New nutrition updates in laying hens

Effects of the energy and digestible lysine content of the diet on brown-egg laying hens

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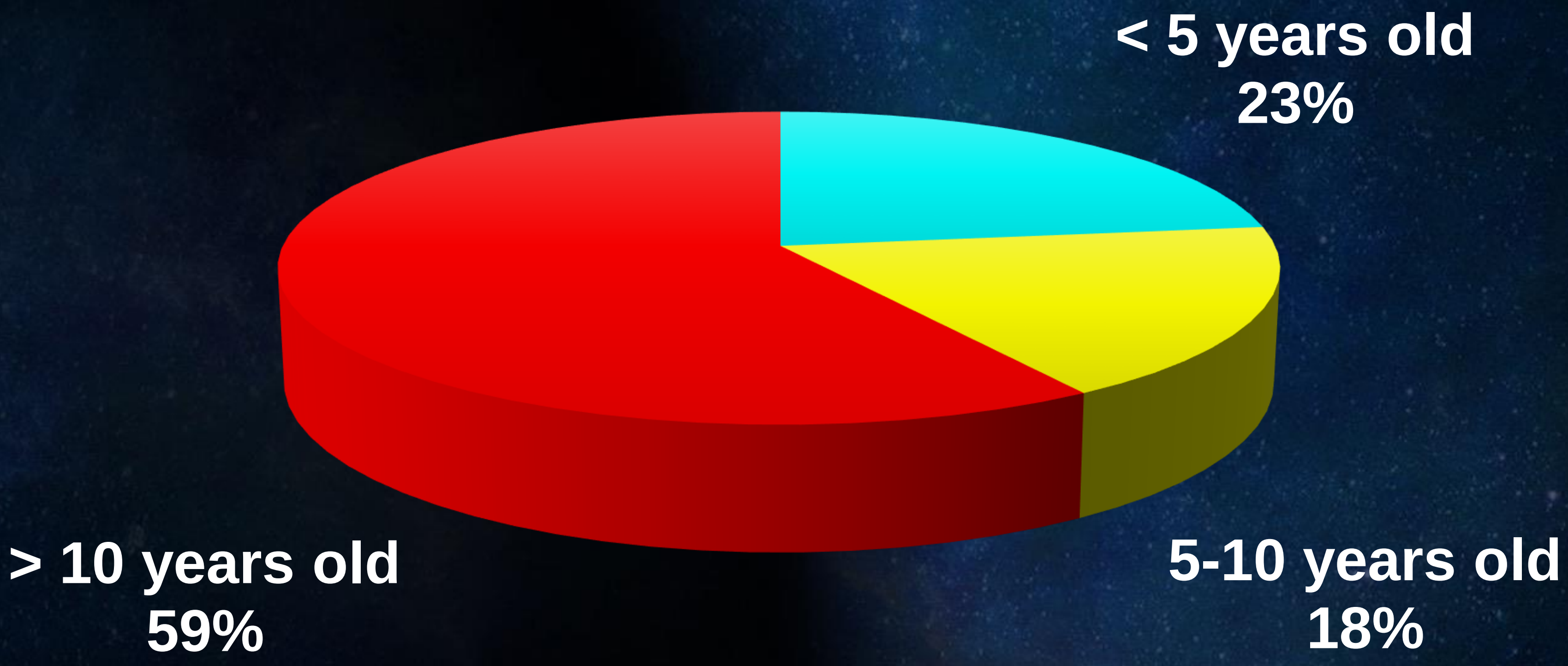
Review DLys requirements



Influence of the energy and digestible lysine contents of the diet on performance and egg quality traits of brown-egg laying hens from 19 to 59 weeks of age

R. Scappaticcio,[*,†] J. García,[*] G. Fondevila,[†] A. F. de Juan,[†] L. Cámara,[†] and G. G. Mateos[†,1]

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https://doi.org/10.1016/j.psj.2021.101211

Experiment Design

- Commercial barn (110,000 Brown hens)
- 8 treatments (9 replicate)
  - **2 AMEn (2,680 *vs* 2,780 kcal/kg)**
    (1,216 *vs* 1,261 kcal/lb)
  - **4 DLys (from 0.68 to 0.80%)**
- Feed corn-soybean meal
  - Feed valued used FEDNA guideline
  - AA according to ideal protein concept by FEDNA
- Hens performance and egg quality

Source: Dr. Scappaticcio

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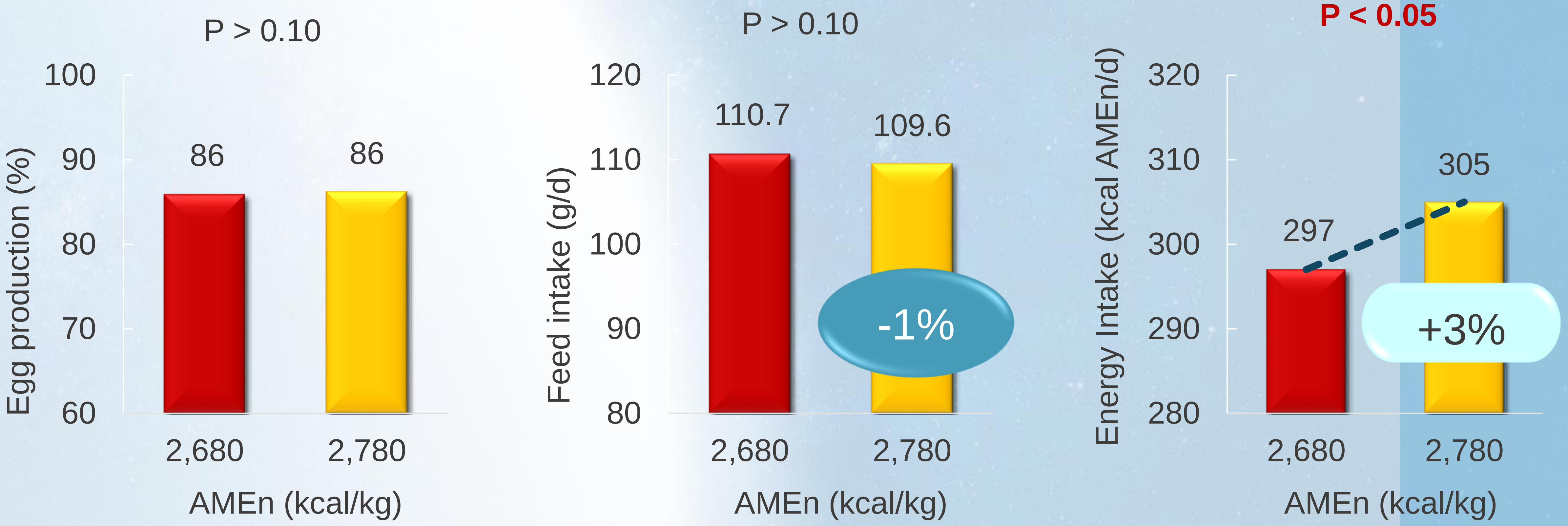
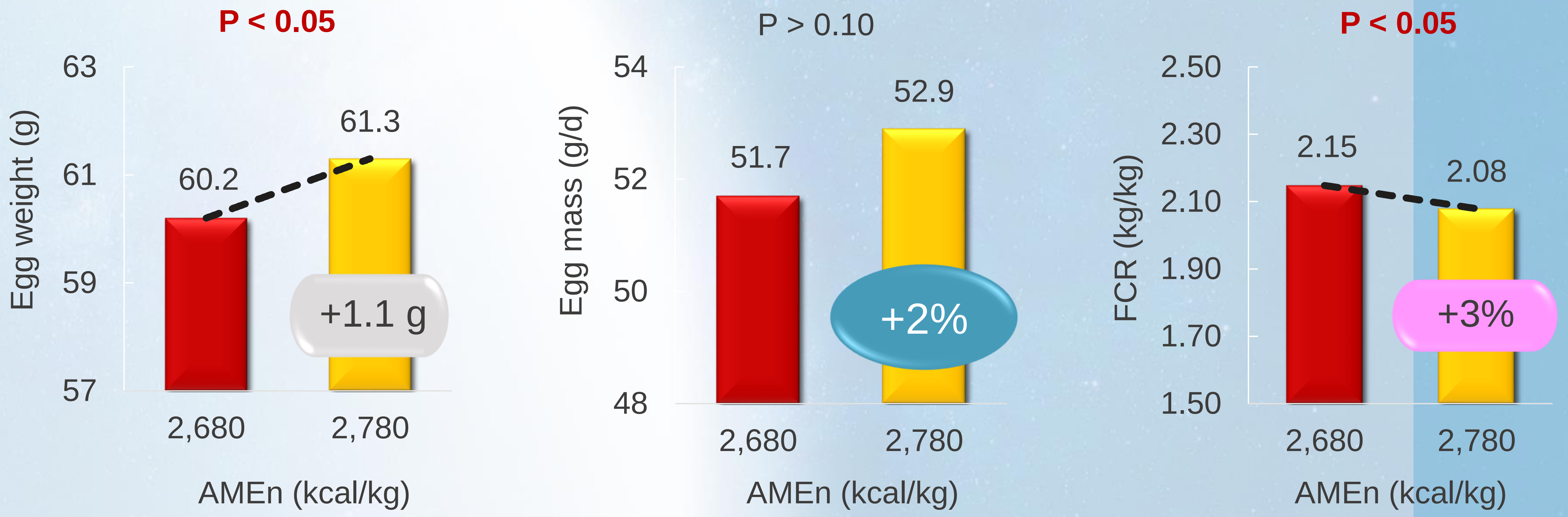
Hen Production (19-59 wk of age)

