

Control of Campylobacter infection in broiler flocks through two-steps strategy: nutrition and vaccination

-CAMPYBRO-

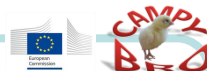
FP7-SME-2013-605835



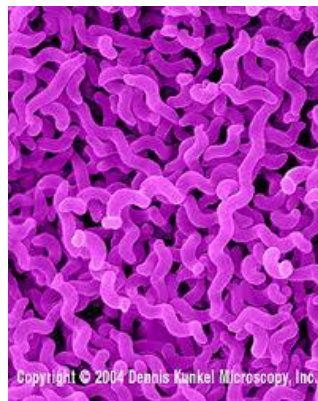
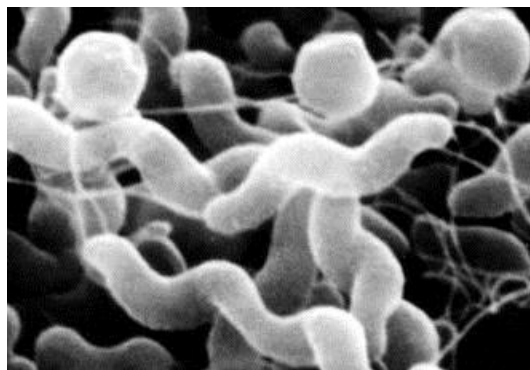
Angers, 21/04/2015



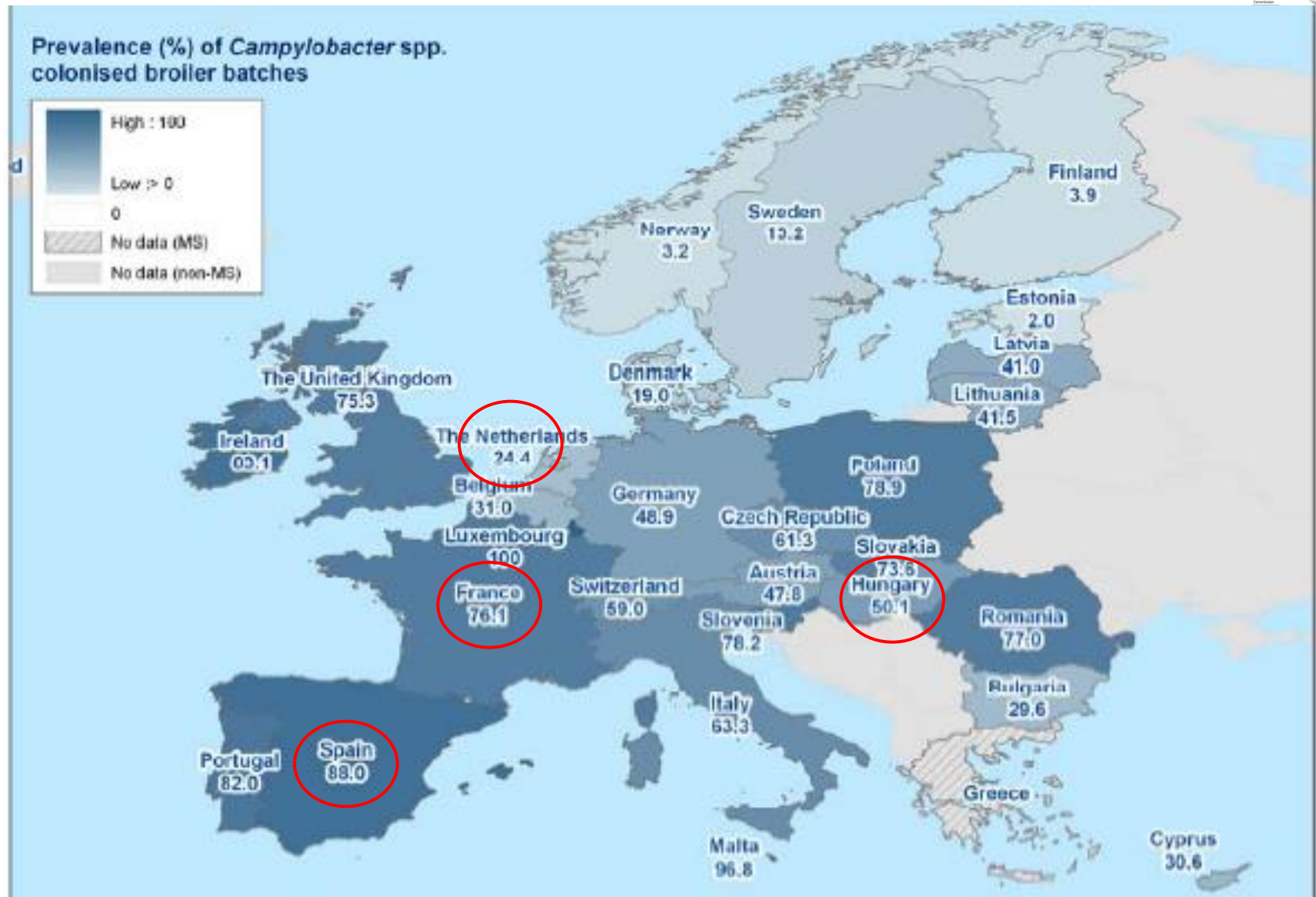
¿Who is *Campylobacter*?



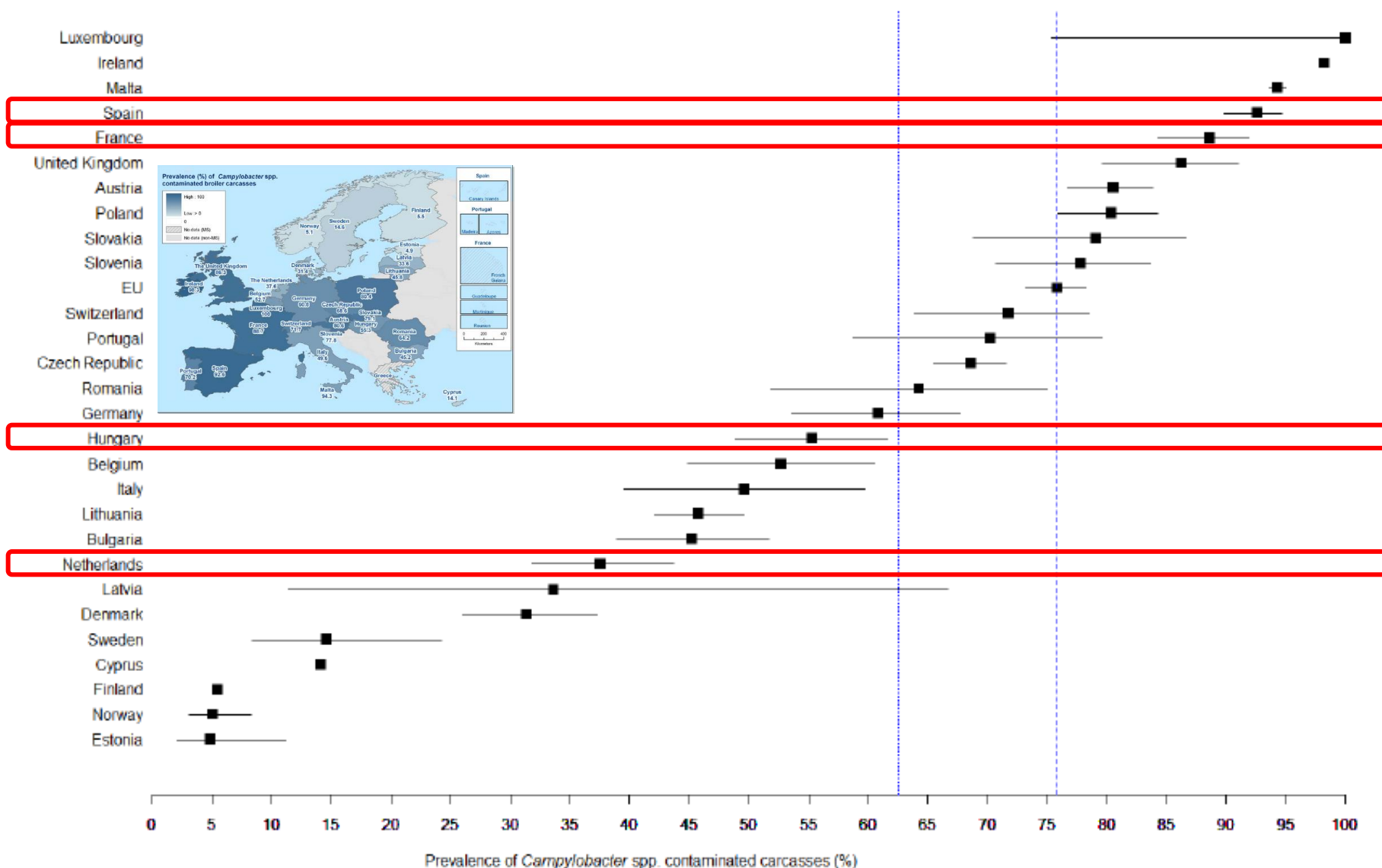
- ❑ ***Campylobacter* spp.**
 - ❑ **Gram-negative bacilli**
 - ❑ **Curved or spiral**
 - ❑ **Motiles by a uni or bipolar flagellum**
 - ❑ **Non sporulating and microaerophilic**
 - ❑ ***C. jejuni*, *C. coli*, *C. lari*, *C. upsaliensis* y *C. helveticus***



