055

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Gutiérrez del Álamo et al., 2009

THE USE OF ENZYMES

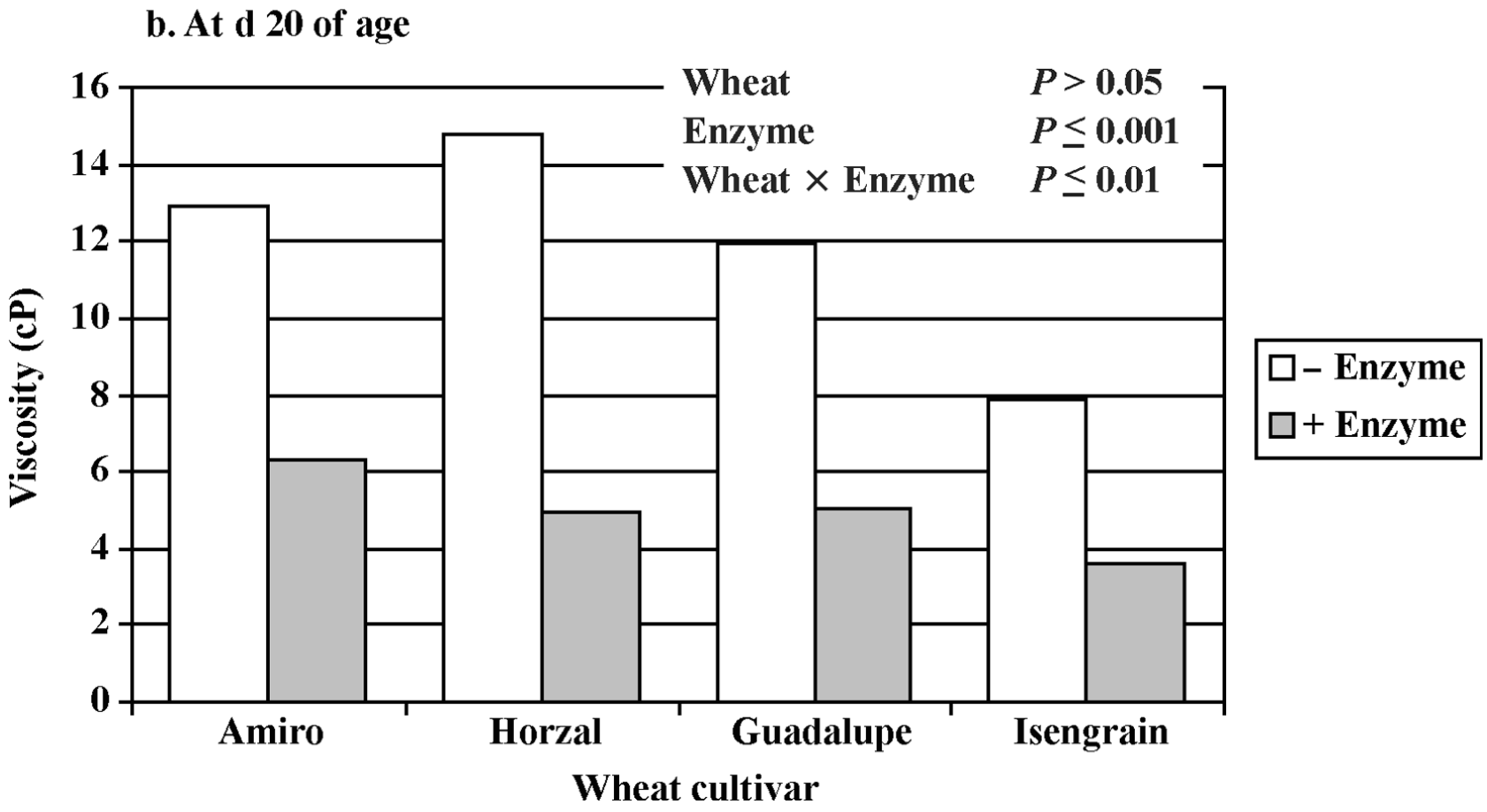
Table I The apparent metabolisable energy (AME) for broiler chicks and the total non-starch polysaccharide (NSP) content of samples of feed wheat. NSP was estimated by summing values for the individual monosaccharides measured after starch extraction and hydrolysis of the starch-free residue