Energy concentration of the diet



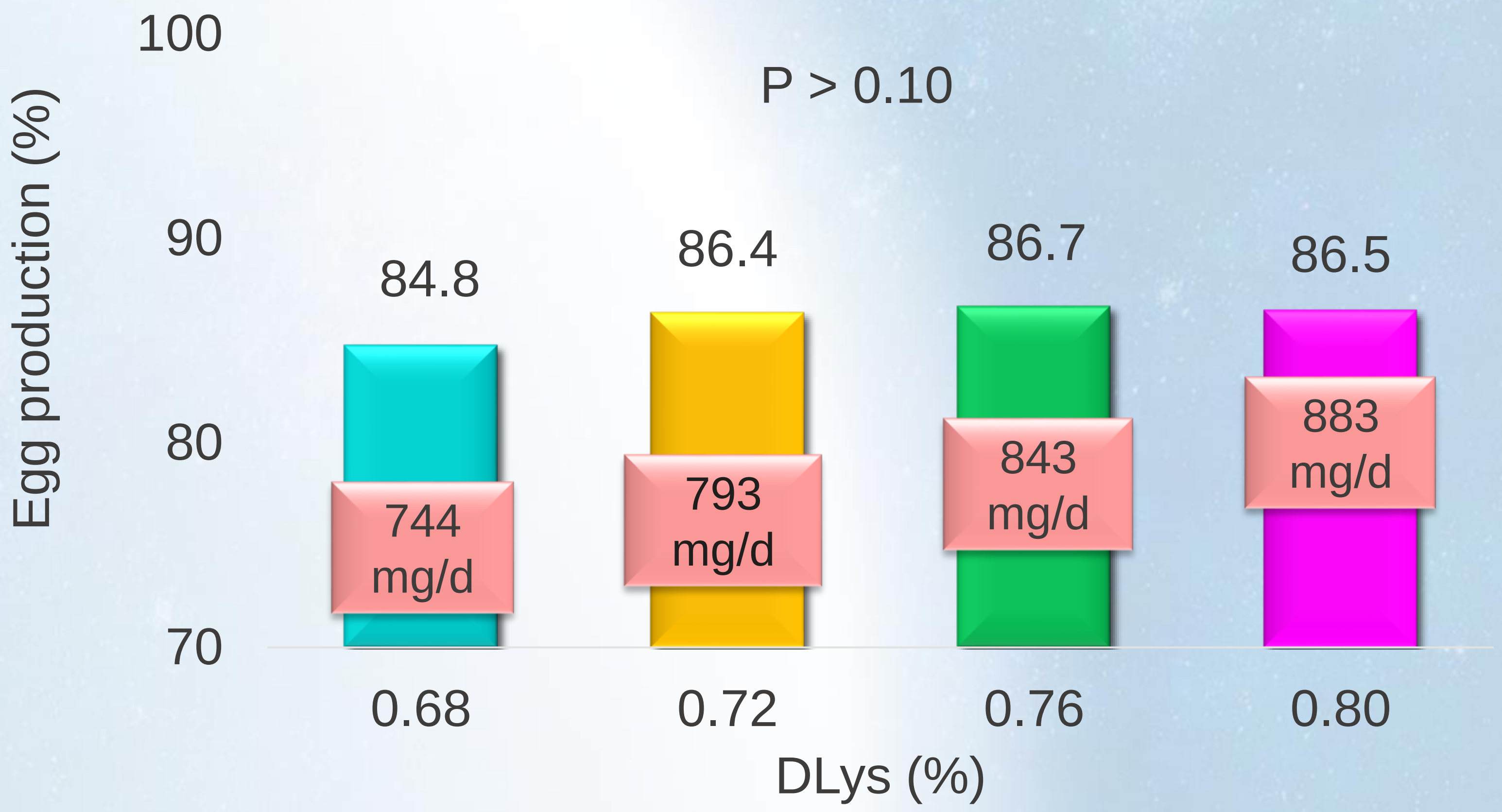
Hen Production (19-59 wk of age)

Energy concentration of the diet



Hen Production (19-59 wk of age)

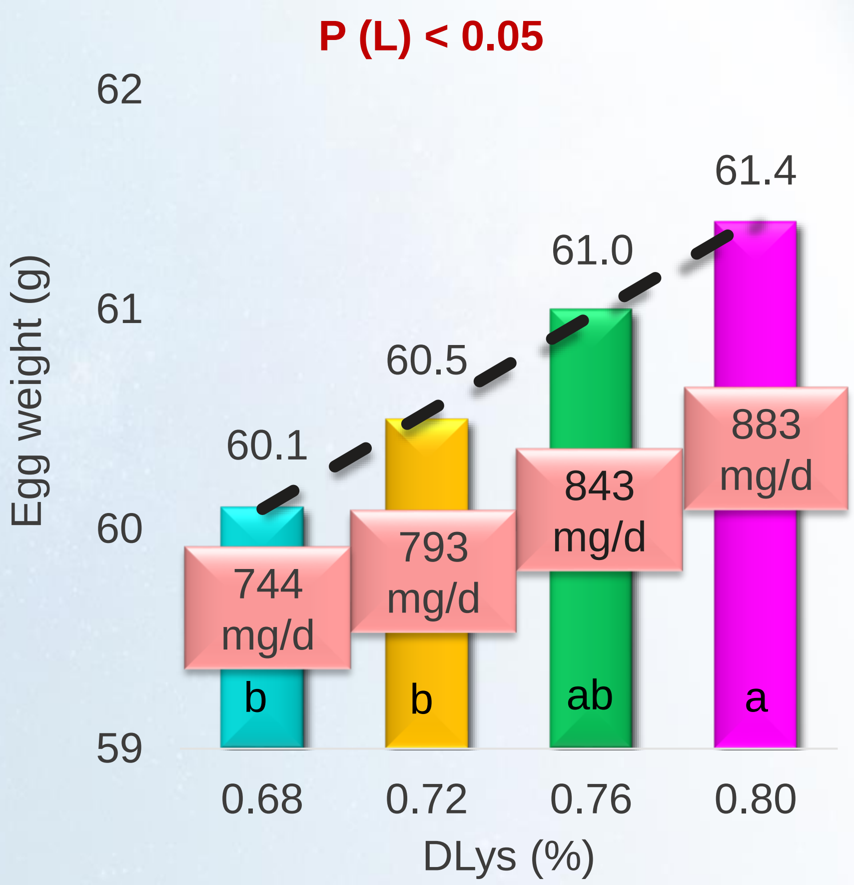
DLys content of the diet

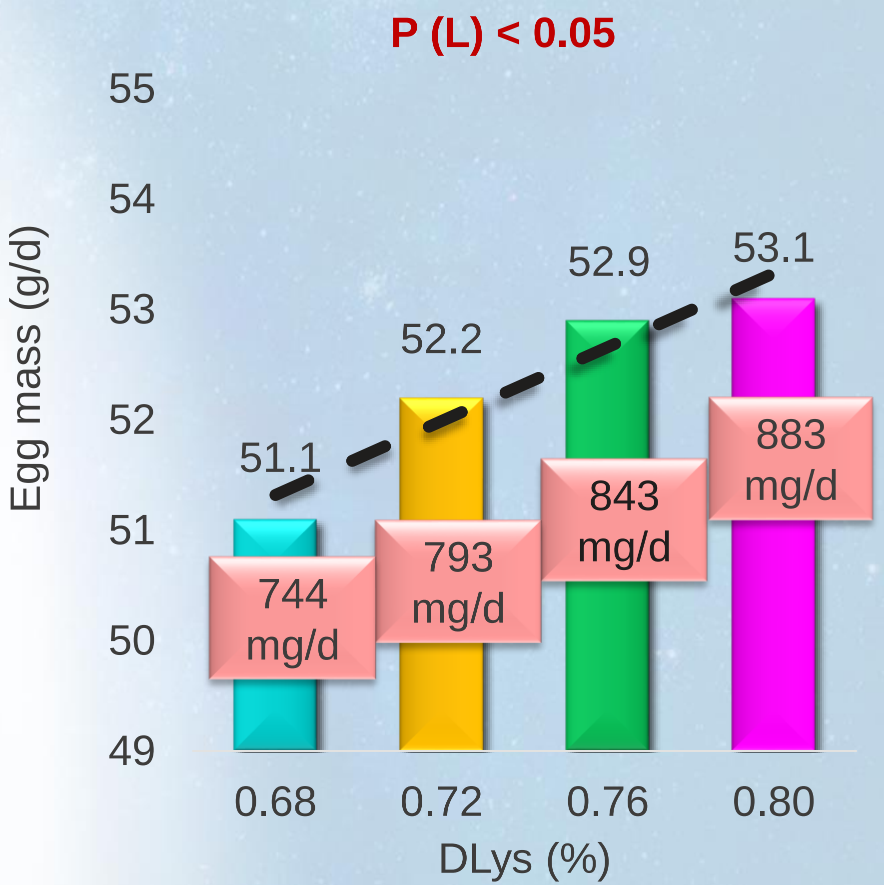


744 mg DLys/d to optimize egg rate

Hen Production (19-59 wk of age)

DLys content of the diet

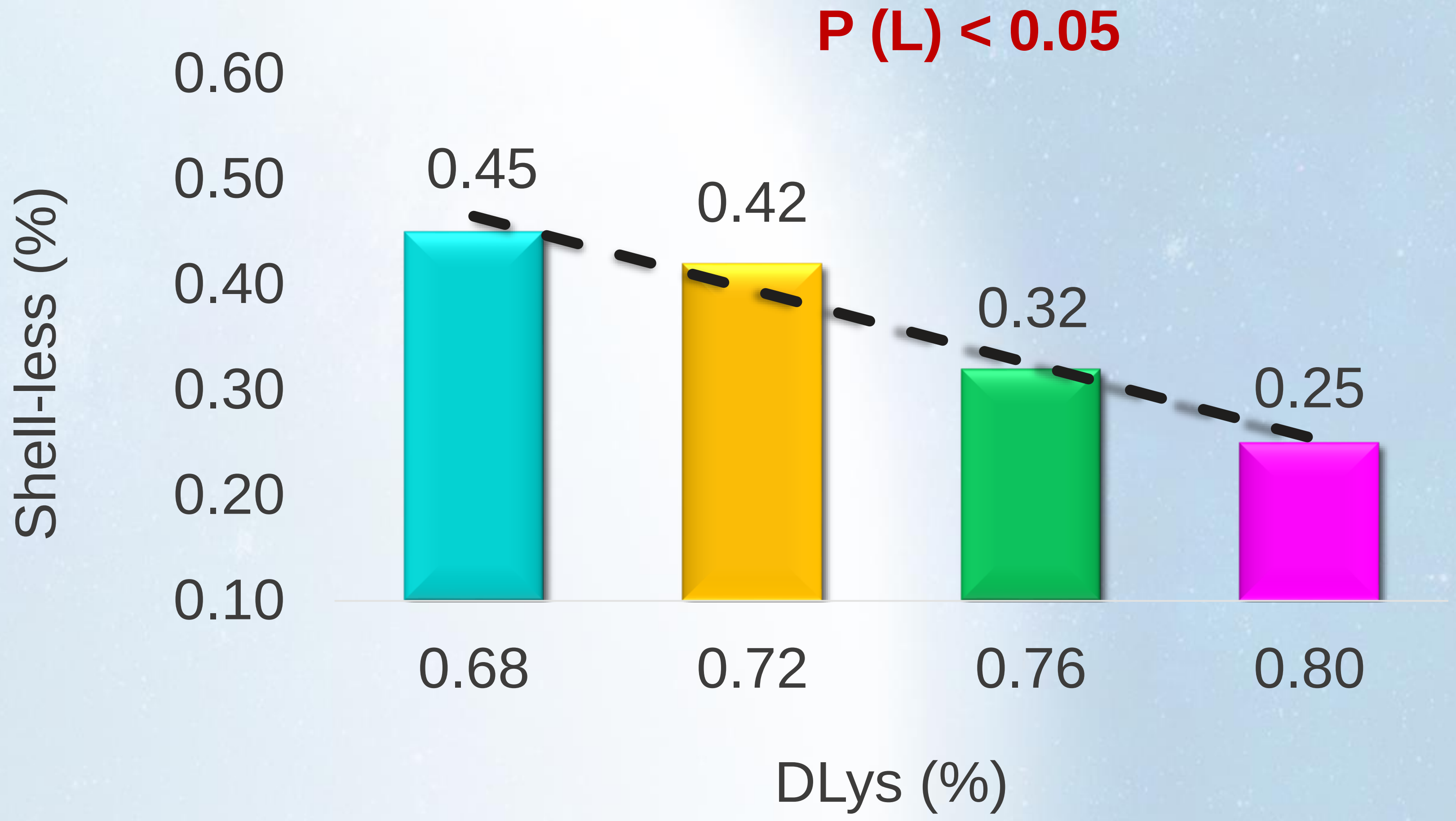


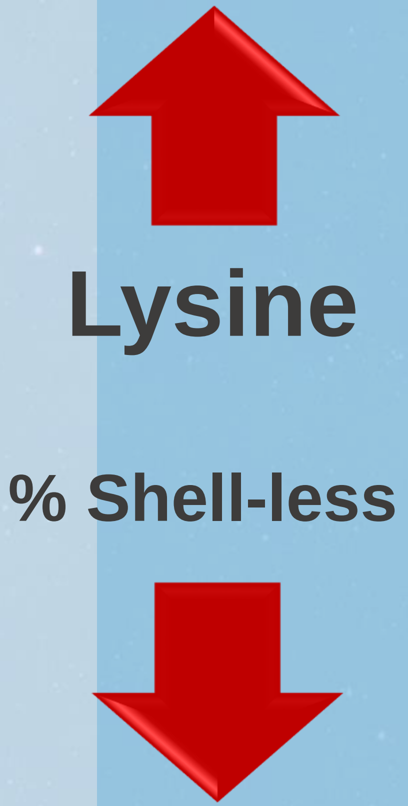


≥ 843 mg DLys/d to optimize egg mass

Egg Quality (19-59 wk of age)