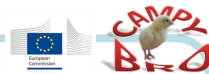
Project Proposal - Necessity (batches)



Project Proposal - Necessity (Carcass)



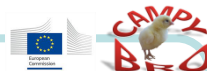
¿Who is *Campylobacter*?



- ❑ **Reservoirs**
 - ❑ **Commensal bacteria in the gastrointestinal tract of domestic and wild animals**
 - ❑ **Main source: birds (chickens, ducks, turkeys...)**
 - ❑ **Other: cattle, pigs, sheep, rodents, dogs, cats, insects**



¿Who is Campylobacter?



- ❑ **Why is so important?**
 - ❑ **First zoonosis in the EU**
 - ❑ **9 millions/year, 2.4 billion€/year**
 - ❑ **High level of infection**
 - ❑ **Broilers, chicken meat (at retail level)**



Brussels, Charlemagne building, 7 May 2014

**DG SANCO WORKSHOP ON THE CONTROL
OF CAMPYLOBACTER IN POULTRY**

Resistance issue: Humans

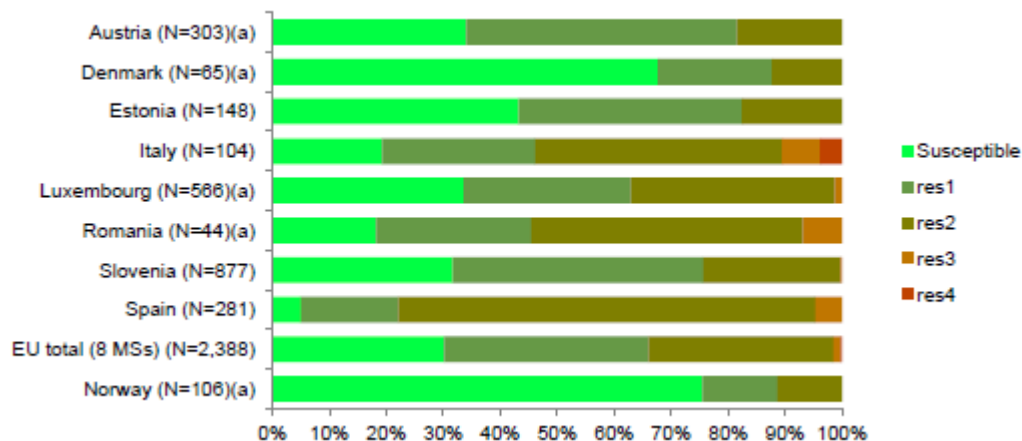


Country	Ciprofloxacin		Co-amoxiclav		Erythromycin		Gentamicin		Tetracyclines	
	N	% Res	N	% Res	N	% Res	N	% Res	N	% Res
Austria ^(a)	303	63.0	–	–	303	0	303	0	303	21.5
Denmark ^(a)	65	23.1	–	–	65	1.5	65	0.0	65	20.0
Estonia	293	57.7	154	8.4	270	0.7	153	0.7	248	21.4
France	3,816	49.7	3,524	0.9	3,822	0.5	3,822	0.5	–	–
Italy	235	67.2	–	–	233	7.3	117	4.3	208	57.2
Lithuania	178	88.2	–	–	222	0.5	–	–	–	–
Luxembourg ^(a)	566	59.4	566	5.7	566	1.2	566	0.4	566	43.8
Malta	138	69.6	–	–	138	18.1	–	–	–	–
Netherlands	2,811	56.9	–	–	2,392	1.9	–	–	1,414	36.4
Romania ^(a)	44	77.3	–	–	44	9.1	44	0	44	56.8
Slovakia	992	39.9	116	4.3	1,205	0.7	7	NA	1,184	19.8
Slovenia	877	64.1	688	14.0	877	0.6	877	0.5	877	27.7
Spain	281	91.5	–	–	281	3.9	281	2.1	281	80.1
United Kingdom	1,110	46.9	11	NA	851	2.5	6	NA	32	34.4
Total (MSs 14)	11,709	54.6	5,059	3.5	11,269	1.5	6,241	0.6	5,222	33.5
Iceland	6	NA	–	–	6	NA	–	–	1	NA
Norway ^(a)	106	20.8	–	–	106	0	106	0.9	106	14.2

SCIENTIFIC REPORT OF EFSA AND ECDC
 EU Summary Report on antimicrobial resistance in zoonotic and indicator bacteria from humans, animals and food in 2013¹

European Food Safety Authority^{2,3}
 European Centre for Disease Prevention and Control^{2,3}

Region	Ciprofloxacin		Co-amoxiclav		Erythromycin		Gentamicin		Tetracyclines	
	N	% Res	N	% Res	N	% Res	N	% Res	N	% Res
Europe (EU/EEA countries)	11,948	54.4	5,062	3.5	11,508	1.5	6,463	0.6	5,451	33.6
Africa	24	54.2	2	NA	23	0.0	20	0.0	24	29.2
Asia	102	90.2	2	NA	102	2.9	96	1.0	99	55.6



EFSA Journal 2015;13(2):4036

Resistance issue: Broilers



Country	Ciprofloxacin		Erythromycin		Gentamicin		Nalidixic acid		Tetracyclines	
	N	% Res	N	% Res	N	% Res	N	% Res	N	% Res
Austria	122	73.0	122	0	122	0	122	70.5	122	24.6
Czech Republic	36	86.1	36	0	36	0	36	88.9	36	27.8
Denmark	54	25.9	54	1.9	54	0	54	25.9	54	20.4
Finland	76	0	76	0	76	0	76	9.2	76	0
France	65	53.8	65	0	65	0	65	55.4	65	69.2
Germany	40	47.5	40	0	40	0	40	42.5	40	32.5
Hungary	56	85.7	56	0	56	0	–	–	56	50.0
Netherlands	167	49.1	167	0	167	0	167	49.7	167	49.1
Slovenia	32	75.0	32	0	32	0	32	68.8	32	34.4
Spain	72	90.3	72	2.8	72	0	72	87.5	72	88.9
United Kingdom	61	31.1	61	0	61	0	61	31.1	61	47.5
Total (MSs 11)	781	54.5	781	0.4	781	0	725	52.3	781	41.4
Iceland	16	0	16	0	16	0	16	0	16	6.3
Norway	96	5.2	96	0	96	0	96	5.2	96	3.1
Switzerland	157	41.4	157	1.3	157	0	157	41.4	157	21.0