Sample	AME (MJ/kg DM)	Ara (g/kg)	Xyl (g/kg)	Man (g/kg)	Gal (g/kg)	Glc (g/kg)	UA (g/kg)	β-Glu (g/kg)	Total NSP (g/kg)
A	8·43	16·9	29·0	2·6	4·09	31·7	3·8	5·9	88·1
		(0·7)	*(0·4)*	*(0·1)*	*(<0·1)*	*(0·7)*	*(0·1)*	*(0·5)*	*(1·3)*
B	8·43	24·0	48·1	2·3	4·8	34·4	4·1	6·7	117·5
		(0·7)	*(1·0)*	*(0·1)*	*(1·5)*	*(0·8)*	*(0·5)*	*(0·1)*	*(3·8)*
C	9·29	26·3	47·4	1·8	3·5	40·1	4·0	6·7	123·1
		(0·1)	*(0·7)*	*(0·1)*	*(0·1)*	*(3·1)*	*(0·4)*	*(0·1)*	*(2·8)*
D	9·43	18·4	25·9	2·0	3·7	32·0	3·8	5·8	85·5
		(0·4)	*(4·3)*	*(<0·1)*	*(0·1)*	*(0·9)*	*(0·1)*	*(0·2)*	*(3·5)*
E	9·89	12·4	26·9	1·7	3·5	39·3	4·4	6·2	88·0
		(1·3)	*(2·0)*	*(0·2)*	*(0·2)*	*(1·9)*	*(0·1)*	*(0·2)*	*(3·1)*
F	10·95	24·9	45·1	1·9	4·1	37·3	3·6	7·1	117·0
		(2·4)	*(4·2)*	*(0·2)*	*(0·3)*	*(2·5)*	*(0·5)*	*(0·2)*	*(9·7)*
G	11·22	12·7	24·1	2·0	3·1	36·9	3·8	6·0	82·6
		(0·9)	*(1·9)*	*(0·2)*	*(0·3)*	*(3·0)*	*(0·2)*	*(0·2)*	*(5·7)*
H	11·41	27·1	53·9	2·0	3·3	39·0	4·0	7·2	129·2
		(3·1)	*(4·4)*	*(0·3)*	*(0·7)*	*(3·8)*	*(0·3)*	*(0·0)*	*(12·1)*
I	12·00	18·8	33·6	2·2	3·9	36·2	3·9	5·8	98·6
		(1·0)	*(2·0)*	*(0·1)*	*(0·1)*	*(2·7)*	*(0·1)*	*(0·1)*	*(5·6)*
J	12·63	17·4	28·4	2·1	3·3	33·0	3·5	5·6	87·6
		(1·0)	*(1·7)*	*(<0·1)*	*(0·1)*	*(1·7)*	*(0·2)*	*(0·3)*	*(3·2)*
K	13·67	23·0	43·5	2·4	3·7	34·7	3·6	6·5	110·8
		(0·7)	*(1·4)*	*(0·1)*	*(0·4)*	*(1·1)*	*(0·1)*	*(0·1)*	*(3·4)*
L	13·74	26·5	47·7	2·2	4·1	39·1	4·1	7·2	123·5
		(0·3)	*(0·9)*	*(<0·1)*	*(0·2)*	*(1·4)*	*(0·1)*	*(0·4)*	*(2·2)*

Ara = arabinose, Xyl = xylose, Man = mannose, Gal = galactose, Glc = glucose, UA = uronic acids, β-Glu = (1→3, 1→4)-β-glucan (all values quoted as anhydrous sugars). Standard deviations shown in parentheses.

Austin et al., 1999

THE USE OF ENZYMES



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Gutiérrez del Álamo et al., 2008

THE USE OF ENZYMES

Table 4. Effect of wheat cultivar and enzyme[1] addition[2] on excreta digestibility and AME_n of broilers (mean values)

	Effect[3]							
	Starter period (10 to 13 d of age)				Grower period (24 to 27 d of age)			
Item	DM (%)	Starch (%)	CP retention (%)	AME_n[4] (kcal/kg of DM)	DM (%)	Starch (%)	CP retention (%)	AME_n[4] (kcal/kg of DM)
Isengrain								
–	70.76	99.26	62.41	2,998	72.23^{ab}	98.46	61.10	3,066^{ab}
+	70.90	99.33	60.28	3,021	72.63^{a}	99.25	59.48	3,077^{ab}
Amiro								
–	70.24	99.13	60.52	2,982	69.81^{bcd}	97.61	58.42	3,005^{bc}
+	71.76	99.53	61.19	3,058	70.80^{abc}	98.51	58.99	2,996^{bcd}
Guadalupe								
–	68.60	99.29	60.40	2,886	69.70^{bcd}	98.97	57.76	2,961^{cd}
+	68.87	99.40	60.42	2,868	68.29^{cd}	98.49	58.01	2,902^{d}
Horzal								
–	68.55	98.51	56.32	2,936	67.34^{d}	97.94	54.09	2,913^{cd}
+	70.39	99.40	58.18	3,014	71.68^{ab}	98.97	57.26	3,108^{a}
Pooled SEM	0.60	0.23	0.86	26.61	0.84	0.45	1.28	32.56
Main effect mean[5]								
Wheat cultivar								
Isengrain	70.83^{ab}	99.29	61.29^{a}	3,010^{a}	72.44^{a}	98.88	60.24^{a}	3,071^{a}
Amiro	71.04^{a}	99.34	60.83^{a}	3,022^{a}	70.33^{b}	98.08	58.72^{a}	3,000^{b}
Guadalupe	68.76^{c}	99.35	60.41^{a}	2,876^{b}	68.98^{b}	98.72	57.89^{ab}	2,930^{c}
Horzal	69.63^{bc}	99.03	57.41^{b}	2,982^{a}	69.62^{b}	98.48	55.75^{b}	3,015^{ab}
Enzyme								
–	69.64	99.06	59.99	2,954	69.78	98.26	57.82	2,985
+	70.45	99.41	60.09	2,989	70.45	98.81	58.42	3,021
Source of variation								
Wheat cultivar	<0.001	0.334	<0.001	<0.001	<0.001	0.330	0.005	<0.001
Enzyme addition	0.034	0.033	0.865	0.039	0.079	0.088	0.521	0.138
Wheat cultivar × enzyme addition	0.397	0.303	0.136	0.241	0.008	0.319	0.316	0.001