DLys content of the diet





Influence of the energy concentration and the standardized ileal digestible lysine content of the diet on performance and egg quality of brown-egg laying hens from 18 to 41 weeks of age

R. Scappaticcio,[*,†] L. Cámara,[†] J. Herrera,[*] G. G. Mateos,[†,1] A. F. de Juan,[†] and G. Fondevila[†]

2022 Poultry Science 101:102197
https://doi.org/10.1016/j.psj.2022.102197

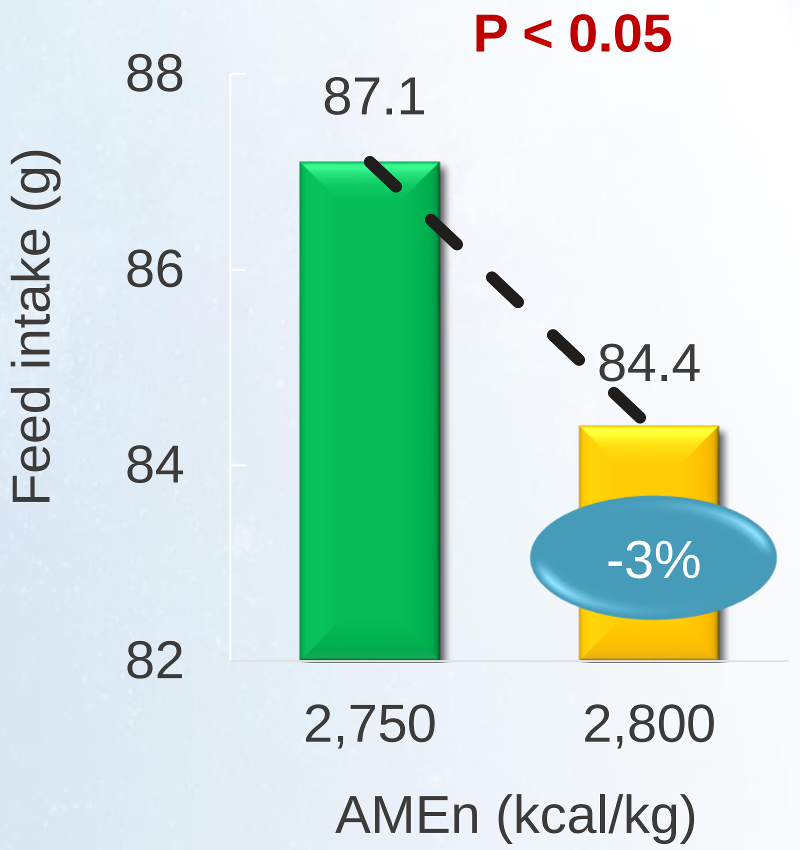
The Experiment: Design and Set Up

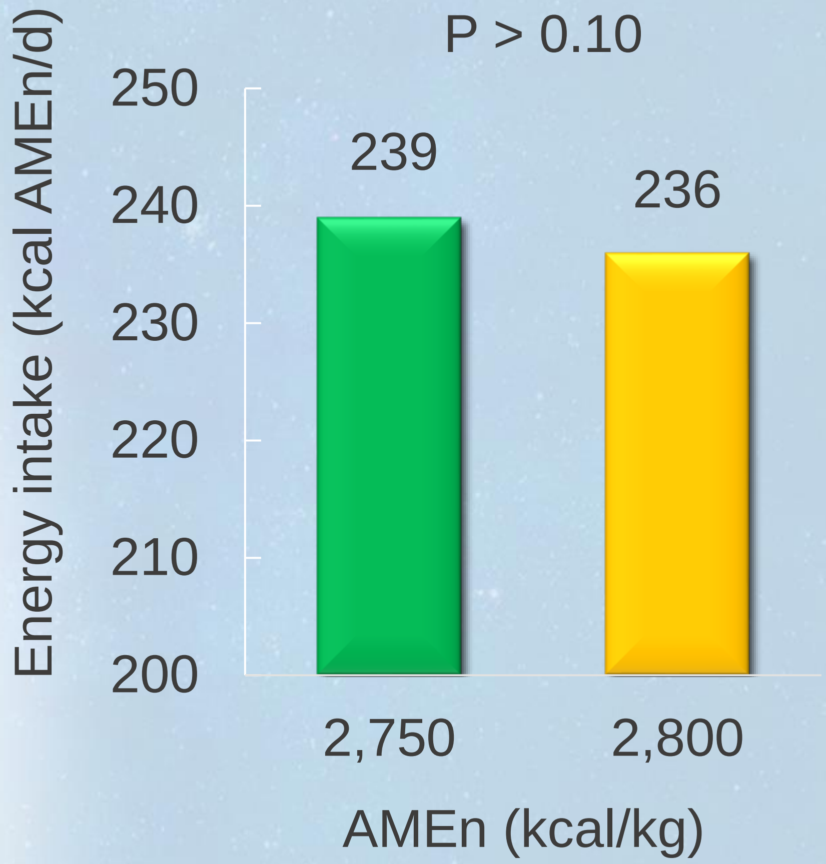
- Commercial barn (110,000 Brown hens)
- 10 treatments (10 replicate)
  - **2 AMEn (2,750 vs 2,800 kcal/kg) (1,248 vs 1,270 kcal/lb)**
  - **5 DLys:AMEn (from 0.24 to 0.28 mg DLys/kcal AMEn) (from 0,665 to 0.785% DLys)**
- Feed corn-soybean meal
  - Feed valued used FEDNA guideline
  - AA according to ideal protein concept by FEDNA
- Hens performance and egg quality
  - Pre-peak phase (18-21 wk of age)
  - Peak production phase (22-41 wk of age)
  - Whole experiment (18-41 wk of age)