EFSA Journal 2015;13(2):4036

Resistance issue: Broilers

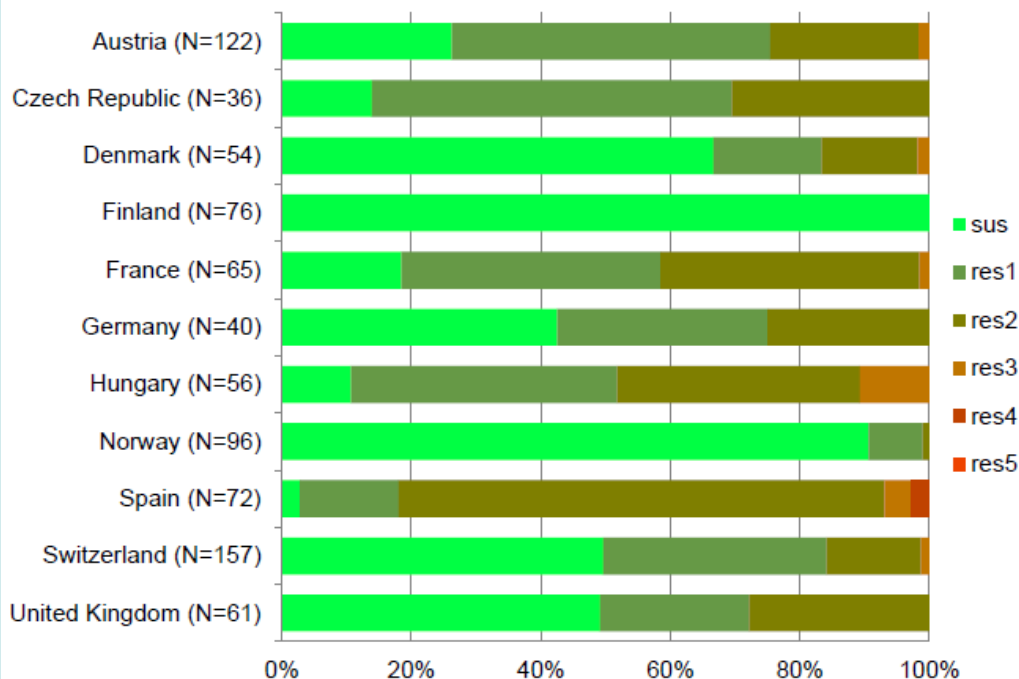
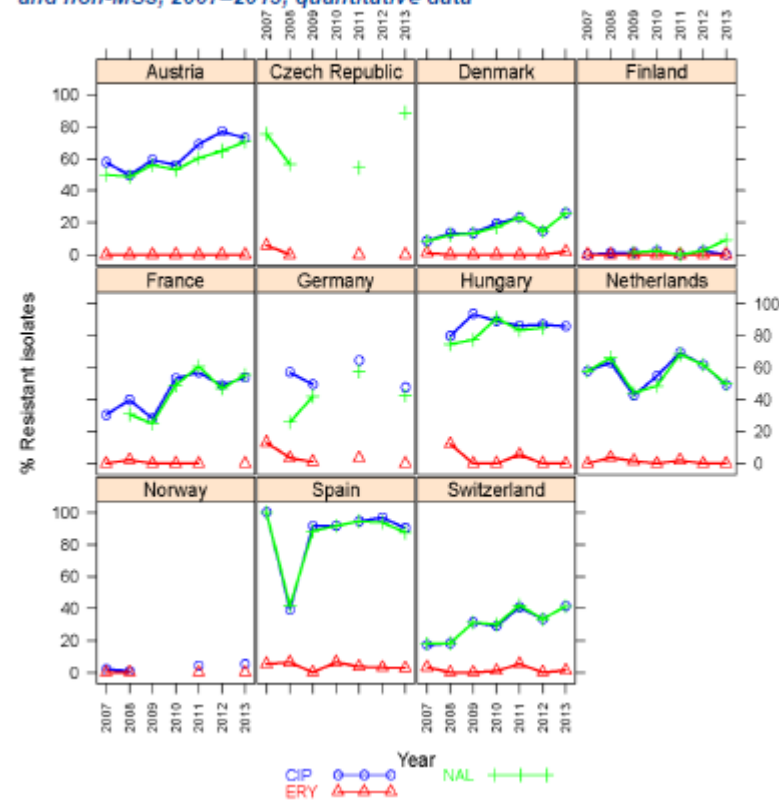


Figure 35. Trends in ciprofloxacin, erythromycin and nalidixic acid resistance in *Campylobacter jejuni* from *Gallus gallus* in reporting MSs and non-MSs, 2007–2013, quantitative data



Campylobacteriosis. New Zealand

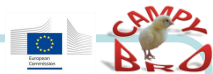
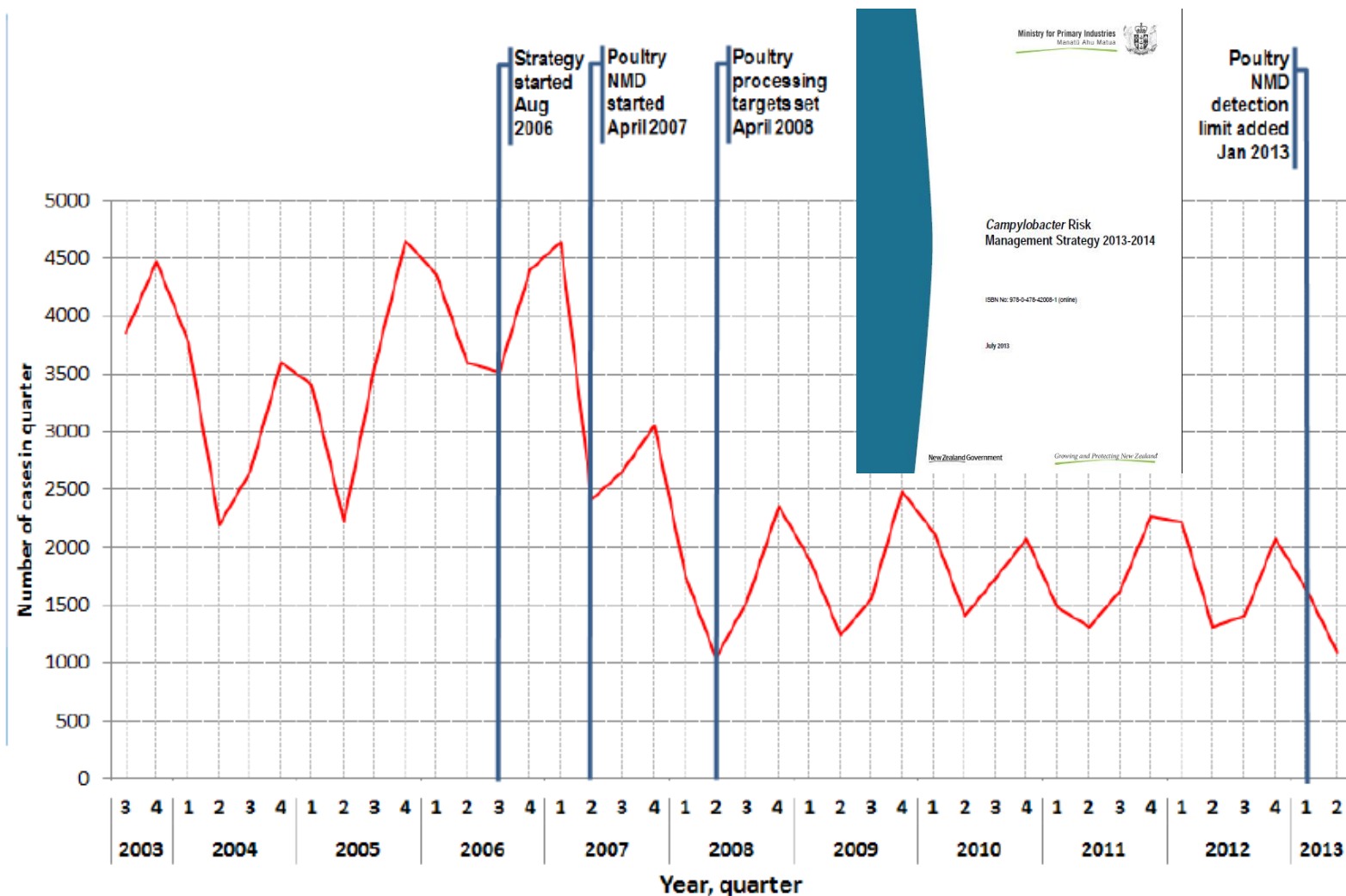


Figure 2: Reported Cases of Human Campylobacteriosis in New Zealand (to 2nd Quarter 2013)



**THE JOINT GOVERNMENT AND INDUSTRY TARGET
TO REDUCE *CAMPYLOBACTER* IN UK PRODUCED CHICKENS BY 2015
DECEMBER 2010**

Campylobacter causes more foodborne illness than any other foodborne pathogen, in the UK, across Europe and in many other countries beyond. In the UK alone, it is estimated to cause around 460,000 cases in the community of which 22,000 require admission to hospital for treatment and as many as 110 die, with an associated total cost of £900 million.