$^{a-d}$Means within a given column with no common superscript are different ($P < 0.05$).

[1]Avizyme 1300 (Danisco Animal Nutrition, Marlborough, UK).

[2]0 (–) or 1 kg/t of feed (+).

[3]Each mean represents 10 cages with 1 animal each.

[4]AME_n = AME of the diets corrected by zero N retention.

[5]Each mean represents 20 and 40 cages with 1 animal each for wheat cultivar and enzyme addition, respectively.

Gutiérrez del Álamo et al., 2008

WHEAT IN FEEDING TABLES

	Dry matter		Crude protein		Starch		AMEn (kcal/kg)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CVB-2007	86.8	1.5	11.1	1.0	58.7	1.9	2868	-
INRA-2002	86.8	1.1	10.5	0.9	60.5	1.9	2880	-
FEDNA-2002	88.6	-	11.2	-	59.0	-	3150	-
Rostagno-2005	87.7	-	11.5	-	54.9	-	3046	-

WHEAT IN FEEDING TABLES

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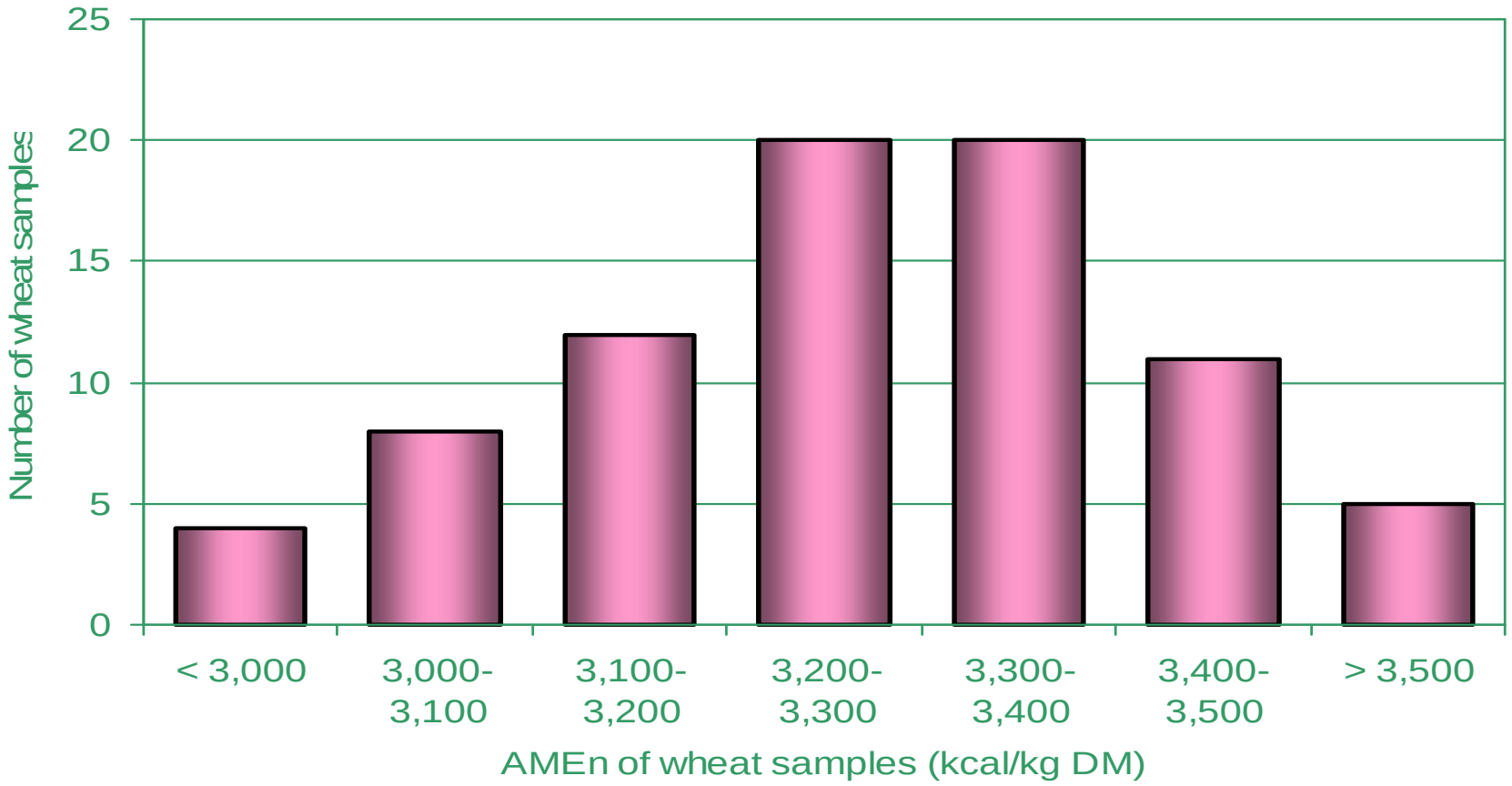
INRA-2002	86.8	1.1	10.5	0.9	60.5	1.9	2880	-
FEDNA-2002	88.6	-	11.2	-	59.0	-	3150	-
Rostagno-2005	87.7	-	11.5	-	54.9	-	3046	-
Gutiérrez del Álamo et al., 2009	**88.2**	**1.9**	**11.7**	**2.0**	**58.3**	**2.2**	**2878**	**136**