Source: Dr. Scappaticcio

Hen Production: Pre-peak Phase

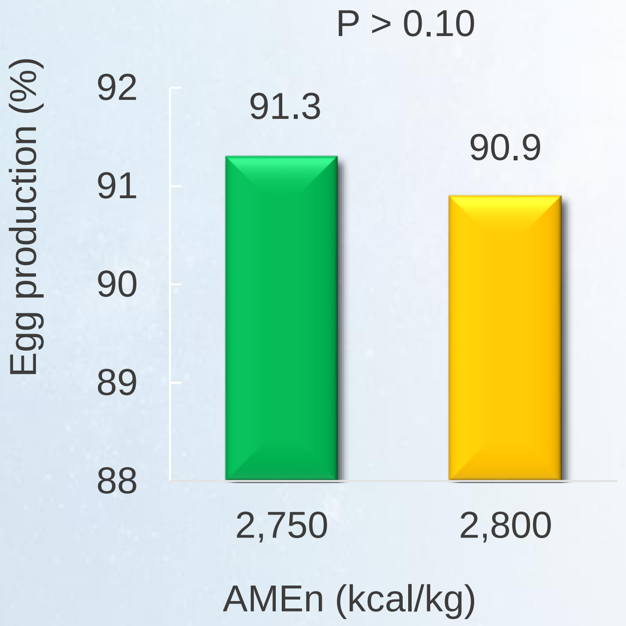
Energy concentration of the diet

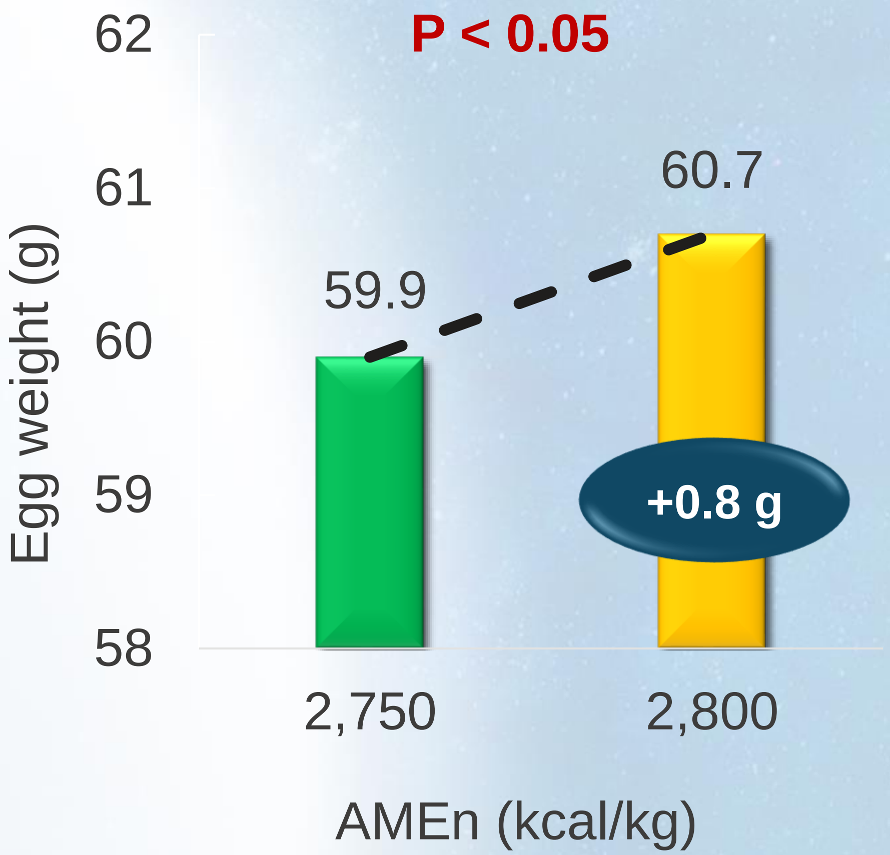


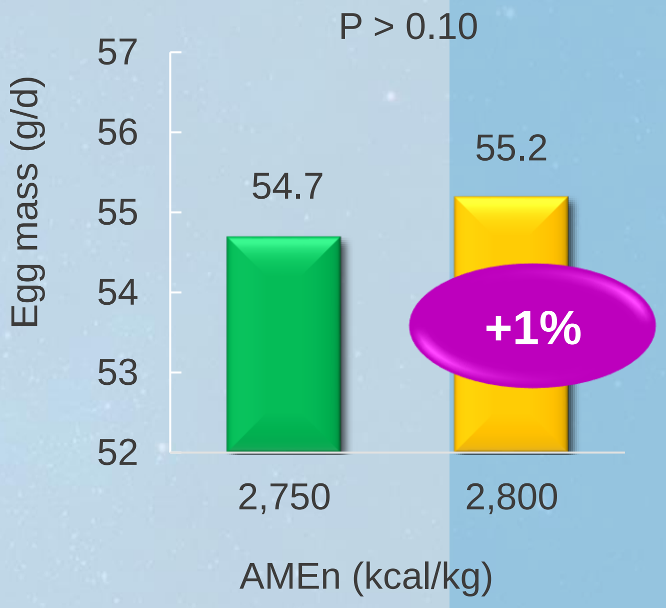


Hen production: Peak Production Phase

Energy concentration of the diet

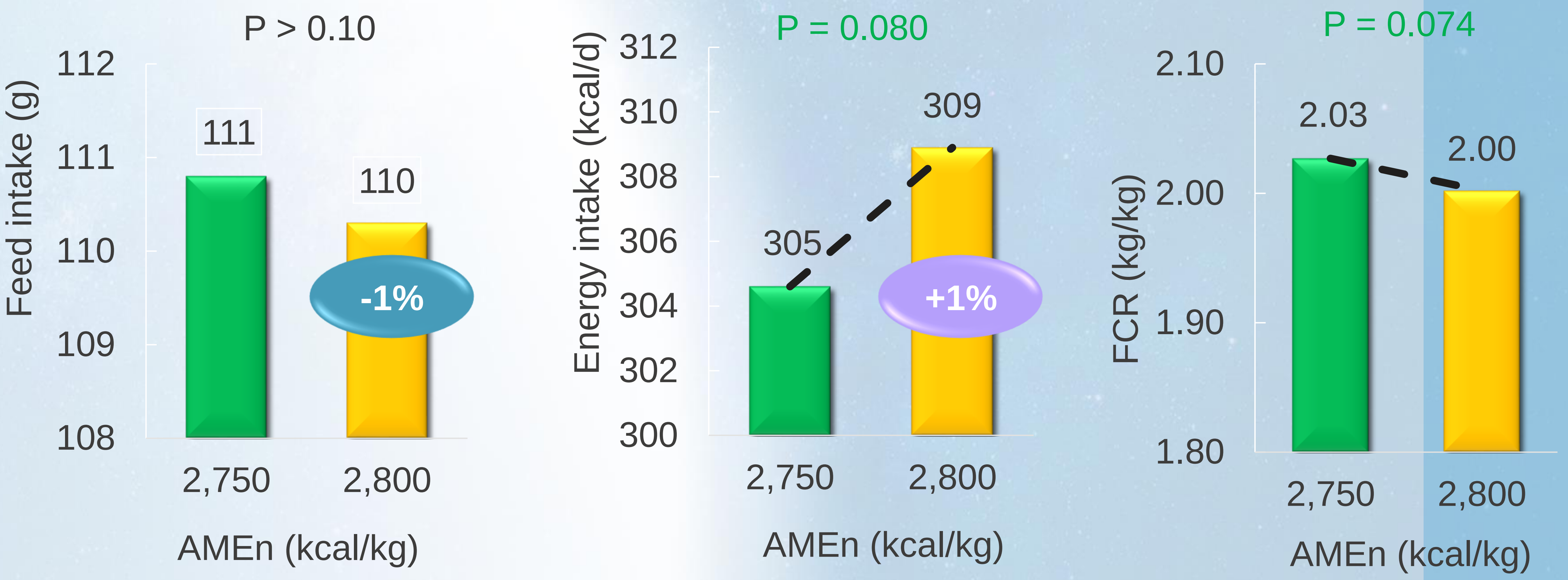






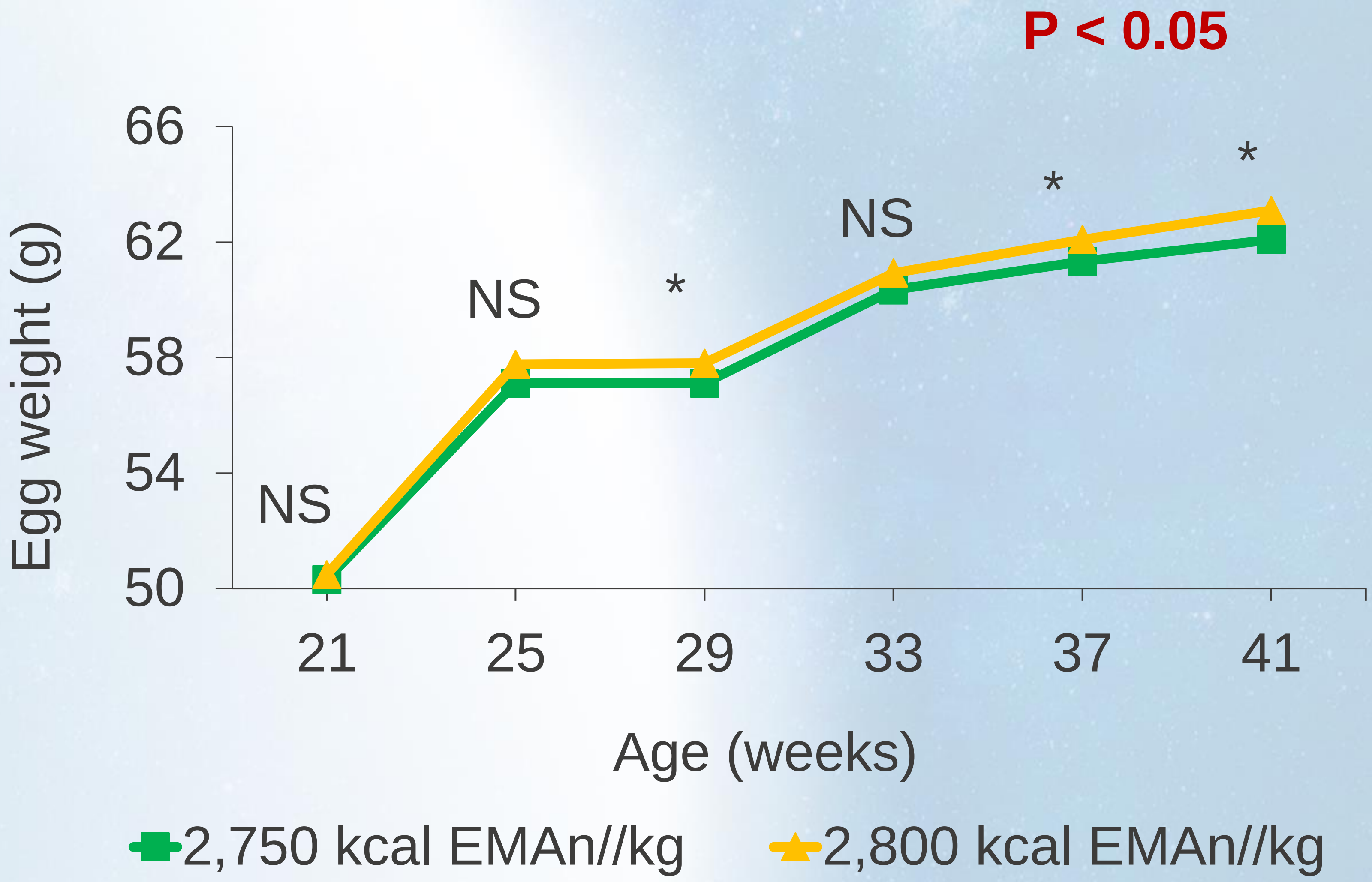
Hen production: Peak Production Phase

Energy concentration of the diet



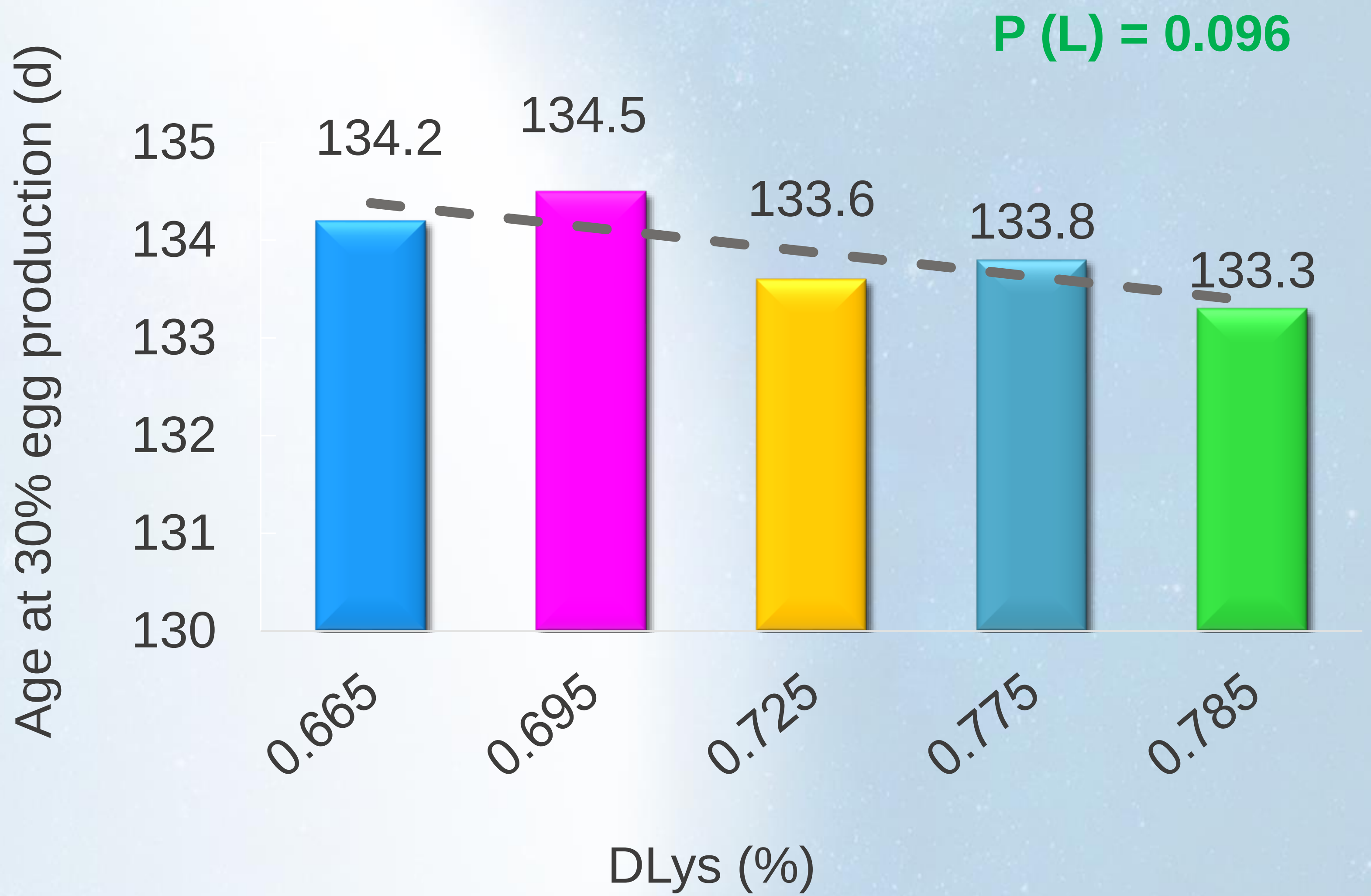
Hen production: The Whole Experiment

Energy concentration of the diet



Hen production: Pre-peak Phase

DLys content of the diet



Hen production: Pre-peak phase

DLys content of the diet

- Requirements for **maintenance**:

  100 mg DLys/kg $BW^{0,75}$ and day

  (Fisher, 1998; Edwards *et al.*, 1999; Rostagno *et al.*,2005; 2017)

- Requirements for **BW gain**:

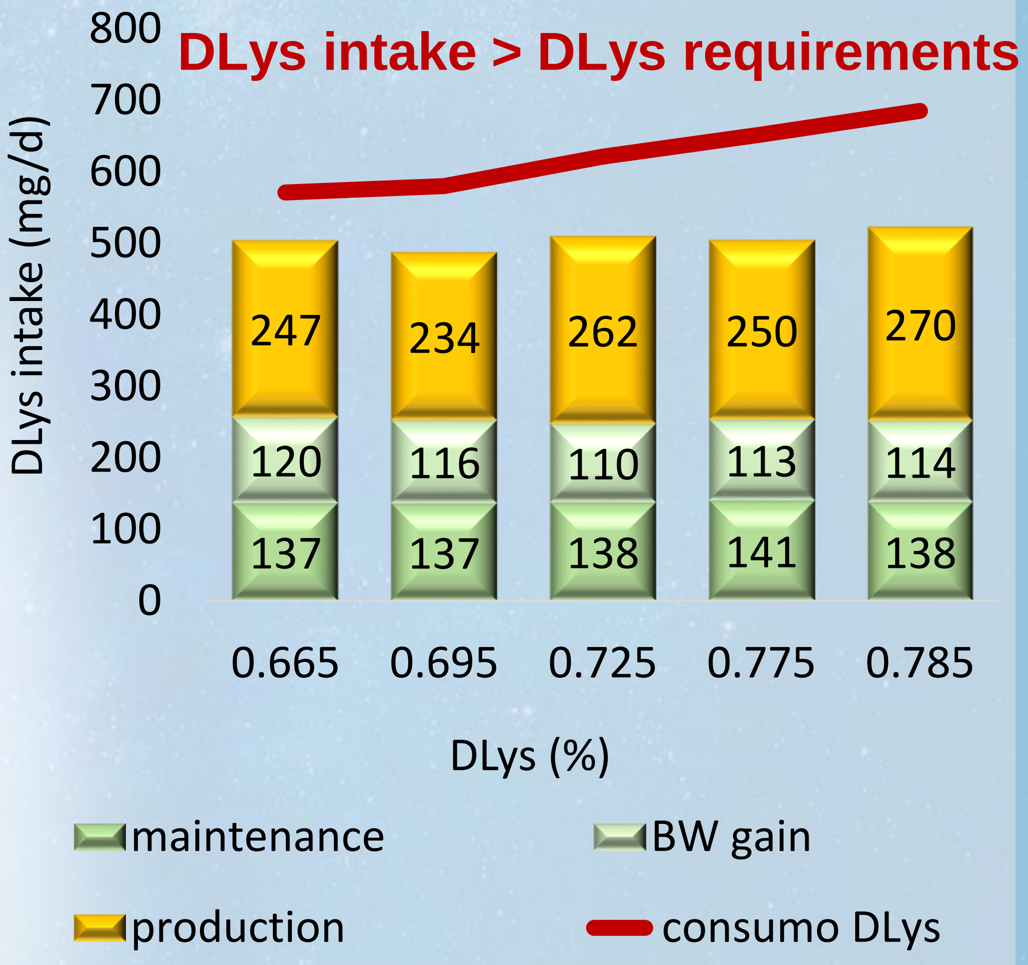
  20 mg DLys/g BW gain and day

  (Emmert y Baker, 1997; Leeson y Summers, 2001; Rostagno *et al.*, 2005; 2017)

- Requirements for **egg production**:

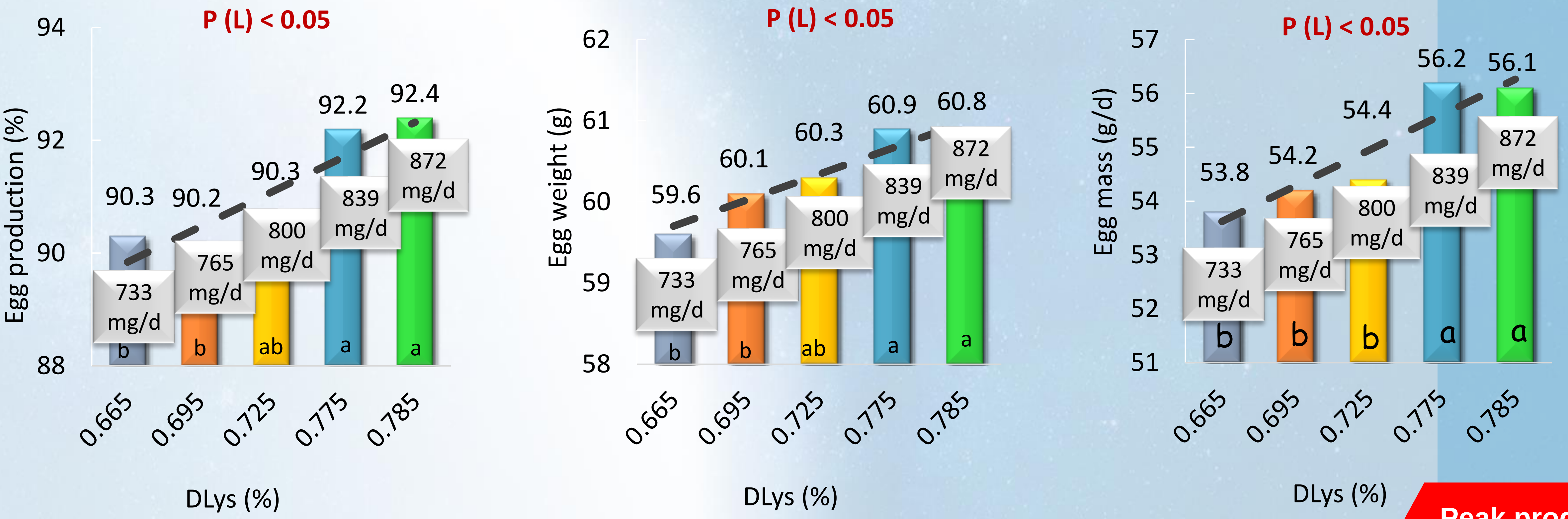
  12.4 mg DLys/g EM and day

  (Fisher, 1998; Joly, 2012; Rostagno *et al.*, 2005; 2017)