ACT
**Acting on
Campylobacter
Together**



Don't wash raw chicken

The target will be monitored using a banding approach, where samples are grouped into 3 bands according to whether the *Campylobacter* counts in chicken are above or below a set level (i.e. <100 cfu/g, 100-1,000 cfu/g, and $>1,000$ cfu/g). The target is limited to 3 bands for simplicity and to allow sensible interpretation when monitoring progress against the baseline. The target focuses on decreasing the proportion of birds in the most contaminated group i.e. $>1,000$ cfu/g. A number of factors affect the likelihood of

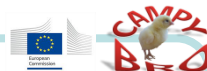
	<i>Campylobacter</i> enumeration		
	<100 cfu/g	100-1,000 cfu/g	>1,000 cfu/g
Baseline	42%	31%	27%
2013 Expected progress	Expected improvement	Expected improvement	19%
Target reviewed 2013 2015 target reset as appropriate			
Model estimates (2015)	68%	22%	10%
Target 2015	Expected improvement	Expected improvement	10% Target

Table 1: Prevalence of *Campylobacter* (cfu/g), for different banded levels, in chicken skin samples (with 95% confidence intervals in brackets).

Chicken Skin	cfu/g			
	<10	10-99	100-1000	>1000
Weighted ² % (95% confidence interval)	27.1 (25.5 – 28.6)	22.7 (21.2 – 24.1)	31.4 (29.7 – 33.0)	18.9 (17.5 – 20.3)
No. samples	807	701	970	583

Retailer	No. of samples	% skin samples positive for Campylobacter (95% confidence interval)	% skin samples >1000 cfu/g Campylobacter (95% confidence interval)	% pack samples positive for Campylobacter (95% confidence interval)
Asda	491	78.9 (75.2 – 82.4)	31.1 (27.0 – 35.2)	13.0 (10.1 – 16.1)
Co-op	274	75.6 (70.2 – 80.6)	16.4 (12.3 – 20.9)	4.4 (2.1 – 7.0)
M&S	103	72.2 (63.0 – 80.7)	20.7 (13.0 – 29.1)	3.8 (0.8 – 8.1)
Morrison's	271	76.2 (71.4 – 80.9)	22.9 (18.0 – 28.0)	13.3 (9.5 – 17.4)
Sainsbury's	451	69.6 (65.4 – 73.7)	14.3 (11.2 – 17.6)	4.0 (2.3 – 6.0)
Tesco	925	68.2 (65.3 – 71.1)	12.3 (10.2 – 14.4)	4.1 (2.9 – 5.4)
Waitrose	96	71.7 (62.1 – 80.5)	15.6 (8.5 – 23.7)	6.2 (2.1 – 11.7)
Others³	450	76.9 (72.9 – 80.7)	23.2 (19.4 – 27.2)	6.8 (4.6 – 9.2)
Total	3061	72.9 (71.4 – 74.5)	18.9 (17.5 – 20.3)	6.8 (5.9 – 7.7)

Retail compromise in the UK



Tesco

At farm level we led and funded the first farmer incentive trial, **rewarding farmers who were able to keep flocks free of Campylobacter**, and are now co-funding larger incentive based trials. We are part of a **'no thinning' trial** and are engaged with our suppliers through regular workshops to assess the impact of a series of innovative biosecurity initiatives. In the processing part of the supply chain we will be co-funding the very first full scale trial of **rapid surface chilling** with one of our suppliers to assess its feasibility at commercial scale.

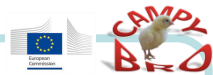
Moy Park

Excellence in biosecurity - Our **biosecurity** on farms is amongst the best in the industry. We have invested in training our farmers and bird collection teams best practice in harvesting and **trials on no-thinning**. We have installed a **'double barrier' system** on a significant number of farms which protects against Campylobacter being spread from flock to flock. **Rapid Surface Chilling** - Moy Park is one of the first processors to invest in a full scale trial of innovative rapid surface chilling technology which reduces Campylobacter levels during production.

Marks & Spencer

M&S farmers that supply to 2 Sisters Food Group have **stopped** part harvesting chickens from flocks through the growing cycle, known in the industry as operating a **'zero thinning'** policy. **This will be rolled out to all M&S farms by the end of the year.** M&S has introduced a **bonus scheme for farmers** that supply to 2 Sisters Food Group which offers farmers a bonus if they produce **Campylobacter free farms**.