VARIATION IN AMEn

Histogram of the wheat AMEn taken from different feed factories around Europe



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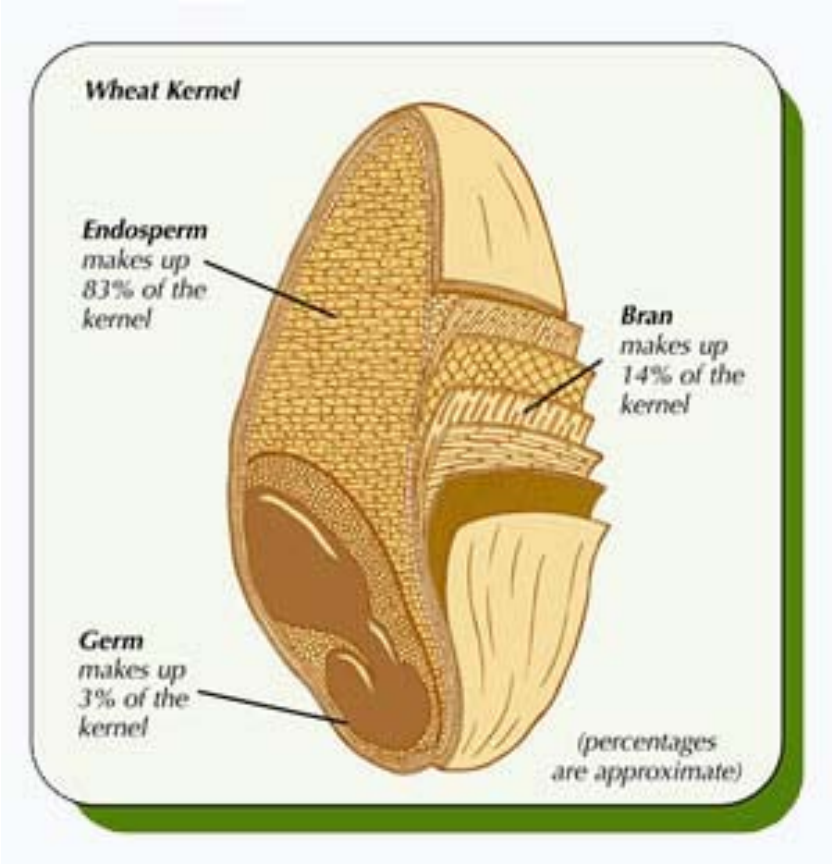
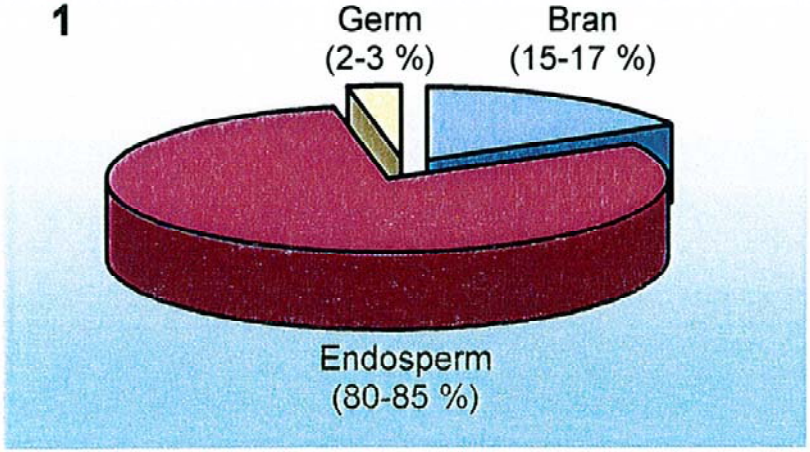
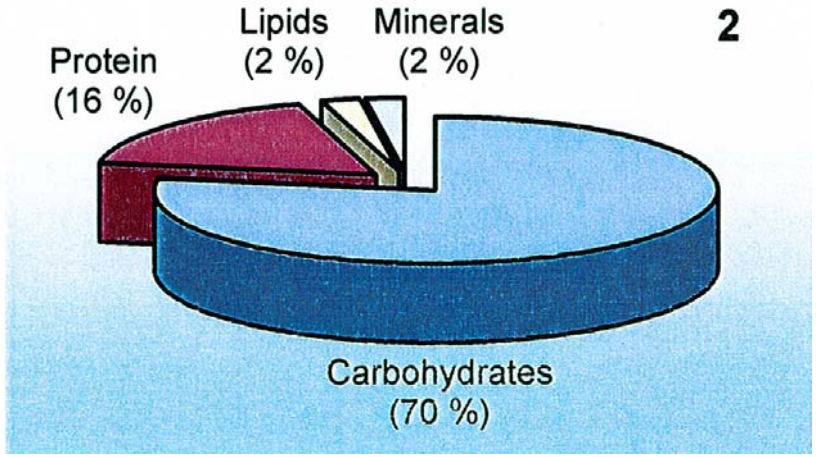
Gutiérrez del Álamo et al., 2009