Hen production: Peak Production Phase

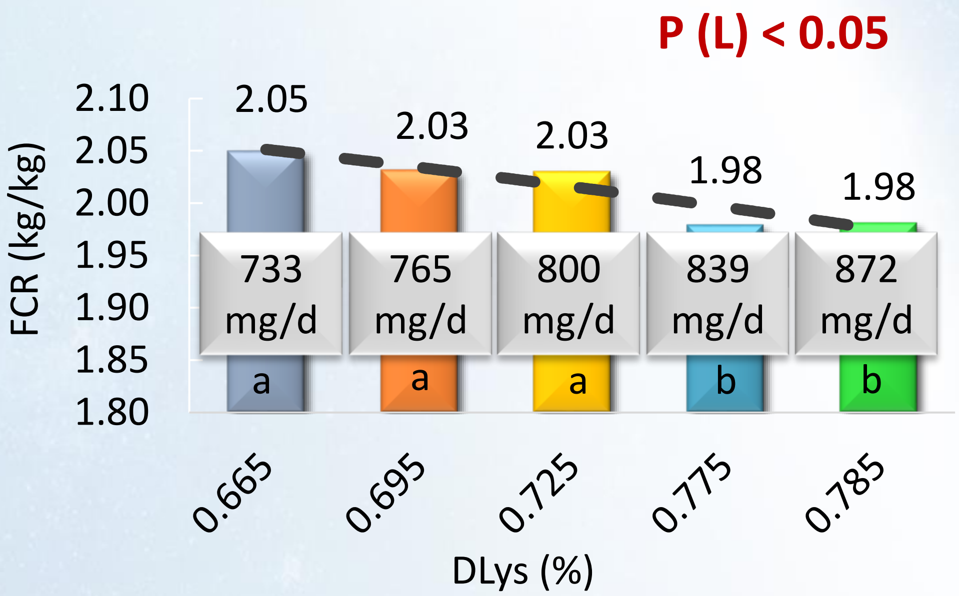
DLys content of the diet

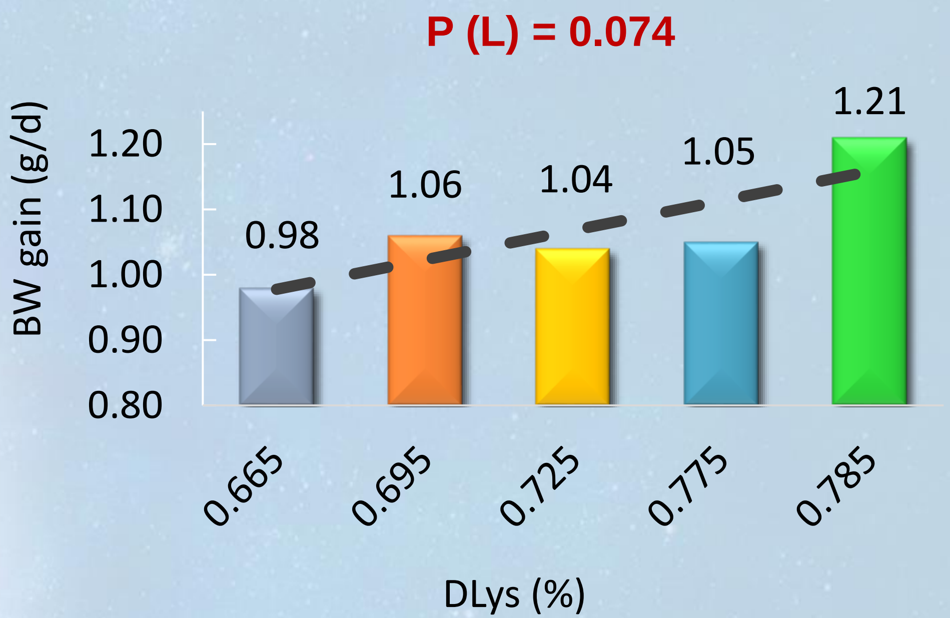


Peak production minimum 839 mg DLys/d

Hen production: Peak Production Phase

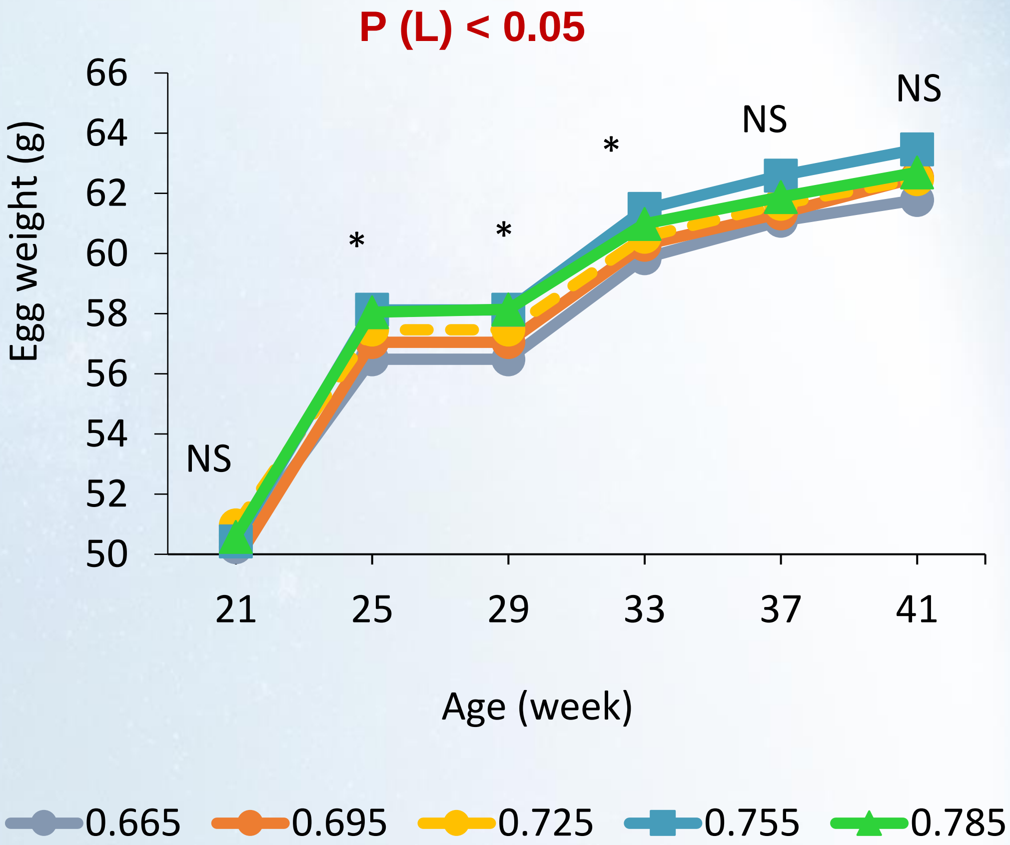
DLys content of the diet

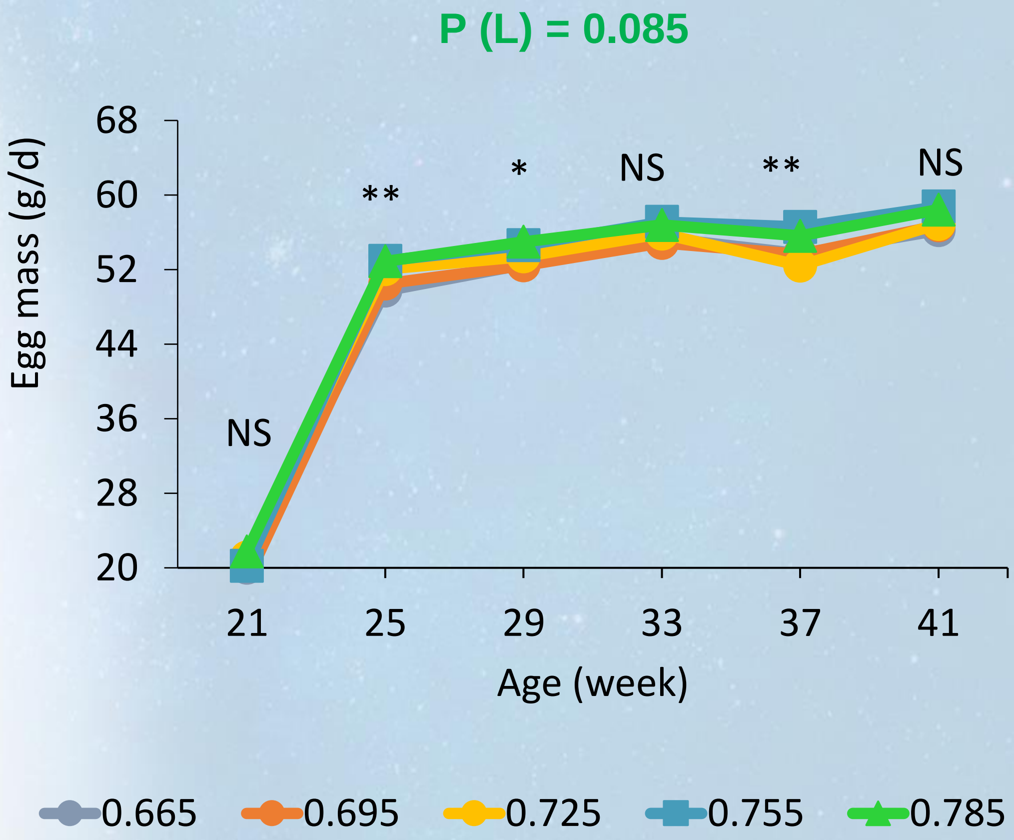




Hen production: The Whole Experiment

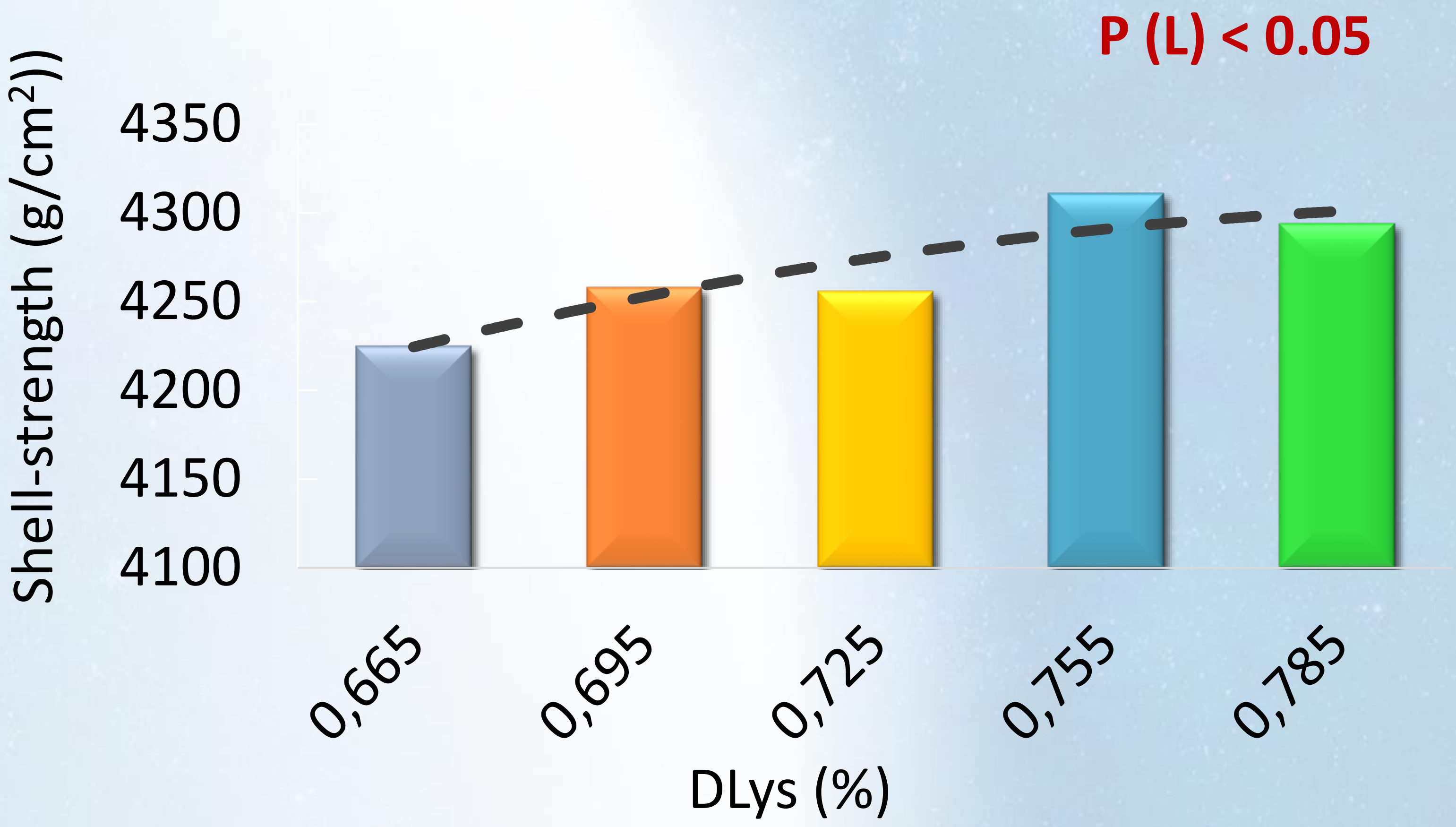
DLys content of the diet





Egg quality (18-41 wk of age)

DLys content of the diet



Lysine

Shell strength

Conclusions

Energy concentration of the diet

1. **Didn't affect** egg production
2. **Increase** in egg weight and egg mass (effect of additional fat supplementation)
3. **Decrease** in feed intake. However, energy intake could increase and improve feed and energy conversion ratios

Conclusions

Energy concentration of the diet

- The energy concentration of the diet should be adjusted according to feed cost and egg price.
- When the main objective is to maximize egg production rather than egg weight, brown laying hens could be fed low-energy diets with beneficial effects on flock profitability.

Conclusions

DLys content of the diet

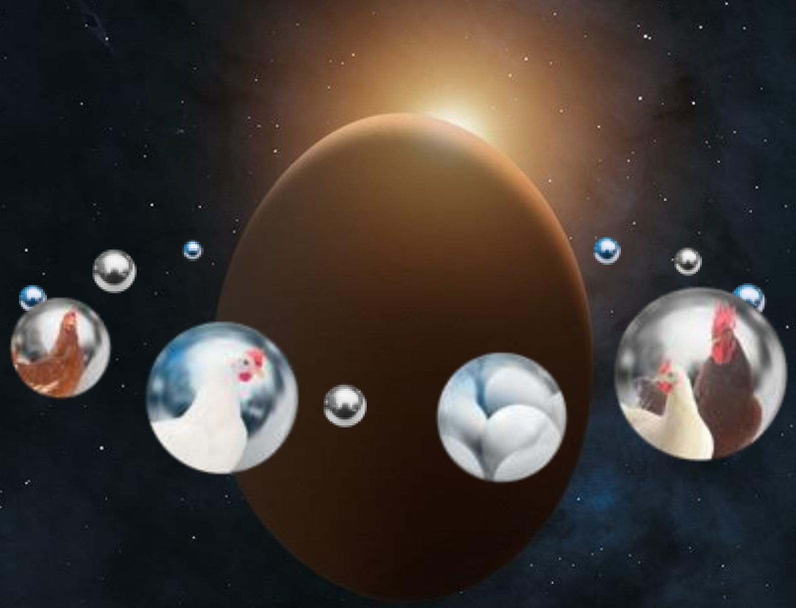
1. Digestible lysine requirements depend on age, production phase, and the response criteria studied.
2. During the pre-peak phase, **571 mg DLys/d** to maximize hen production and body weight gain but if the objective is to anticipate egg production a minimum of **685 mg DLys/d** might be needed.
4. To maximize egg production during the whole egg cycle, **744 mg DLys** per day could be sufficient.
5. During the peak production phase, a minimum intake of **839 mg DLys/d** is required to optimize egg production, egg weight, and to improve FCR.