Retail compromise in the UK

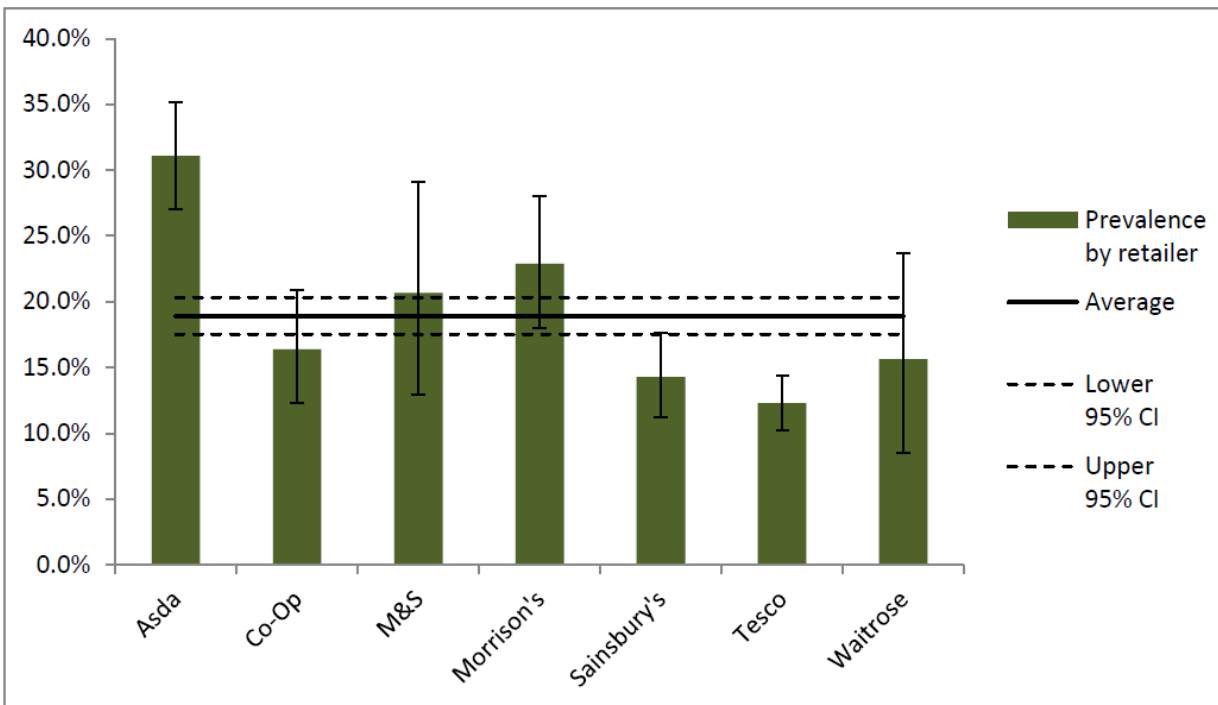


The Co-operative Food

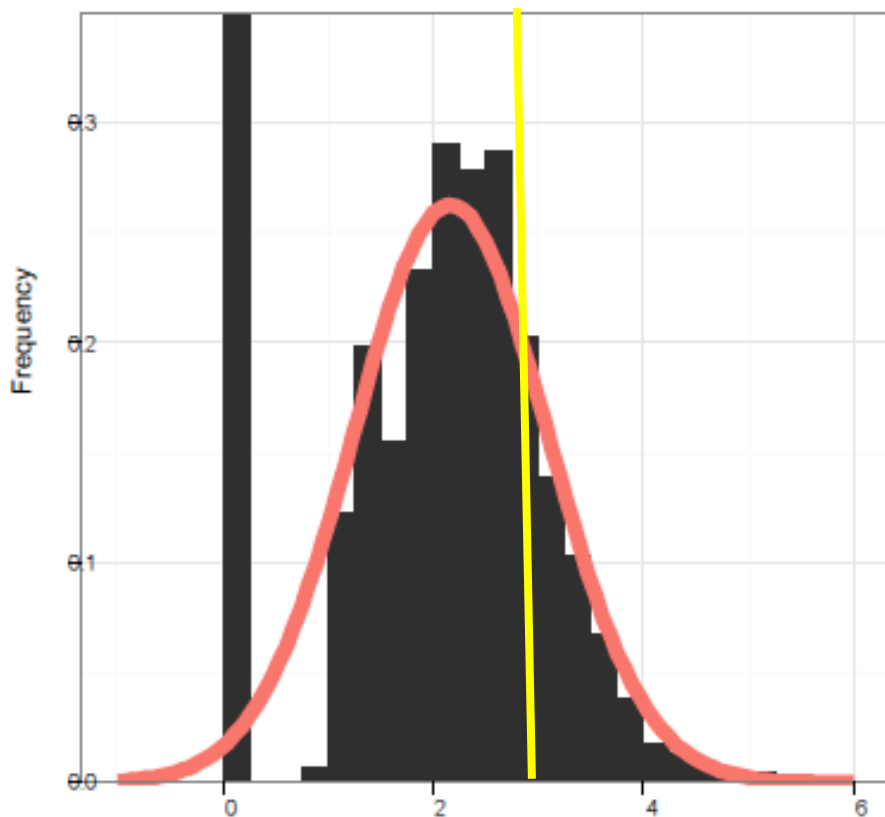
On farms and in agriculture we work with our farmers direct through our Farming Groups on best practice, biosecurity and we are co-funding the Farmer Incentive Scheme and Non-thinning trials. The Co-operative Food announcing that its entire **‘whole chicken’** range will **only be available to buy in ‘roast-in-the-bag’ packaging**. The move will support customer food safety by eliminating the need for consumers to handle raw chicken.

Aldi

Aldi also recently launched a **“Cook in the Bag” chicken**, which means our **customers will no longer need to handle raw chicken in their kitchen**.



The Netherlands/Belgium



Microbiological criteria as a decision tool for controlling *Campylobacter* in the broiler meat chain.

RIVM Letter Report 330331008/2013
A.N. Swart | M.-J.J. Mangen | A.H. Havelaar



National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

A critical limit of 1000 *Campylobacter* bacteria per gram would reduce the number of human disease cases by two-thirds. The costs to the poultry industry to meet this criterion (estimated at 2 million euro per year) are considerably lower than the averted costs of illness (approximately 9 million euro per year).

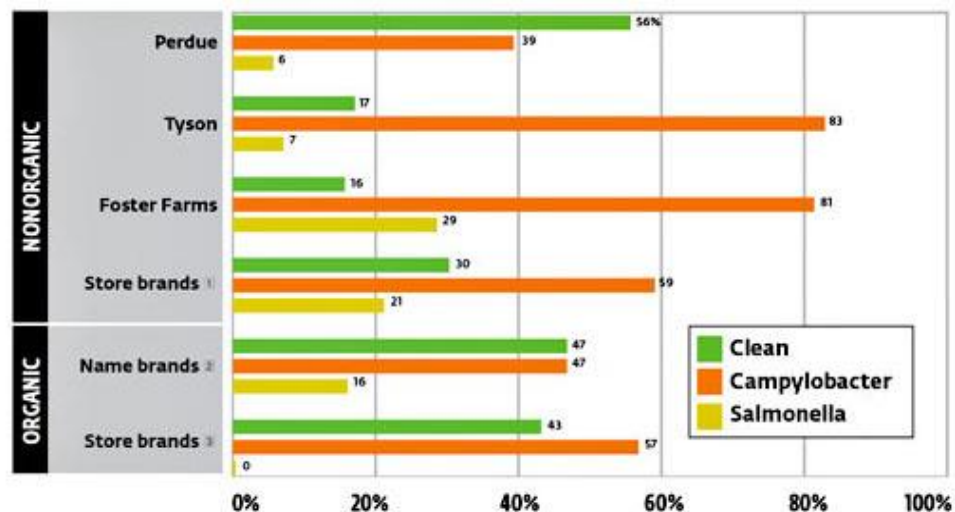
Annexe à l'arrêté royal du 26 avril 2009 concernant des critères microbiologiques applicables
aux denrées alimentaires

Critères d'hygiène des procédés

Catégorie de denrées alimentaires	Micro-organisme/ Métabolite	Limites (1)		Plan d'échantillonnage (2)		Point d'application du critère	Actions correctives
		m	M	n	c		
1. Viandes hachées de volaille et préparations de viande à base de viande de volailles, destinées à être consommées cuites (3)	<i>Campylobacter</i> spp. thermotolérants	100 ufc/g		5	0	Fin du processus de production	Améliorations de l'hygiène de la production, de la sélection et/ou de l'origine des matières premières

Establishment of Risk based microbiological criteria in the Nordic countries: A case study on Campylobacter in broiler meat

The study confirms that the risk of campylobacteriosis from broiler meat produced in the Nordic countries (and especially Norway and Finland) is low compared to most other European countries. When using different data sets from the same country, the results differ between them, but the ranking of countries is unaltered. It is for example found that microbiological criterion based on $n=5$ samples, with a threshold concentration of $m=1000$ cfu/g that may be exceeded in $c=1$ out of 5 samples, gives between 0 and 10% non-complying batches of poultry meat in the Nordic countries. The risk reduction obtained by implementation of this MC varies greatly, and is, in general, larger when more non-complying batches are no longer accepted on the fresh meat market. Detailed results per country can be obtained from the report.

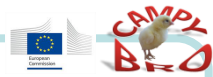


Cost of foodborne illness estimates for *Campylobacter* (all species)