WHEAT GRAIN







Gutiérrez del Álamo et al., 2007

PAERSON CORRELATIONS

Item[1]	Ileal starch digestibility	Fecal starch digestibility	Wheat AMEn
CP	-0.609 (<0.0001)	-0.567 (0.0001)	-0.280 (0.029)
ASH	-0.023 (0.883)	-0.062 (0.702)	-0.170 (0.235)
ST	0.447 (0.003)	0.469 (0.002)	0.418 (0.002)
EE	-0.388 (0.031)	-0.287 (0.072)	0.060 (0.677)
CF	0.340 (0.031)	0.180 (0.265)	0.132 (0.360)
NDF	-0.419 (0.007)	-0.372 (0.017)	0.240 (0.092)
ADF	0.097 (0.551)	0.202 (0.211)	-0.072 (0.616)
ADL	-0.185 (0.250)	0.139 (0.391)	-0.301 (0.033)
SW	0.228 (0.156)	0.087 (0.590)	0.070 (0.624)
VISC	0.236 (0.141)	0.098 (0.545)	-0.136 (0.344)

[1] CP = crude protein; ST = starch; EE = ether extract; CF = crude fiber; NDF = neutral-detergent fiber; ADF = acid-detergent fiber; ADL = acid-detergent lignin; SW = specific weight; VISC = viscosity.

Gutiérrez del Álamo et al., 2009

WHEAT PROTEIN

WHEAT FLOUR

- **Starch** ± 65-75 %
- **Proteins** ± 10-15 %
- **Water** ± 15 %

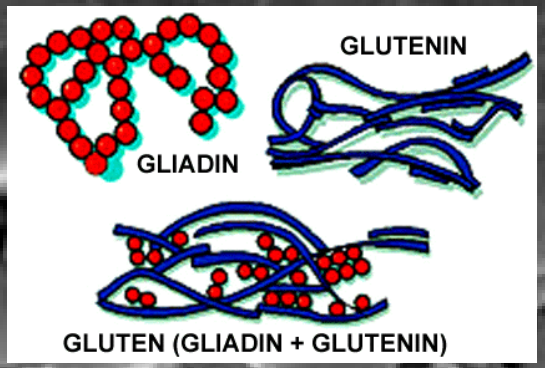
Gluten (80-90 %)

- **Albumins**
- **Globulins**

Alcohol soluble

Gliadins

Ω, γ, α - gliadins



No alcohol soluble

Glutenins

LMW, HMW - glutenins

Federación de Asociaciones de Celíacos en España, 2002.