Conclusions

Egg quality

AMEn and **DLys** have limited effects on egg quality, except for shell quality, which in turn might improve with increases in the level of DLys

Thank you for your attention



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AMEn effects

Energy increase effects

Experiment	Age	Egg production									
		Egg rate (%)	Day to 30% egg production (d)	Feed intake (g/d)	Energy Intake (kcal/d)	Egg weight (g)	Egg mass (g/d)	FCR (kg/kg)	ECR (kcal/g egg)	BW (g)	BW gain (g/d)
1	19-59	↔		↔		↑	↔	↓		↔	
2	18-21	↔	↔	↓	↔	↔	↔	↔	↔		↔
	22-41	↔		↔	↗	↑	↔	↘	↔		↔
	18-41	↔		↔	↔	↑	↔	↔	↔		↔

Experiment	Age	Egg quality					Egg components (% of the eggs)		
		Haugh units	Shell strength (g/cm^2)	Dirty eggs (%)	Broken eggs (%)	Shell-less eggs (%)	Albumen	Yolk	Shell
1	19-59	↔	↔	↔	↔	↔	↔	↔	↔
2	18-41	↔	↔	↔	↔	↔			

DLys effects

Lysine increase effects

Experiment	Age	Egg production									
		Egg rate (%)	Day to 30% egg production (d)	Feed intake (g/d)	Energy Intake (kcal/d)	Egg weight (g)	Egg mass (g/d)	FCR (kg/kg)	ECR (kcal/g egg)	BW (g)	BW gain (g/d)
1	19-59	↔		↔		↑	↑	↔		↔	
2	18-21	↔	↘	↗	↗	↔	↔	↘	↘		↔
	22-41	↑		↔	↔	↑	↑	↓	↓		↗
	18-41	↔		↔	↔	↑	↗	↔	↔		↔

Experiment	Age	Egg quality					Egg components (% of the eggs)		
		Haugh units	Shell strength (g/cm^2)	Dirty eggs (%)	Broken eggs (%)	Shell-less eggs (%)	Albumen	Yolk	Shell
1	19-59	↔	↔	↔	↔	↓	↔	↔	↔
2	18-41	↔	↑	↔	↔	↔			

	Small egg (48 g)	Medium size egg (58 g)	Large egg (68 g)	Extra Large egg (78 g)	Per 100 gr
Energy (kcal)	54	66	78	90	131
Fat (g)	3.7	4.6	5.4	6.2	9.0
Carbohydrate (g)			trace		
Sugars (g)			trace		
Protein (g)	5.2	6.4	7.5	8.7	12.6

Table 2. Amino acid content of the egg (Adapted by McNamara, 2013).

amino acid	mg per 100 g egg	% of protein
Alanine	740	5.7
Arginine	820	6.4
Aspartic acid	1,330	10.3
Cystine	270	2.1
Glutamic acid	1,670	12.9
Glycine	430	3.3
Histidine	310	2.4
Isoleucine	670	5.2
Leucine	1,090	8.4
Lysine	910	7.1
Methionine	380	2.9
Phenylalanine	680	5.3
Proline	510	4.0
Serine	970	7.5
Threonine	560	4.3
Tryptophan	170	1.3
Tyrosine	500	3.9
Valine	860	6.7

Egg weight (g)	Lys (mg)	DLys (mg)[1]	% about recommendation (744 and 839 mg/d)
55	455	410	55% or 49%
60	546	492	66% or 59%
65	592	532	72% or 63%

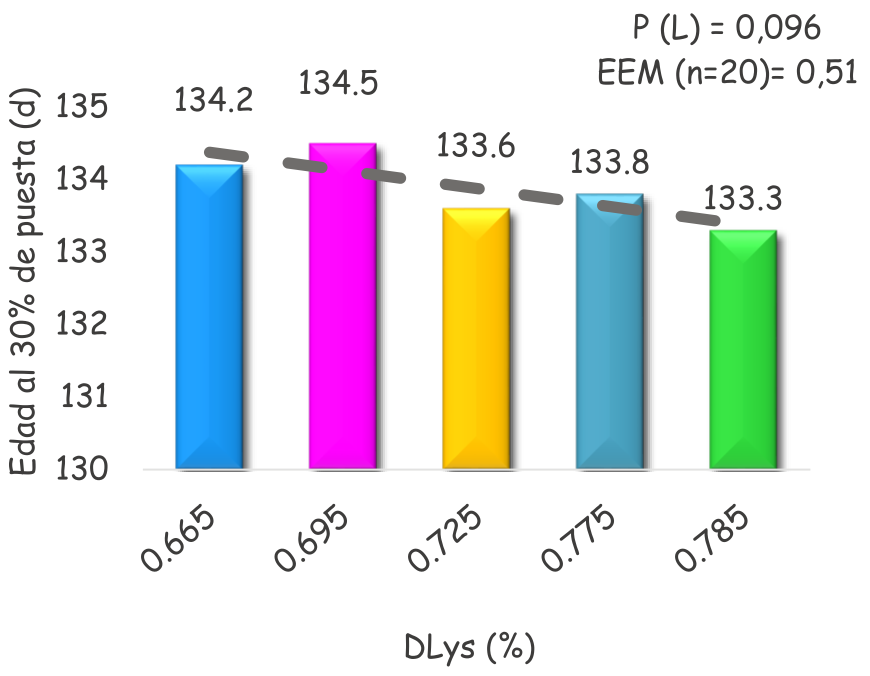
[1]digestibility estimated 90%

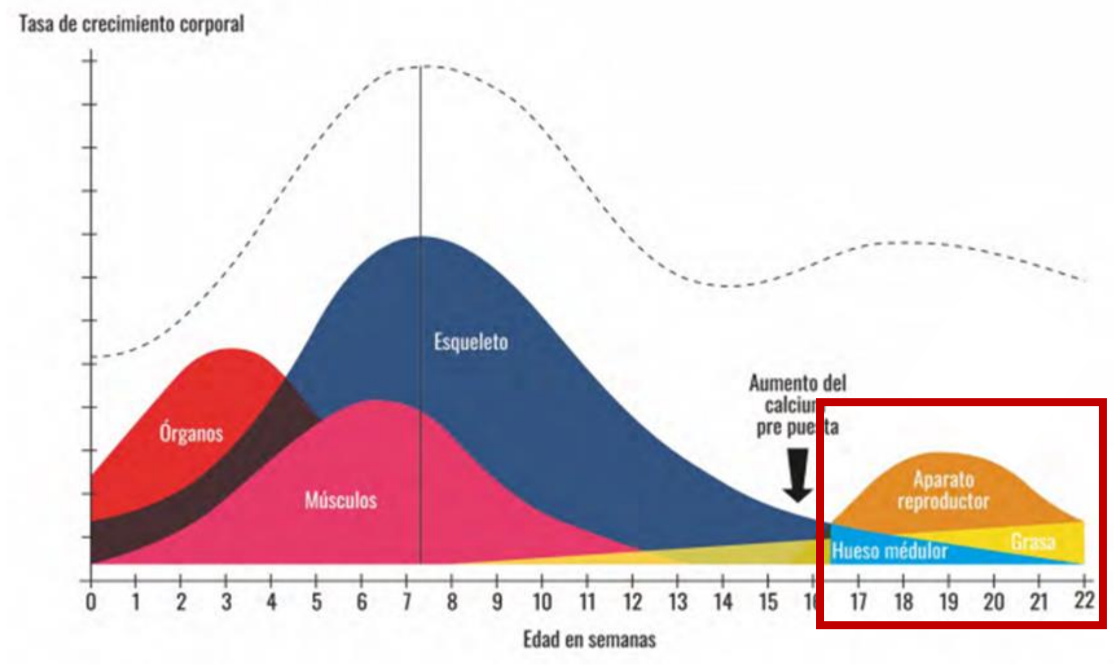
Table 5. Lysine intake (mg/d) for maximal response on egg rate, egg weight, egg mass, and feed conversion ratio according to different authors.

Reference	Strain	Age	Analized Lys	Egg rate	Egg weight	Egg mass	Feed conversión ratio
Nathanael and Sell (1980)	White	22-42		702			
	White	42-54			718		
Schutte and Smink (1998)	White	24-36	AFD[1] Lys	540		720	720
Coon and Zhang (1999)	White	33-49	digestible			705	
	White	35-47	digestible			636	
Novak et al. (2004)	White	20-43		860	959		959
	White	44-63		715	816		816
Wijtten et al. (2006)	Brown	24-40	AFD Lys	650			700
Bregendahl et al. (2008)	White	26-34	true digestible	482	649	538	693
	White	50-58	true digestible	511	573	508	690
Schmidt et al. (2008)	White	79-95	digestible		788	838	
Rocha et al. (2009)	White	24-40	digestible				753
Cupertino et al. (2009)	White	54-70	digestible	787	767	784	764
	Brown	54-70	digestible	742		748	748
Lemme (2009)		peak production	digestible			830	
Jardim Filho et al. (2010)	White	25-49	digestible	684		727	727
Silva et al. (2010)	White	48-56	total	960			
Bouyeh (2011)	Brown	52-64	total				768
Figuereido et al. (2012)	White	42-58	DLys	688	766	780	805
Silva et al. (2015)	White	37-40	digestible			707	
	White	41-44	digestible			660	
	White	45-48	digestible			669	
Van Krimpen et al. (2015)	Mixed		DLys	850	855	855	855
Kakhki et al. (2016)	White	32-44	digestible	814	778	810	792
Leite (2018)	Brown	28-40	digestible				577
Kumar et al. (2018)	White	27-66	DLys	769	903	839	839
Pastore et al. (2018)	White	20-40	DLys	813	856	835	848
Spangler et al. (2018)	White	22-47	DLys			706	778
Macelline et al. (2021)						726	726