Mean estimates, 2013

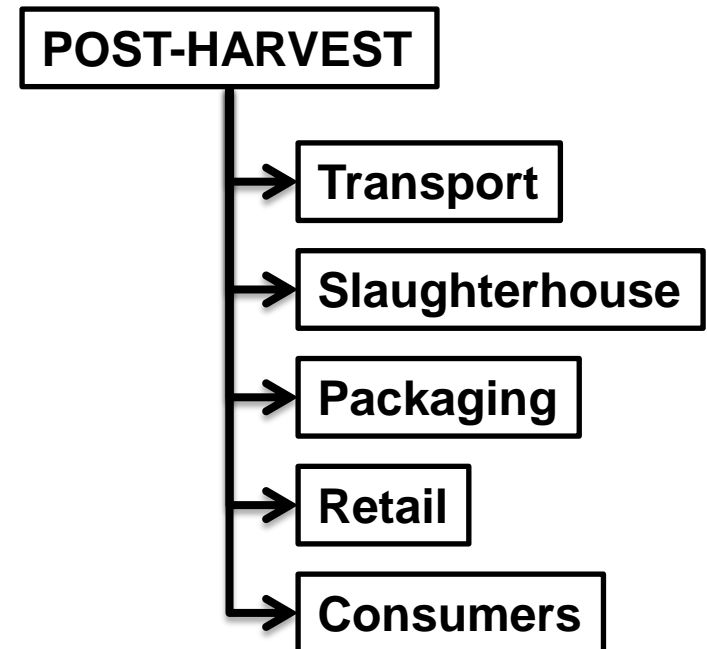
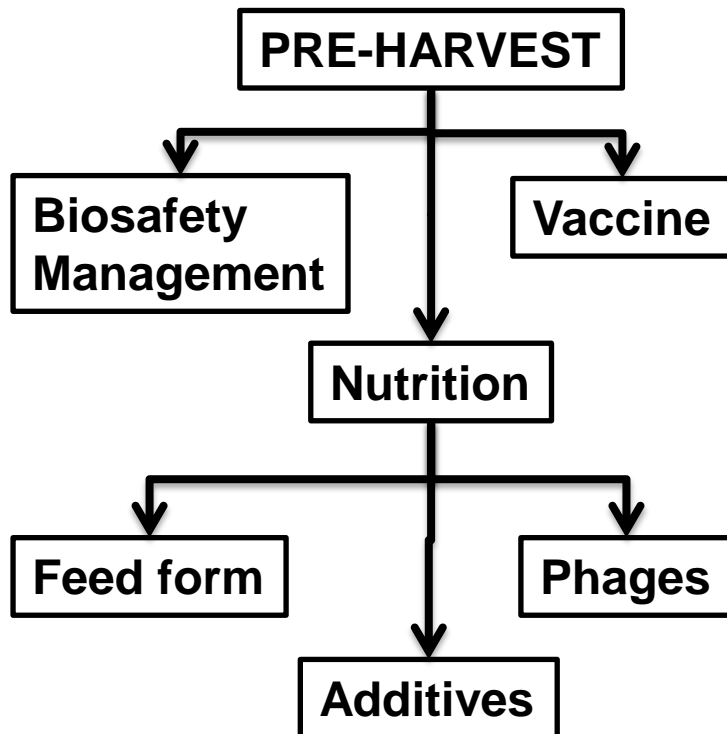
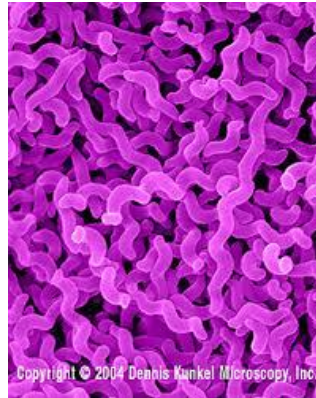
				Total	Acute illnesses			Chronic	
					Non-hospitalized		Hospitalized	Post-hospitalization outcomes	
					Didn't visit physician; recovered	Visited physician; recovered	Hospitalized		
Health outcomes				Total cases			Post-hospitalization recovery	Hospitalized; died	Morbidity illness with Guillan Barré syndrome
Number of cases				845.024					Death associated with Guillan Barré syndrome
Cases by outcome					790.930	45.631	8.463	8.387	76
Medical costs									
Physician office visits						\$8.685.436	\$805.421	\$1.140.269	
Emergency room visits						\$2.614.374	\$1.454.623	\$0	
Outpatient clinic visits						\$9.018.943	\$1.115.131	\$0	
Hospitalizations						\$0	\$117.957.499	\$0	
Total medical costs by outcome						\$20.318.753	\$121.332.675	\$1.140.269	
Premature death								\$657.959.135	\$748.428.516
Productivity loss, nonfatal cases					\$44.709.190	\$8.043.747	\$4.305.437	\$2.133.387	
Total costs by outcome					\$44.709.190	\$28.362.500	\$125.638.112	\$3.273.656	\$657.959.135
Total cost of illness				\$1.928.787.166					

Key messages

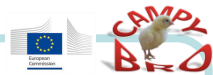


- ❑ **Campylobacteriosis: most important EU zoonosis**
- ❑ **Poultry meat: main source**
- ❑ **High level of contamination both in batches and carcasses**
- ❑ **Interventions at primary production is required**
- ❑ **No practical real tools are available to producers**
- ❑ **Both consumers and EU authorities will ask producers to reduce Campylobacter in broilers**
- ❑ **CAMPYBRO will develop strategies to do so:**
 - ❑ **Short-medium term: through nutrition**
 - ❑ **Long term: through vaccination**

Campylobacter control



Biosafety and management



- ❑ **Biosafety**
 - ❑ **Always positive**
 - ❑ **Personnel, pest control, facilities design**
 - ❑ **However, no clear effects after the improvement done in the last years**
 - ❑ **Extreme biosafety is needed to success**
 - ❑ **Most of the fattening farms within the EU are old, and extreme measures are difficult to apply**
- ❑ **Management**
 - ❑ **Avoid thinning: biggest biosecurity problem**
 - ❑ **Decrease slaughtering age**
 - ❑ **Possibilities depends on the market**

Biosafety: Camcon project

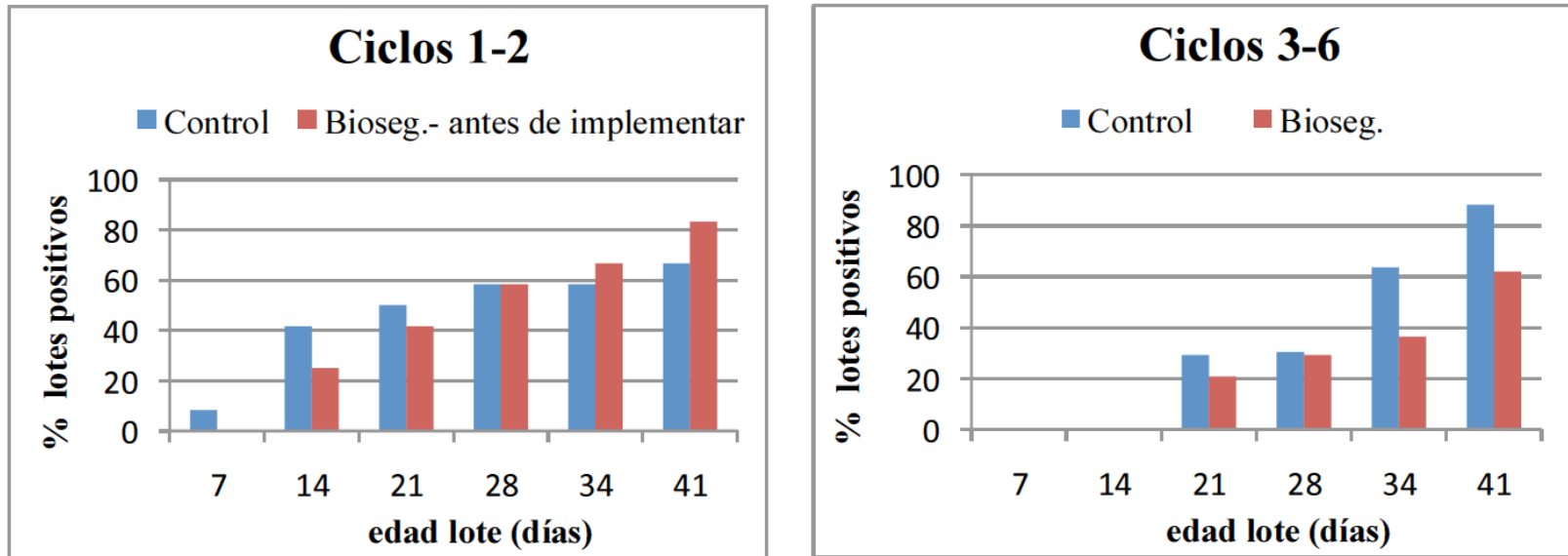
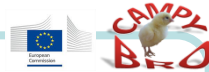
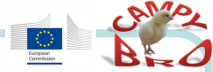


Figura 1. Porcentaje de lotes positivos en los dos grupos de granjas antes (A) y después (B) de implementar la mejora de las medidas de bioseguridad

❑ After thinning, all positive

Biosafety: Flies screens



UK: The second year of fly sampling was repeated during June to August 2012 in the UK on the four broiler farms in North Wales. However, flies were subject to killing with CO₂ and then flies of similar species/families were placed in batches of 10 flies for culture. In total, 1293 flies representing 28 different families were cultured in 127 batches from flies collected from the broiler farms and four batches (3.2%) of flies from three broiler farms were positive for *Campylobacter*. *C. jejuni* only was