WHEAT PROTEIN

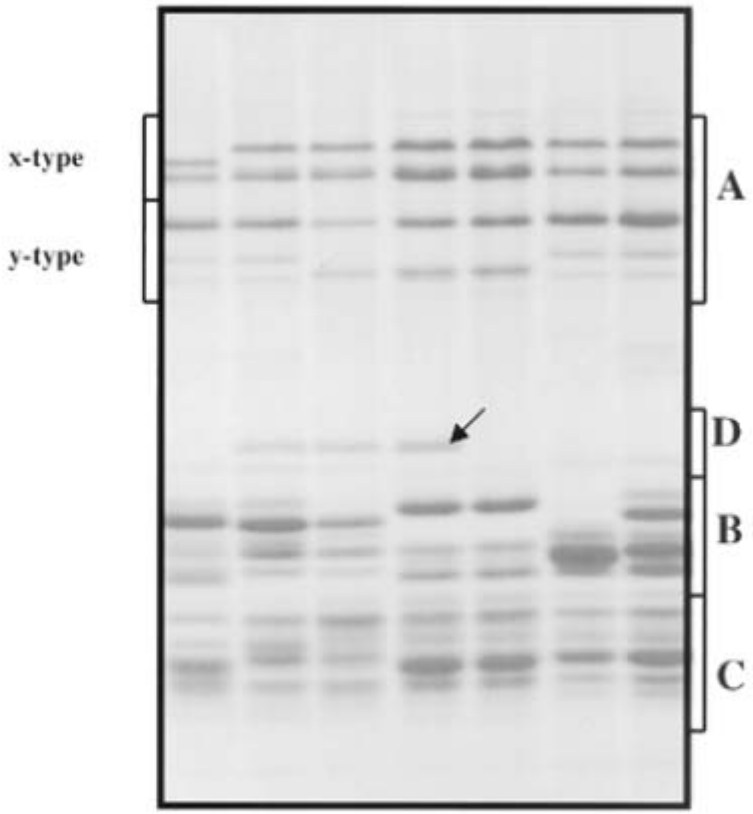
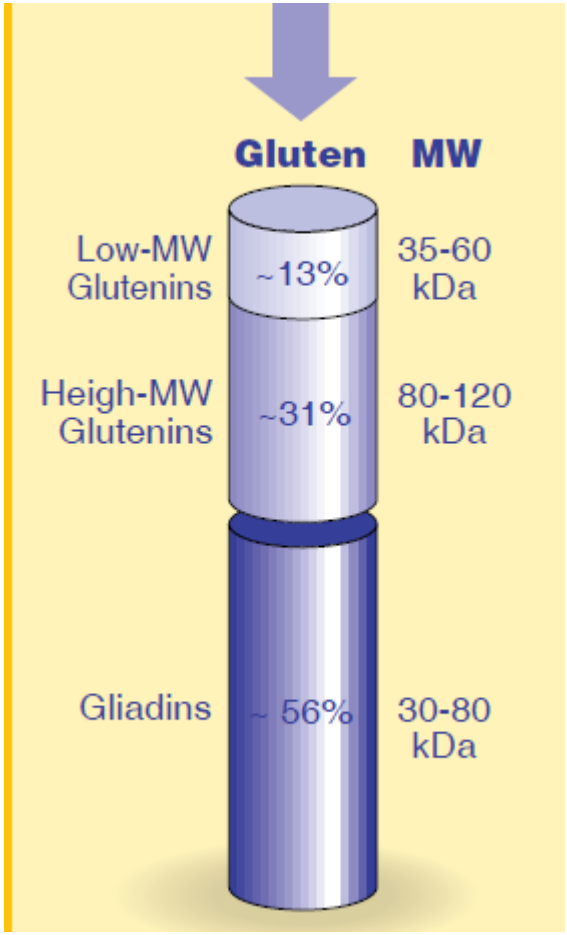


Fig. 2. SDS-PAGE of polymeric protein (after reduction to subunits), performed according to the one-step one-dimensional procedure of Gupta and MacRitchie (1991) (Gianibelli unpublished results). Group A: HMW glutenin subunits showing x- and y-type glutenin subunits. Groups B-, C-, D-: LMW glutenin subunits. Arrow indicates subunit D.