[1]Apparent faecal digestible

Pre-peak (18-21 wk of age)
DLys content of the diet





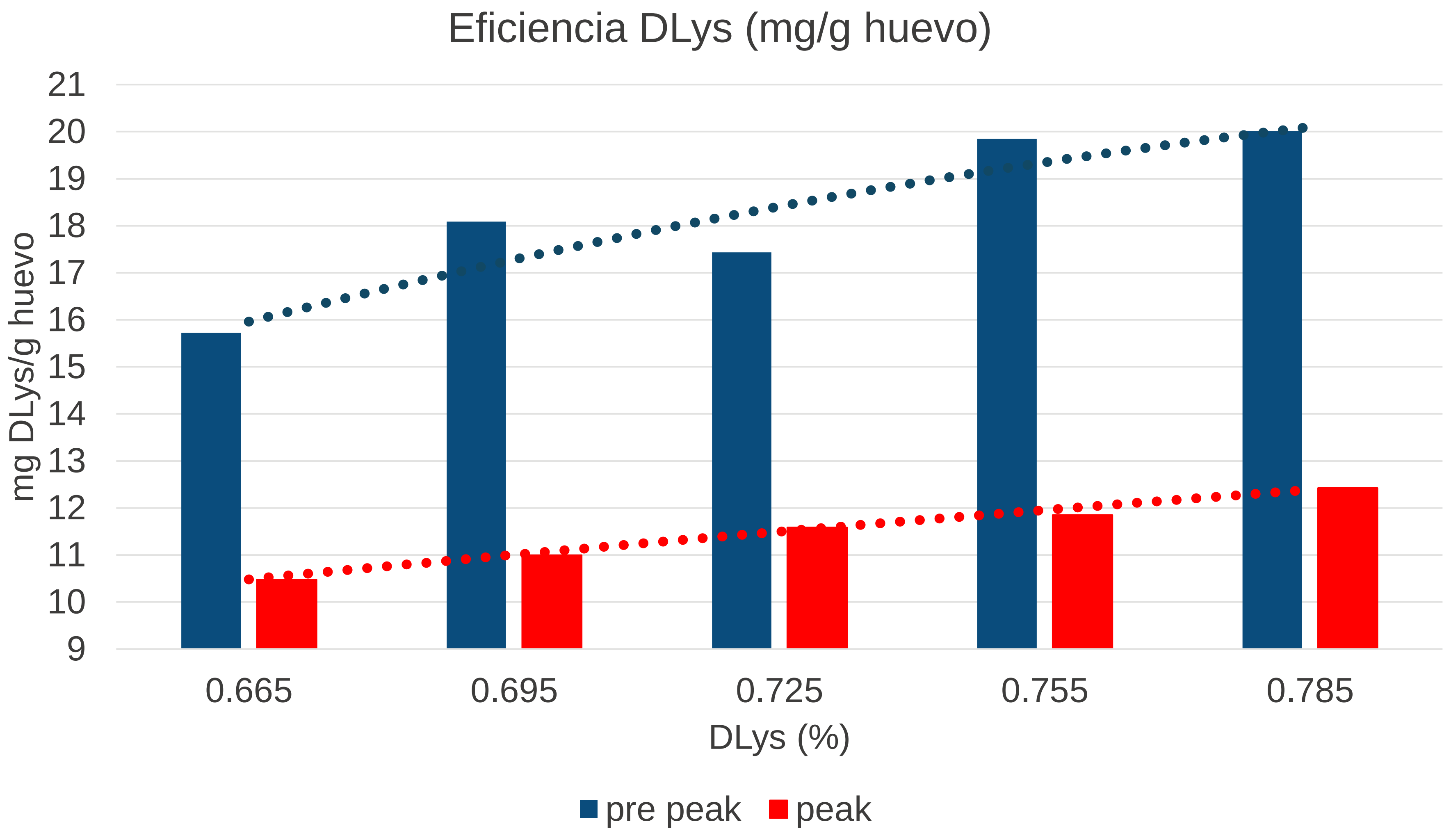
Altos niveles de AA en la dieta facilitan el inicio puesta (*Bunchasak and Silaparson, 2005*)

Deficiencia de Lys afecta desarrollo tracto reproductivo (Kwakkel *et al.*, 1991)

Desde 16-22 gran parte AA dieta se destinan a desarrollo tracto reproductivo (Kwakkel *and van Esch, 1995; Silva et al., 2000*)

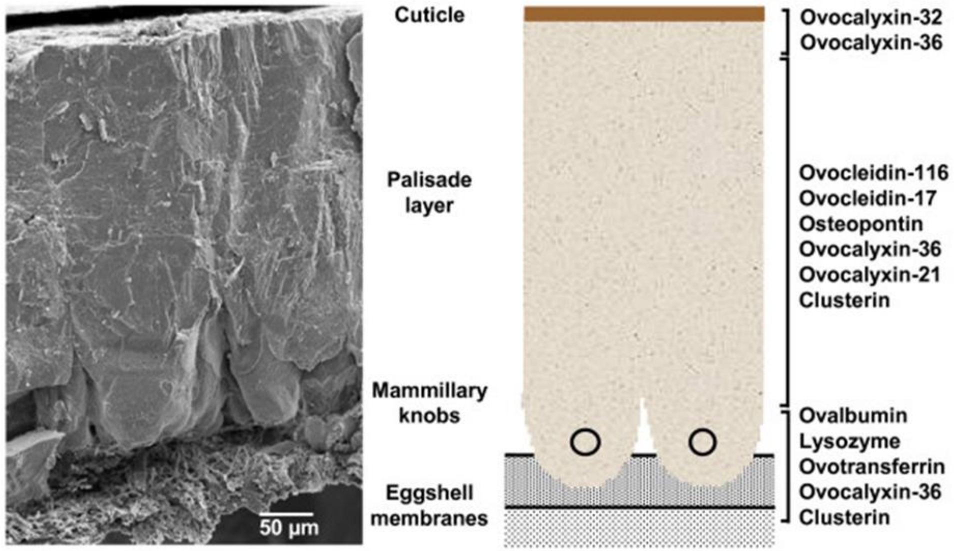
Aportar los adecuados nutrientes en la fase de pre pico es fundamental para maximizar IP (*Leeson and Summers, 2001*)

DLys efficiency experimento 2



Egg quality-organic matrix and ovocleidin 17

the shell (1). The organic matrix of this layer can be isolated after decalcification with chelating agents or acid and constitutes 2-5% of the dry weight of the whole layer. It



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1.1. Ovocleidin-17. Analyzing the eggshell matrix has identified several proteins unique to the matrix and therefore expected to be crucial to the production of the eggshell. Of these, the C-type lectin group is thought to be present in all the avian species. This group is thought to have a well-preserved residue structure with a calcium binding region.[3] Of these, ovocleidin-17 (OC-17) was the first to be characterized[4] and subsequently

OC-17 may be different to other C-type lectins. Morphological control of calcium carbonate has, however, been observed[6] where crystal aggregation and step rounding was reported. The function of OC-17 in eggshell mineralization remains uncertain, but the above experimental data suggests that the primary role of OC-17 may be in the initial crystallization process.

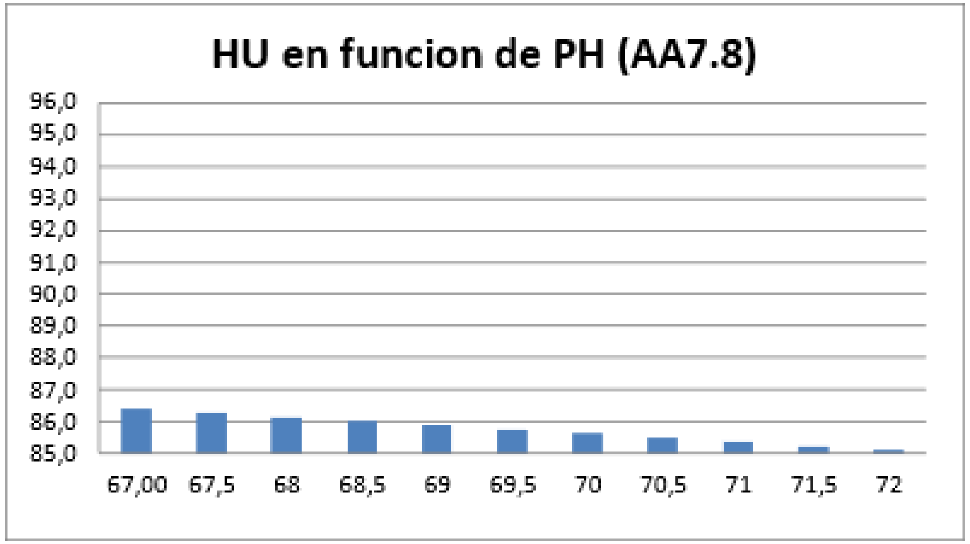
Freeman et al., 2011

Egg quality-main factors affecting UH

The DLys content of the diet had limited effects on egg quality, in agreement with data of Bouvarel et al. (2010) and Spangler et al. (2018). In this respect, the DLys content of the diet affected shell quality, exclusively, with a decrease in the incidence of shell-less eggs in Exp. 1 and an increase in shell strength in Exp. 2 as the dietary DLys increased. We do not have any clear explanation on the benefits of DLys on shell quality observed but previous authors (Leeson and Caston, 1997; Keshavarz and Nakajima, 1995) reported improvements in shell quality with increases in the CP content of the diet, in agreement with the results reported herein. Simkiss and Taylor (1957) reported that the shell protein matrix is composed of 70% protein. Also, Macelline et al. (2021) suggested that low CP diets could result in deficiencies in certain non-essential AA, such as glycine, serine, and glutamic acid, with less nitrogen available for the endogenous synthesis of protein. In this respect, Pereira et al. (2019) reported that glutamic acid was required during the process of egg-shell formation and calcification, which in turn might explain the improvements in shell quality observed in the current research.

Egg quality-main factors affecting UH

a. Diseases
b. Age
c. Environment and housing (heat stress)
d. Time since deposition (>24h falls rapidly)
e. Storage
f. Nutrition factors (**William, 1992**)
    i. Feed acidifying additives improve UH
    ii. High levels of Mg improve HU
    iii. DDGS improve UH



Statistical analysis-1

- Factorial design: 2 AMEn x 4 DLys
  - Proc. MIXED (SAS Inst., 2018)
    - Tukey test to separate average means
  - Proc. REG (SAS Inst., 2018) lineal and quadric effects of the DLys level
- Experimental unit: enriched cage with 9 hens
- No interactions between AMEn and DLys content of the diet were detected for any of the traits studied and therefore, only main effects are presented.

Statistical analysis-2

- Factorial design 2 AMEn x 5 DLys:AMEn ratio
  - Proc. MIXED (SAS Inst., 2018)
    - Tukey test to separate average means
  - Proc. REG (SAS Inst., 2018) lineal and quadric effects of the DLys level
- Experimental unit: enriched cage with 10 hens
- No interactions between AMEn and DLys:AMEn ratio of the diet were detected for any of the traits studied and therefore, only main effects are presented.

Ideal protein concept

Tabella 7: Rapporto proteico ideale nel mangime pollastra

	Starter	Svezzamento	Sviluppo
Lisina	100 %	100 %	100 %
Metionina	44 %	45 %	47 %
Met. + Cis.	75 %	80 %	85 %
Treonina	66 %	70 %	70 %
Triptofano	19 %	21 %	24 %
Isoleucina	69 %	76 %	76 %
Valina	78 %	78 %	80 %
Arginina	105 %	105 %	106 %

Tabella 24: Rapporto proteico ideale nelle galline ovaiole

	Deposizione
Lisina	100 %
Metionina	50 %
Metionina + Cisteina	90 %
Treonina	70 %
Triptofano	22 %
Isoleucina	80 %
Valina	88 %
Arginina	104 %

Liebig barrel

Ideal protein concept-N2

	values		Ideal protein			
	H&N	COST.	COSTUMER	H&N	FEDNA	COSTUMER CORRECTION
Digestible Lys poultry (%)	0.709	0.8505	100	100	100	120
Digestible Met poultry (%)	0.502	0.5243	71	45	45	59
Digestible M+C poultry (%)	0.757	0.8183	107	80	80	89
Digestible Thr poultry (%)	0.538	0.6038	76	70	68	63
Digestible Trp poultry (%)	0.176	0.201	25	21	20	21
Digestible Arg poultry (%)	1.02	1.084	143	105	105	119
Digestible Val poultry (%)	0.739	0.7877	104	78	76	87
Digestible Ileu poultry (%)	0.616	0.6647	87	76	70	72