O57b - House fly (*Musca domestica*) as a vector for *Campylobacter jejuni* and *Campylobacter coli* in Spanish broiler farms

Saulo Urdaneta¹, Sandra Talavera¹, Marta Verdún¹, Nonito Pagès¹, Roser Dolz¹, Birthe Hald², Marta Cerdà-Cuellar^{1,3}

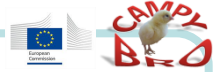
¹Centre de Recerca en Sanitat Animal (CReSA), UAB-IRTA, Campus UAB, 08193-Bellaterra, Barcelona, Spain,

²National Food Institute, Technical University of Denmark, Mørkhøj Bygade 19, DK-2860, Søborg, Denmark,

³Institut de Recerca i Tecnologia Agroalimentàries (IRTA), Barcelona, Spain

The vector potential of flies (Diptera: Brachycera) for *Campylobacter jejuni* and *Campylobacter coli* on 5 Spanish broiler farms was evaluated in a longitudinal field study from April to November in 2011 and 2012. The prevalence of *C. jejuni*- and *C. coli*-positive flies was determined in 1304 flies captured from house surroundings of the farms. Flies were macerated individually, pre-enriched in Bolton broth for 24 h at 42°C, streaked onto modified *Campylobacter* blood-free selective agar and incubated under microaerobic conditions for 48 h at 42°C. Additionally, direct PCR detection was performed from Bolton enrichment broths (2012 sampling only). Overall, 22 flies were positive by culture (*C. jejuni*, n=18; *C. coli*, n=4). *Musca domestica* (house fly) was the most frequent (89.8%) fly species captured and the only species from which *Campylobacter* was isolated. The prevalence of positive flies detected by culture was 1.7% (22/1304) with a peak in September where 31.8% (7/22) of all the positive flies were found. By PCR, overall prevalence was 10.5% (87/876), with a peak of 32.18% (28/87) of the PCR positive in August. The PCR-positive flies were mainly *M. domestica*, but also few *Ophyra* sp. (black garbage fly), *Calliphora* sp. (blow fly) and *Fannia canicularis* (lesser house fly). Most of the broiler flocks became *Campylobacter* positive around the same time or just after detecting *Campylobacter* in the sampled flies. We conclude that flies, especially *M. domestica*, near broiler houses constitute a risk for infection of broilers with *C. jejuni* or *C. coli*.

Biosafety: Flies screens



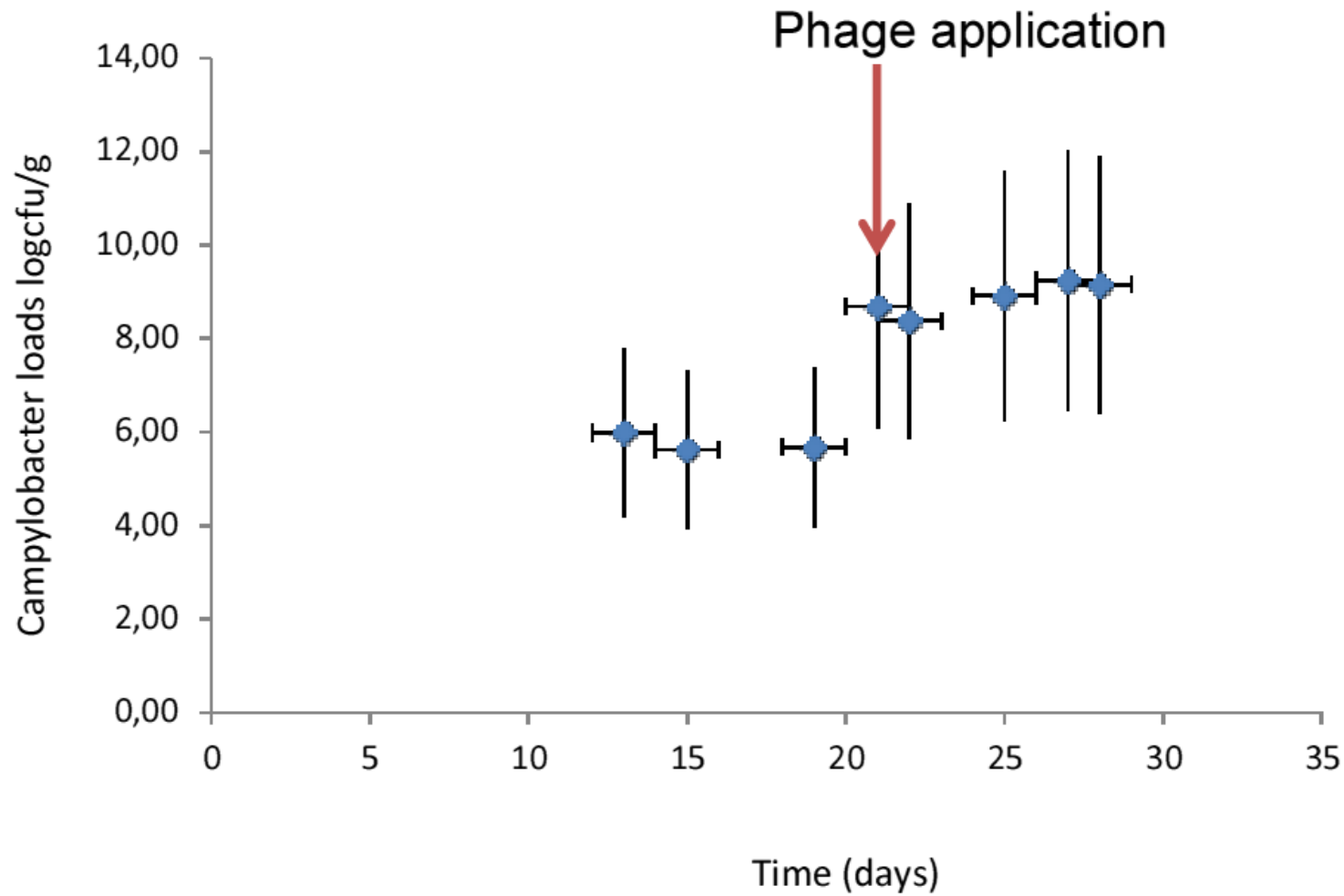
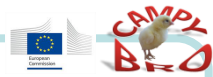
O46b - Quantitative estimation of *Campylobacter jejuni* survival in house flies at 20°C and 42°C after inoculation with 3×10^3 CFU.

Annette Nygaard Jensen¹, Henrik Skovgård², Birthe Hald¹

¹National Food Institute, Technical University of Denmark, Søborg, Denmark, ²Aarhus University, Slagelse, Denmark

Flies have been reported as transmitters of *Campylobacter* into broiler houses. However, it is uncertain if flies serve as passive carriers or if colonization of the fly gut is feasible under favorable temperatures. This study aimed to follow the *Campylobacter* numbers in flies over time at two temperature regimes. Methods: A total of 35 newly emerged house flies of a laboratory breed were inoculated on their proboscis with 1 µl of a *Campylobacter jejuni* suspension containing 3.5×10^3 CFU. The inoculated flies were held dark for 0 h (positive controls), 2, 4 and 8 h at 20°C and 42°C (5 replicates per treatment) before enumeration of *C. jejuni* by plate spreading of 10-fold dilution series of homogenized single flies onto Abeyta-Hunt-Bark agar. Results: Two hours post-inoculation, the *C. jejuni* numbers in flies were similar at 20°C (2.5×10^3 CFU) and at 42°C (1.4×10^3 CFU). All flies held at 20°C were *C. jejuni* positive after 4 h (2.2×10^2 CFU) and 8 h (1.7×10^2 CFU). At 42°C, the *C. jejuni* numbers were reduced to 4.4×10^1 CFU (2 positive flies) after 4 h and to zero after 8 h. In comparison, *C. jejuni* (3.5×10^3) inoculated into Brain Heart Infusion Broth in a microaerobic atmosphere at 42°C increased to 1.1×10^6 CFU after 8 h incubation. Conclusion: The reduction in *C. jejuni* numbers over time indicated that the house flies served merely as passive carriers and that *C. jejuni* did not colonize the fly gut even at their optimum growth temperature (42°C).