Gianiballi et al., 2001



Senter, 1992

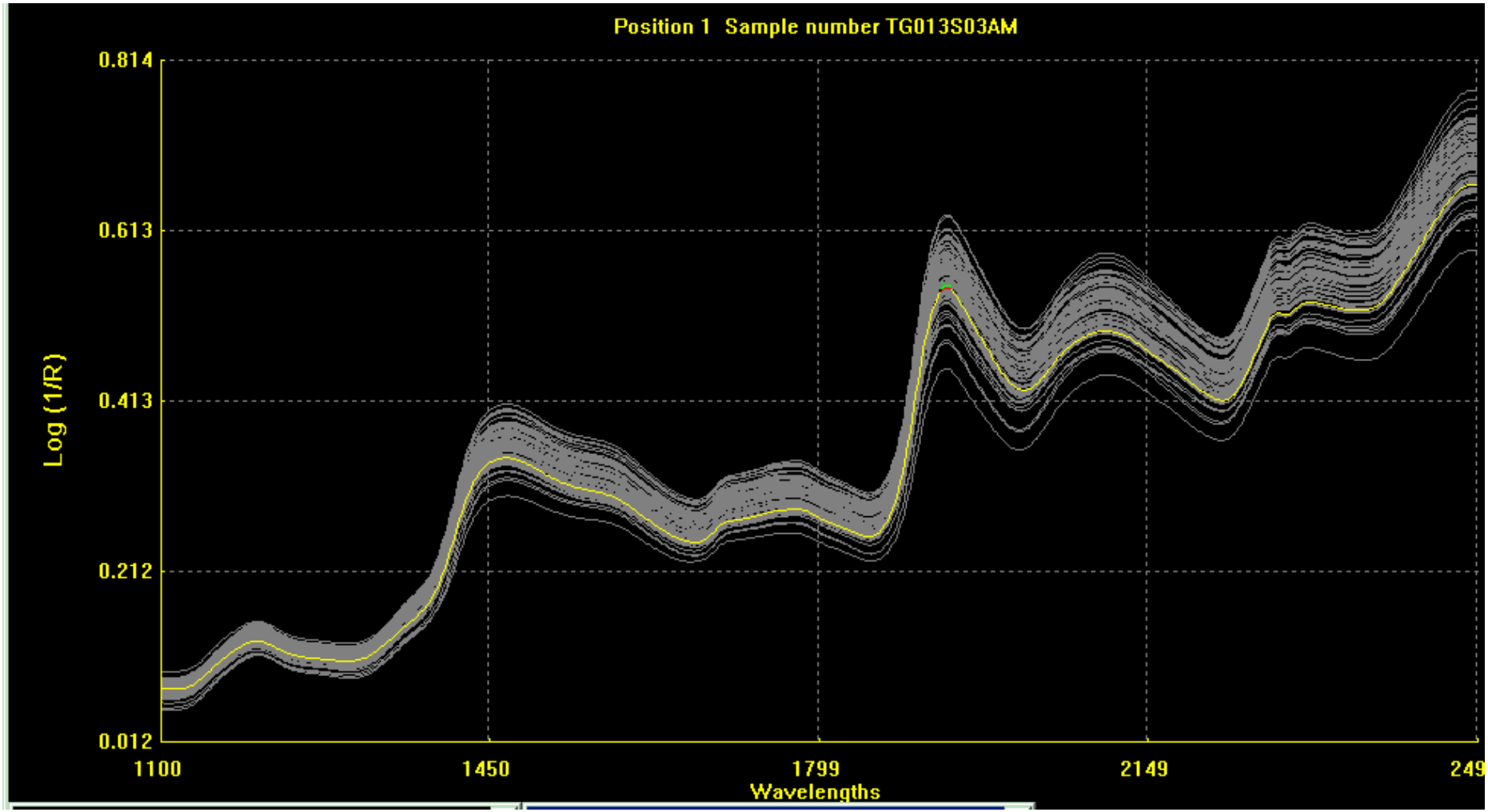
FORMULA

- *CVB-2007 ($AME_{broilers}$, kcal/kg) =*

  3.72 x CP x dig. CP + 9.28 x CFAT x dig. CFAT + 4.14 x NFE x dig. NFE

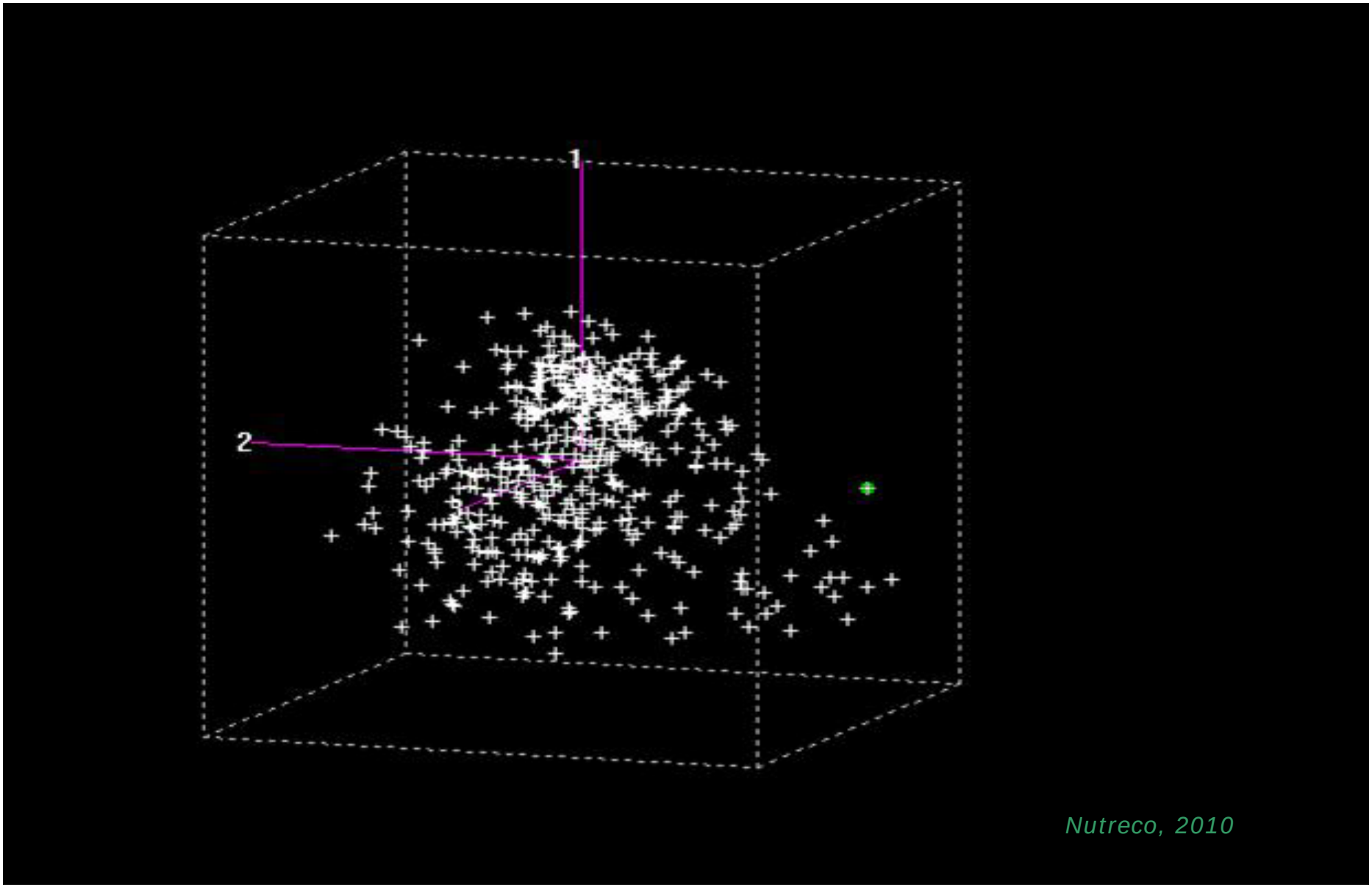
  NFE = DM – Ash – CP – CFAT – CFIBRE (consists of carbohydrates, sugars, starches, and a major portion of the hemicellulose)

NIRS



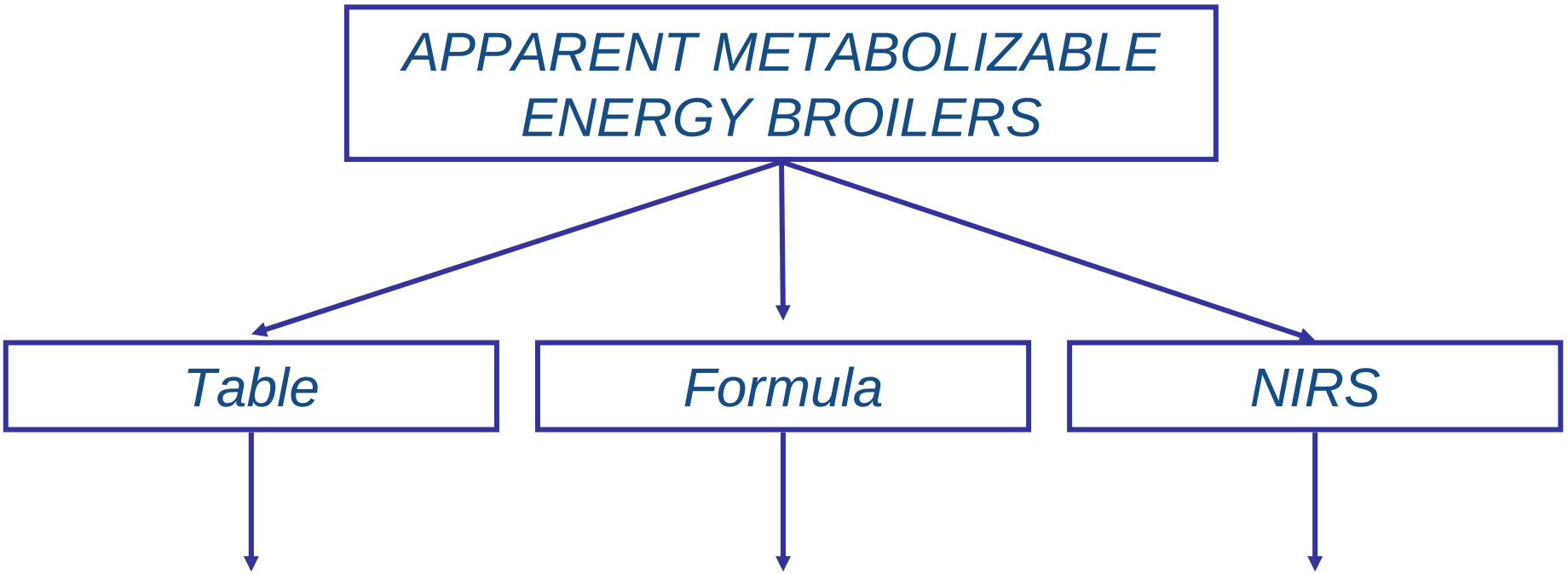
Nutreco, 2010

NIRS



Nutreco, 2010

ESTIMATING WHEAT AMEn



CONCLUSION

- *AMEn of wheat is variable and depends on factors until know not controlled by nutritionists*
- *Specific weight is not the answer to buy wheats*
- *There is no knowledge on how and why to buy a certain wheat crop*
- *Starch is the main factor affecting AMEn but*

- *Modifications to the predicting formula can be applied based on knowledge*
- *NIRS is a good tool to determine wheat quality (AMEn) in each sample arriving to the feed mill*

THANKS

nutreco