Phage therapy: Camcon project



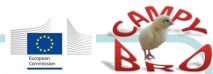
Control of Campylobacter infection in broiler flocks through two-steps strategy: nutrition and vaccination

-CAMPYBRO-

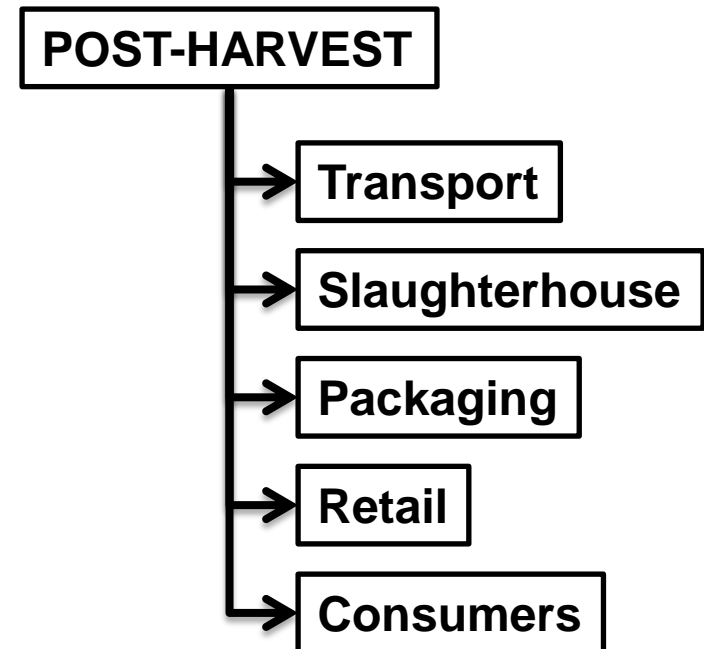
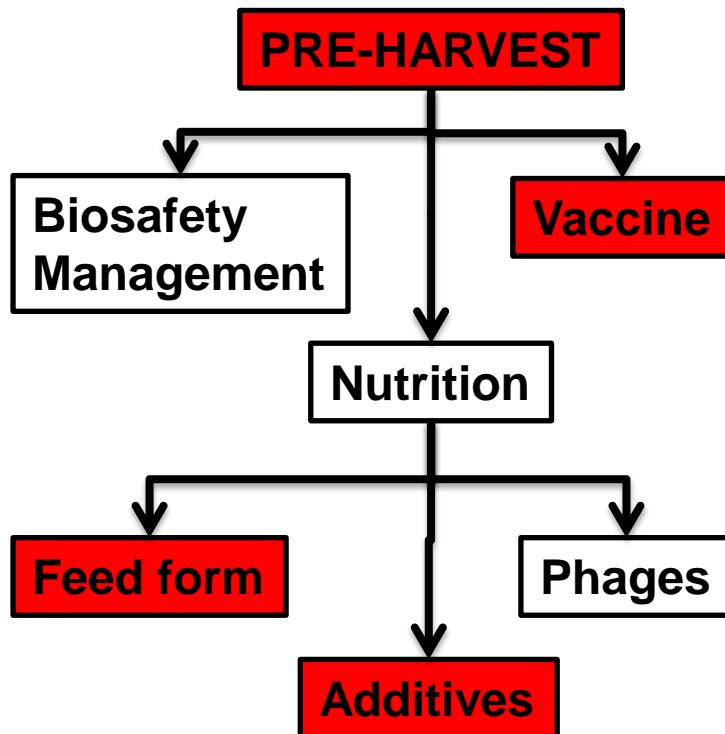
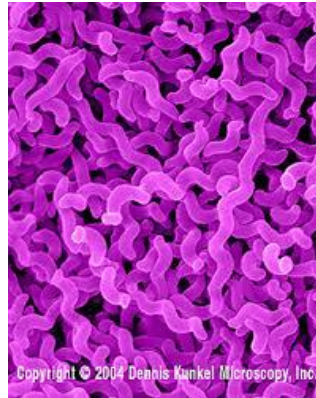
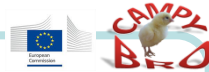
FP7-SME-2013-605835



Consortium



CAMPYBRO PROJECT



Work Packages



CAMPYBRO	WP	Year 1												Year 2												Year 3																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36									
WP 1. Efficacy of several compounds against Campylobacter in broilers orally infected looking for synergies	WP1																																													
T1.1. In vivo effectiveness of products based on plant extracts, organic acids, prebiotics, and probiotics against Campylobacter.	T1.1	•	•	•	•	•	•	•	•	•																																				
T1.2 In vitro effectiveness of mixtures of products: Synergistic effect	T1.2										•	•	•																																	
T1.3. In vivo effectiveness of product mixtures based on plant extracts, organic acids, prebiotics, and probiotics against Campylobacter.	T1.3													•	•	•																														
WP 2. Feed presentation strategies against Campylobacter.	WP2																																													
T2.1. Effect of feed composition, particle size and feed presentation on the prevalence of Campylobacter in broilers orally infected	T2.1	•	•	•	•	•	•	•	•	•																																				
T2.2 Effect of whole grain feeding on the prevalence of Campylobacter in broilers orally infected.	T2.2										•	•	•	•	•	•																														
WP 3. Interactions between products and feed presentation against Campylobacter. Synergies.	WP3																																													
T3.2. Interactions between product mixtures and feeding strategies against Campylobacter looking for synergies	T3.1																•	•	•	•	•	•	•	•	•																					
T3.2 Studies in the effect of the duration of treatment on the final infection: design of funtional diets	T3.2																•	•	•	•	•	•	•	•	•																					
T3.3. Study on the correlation between in vitro and in vivo results. Cost-Benefit analyses.	T3.3																							•	•	•																				
WP 4. Application of different nutritional strategies against Campylobacter in experimental farm and field trials.	WP4																																													
T4.1. Effect of different strategies against Campylobacter on performance parameters and level of infection of broilers chickens in experimental farm.	T4.1																									•	•	•	•	•	•															
T4.2. Effect of different strategies against Campylobacter on performance parameters and level of infection of broilers chickens in commercial farms.	T4.2																									•	•	•	•	•	•															
T4.3. Effect of different strategies against Campylobacter on performance parameters and level of infection of turkeys in commercial farms.	T4.3																									•	•	•	•	•	•															
WP 5. Development of a novel vaccine against Campylobacter based on reserve vaccinology	WP5																																													
T5.1. Exhaustive identification of new potential vaccine antigens against Campylobacter using the reverse vaccinology strategy.	T5.1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•																														
T5.2. Development of an in vitro test to visualize the recognition of Campylobacter antigens by antibodies.	T5.2																•	•	•	•	•	•	•	•	•																					
T5.3. Determination of an efficient sub-unit vaccination protocol	T5.3	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•																					
T5.4. Selection of the Campylobacter proteins that will be evaluated for their protective capacity	T5.4																									•	•	•	•	•	•	•	•	•	•	•	•	•								
T5.5. Assessment of the protective potentials against Campylobacter induced by the selected vaccine candidates.	T5.5																									•	•	•	•	•	•	•	•	•	•	•	•	•								
WP 6. Evaluation of the developed nutritional strategies in different geographical situations.	WP6																																													
T6.1. Evaluation of developed nutritional strategies in South, Central, and East European conditions	T6.1																																													
WP 7. Project Management	WP7																																													
T7.1. Contractual, legal, Administrative and financial management and overseeing of ethical and gender issues	T7.1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•								
T7.2. Monitoring and coordination of technical activities of the project, and planning, organizing and reporting of Project Coordinating Committee and General Assembly	T7.2	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•								
T7.3. Relationship with the European Commission	T7.3	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•								
WP 8. Dissemination, training and exploitation	WP8																																													
T8.1. Dissemination of project results	T8.1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•								
T8.2. Training to achieve project results implementation	T8.2													•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•									
T8.3. Exploitation of project results	T8.3													•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•									
MILESTONES		MILESTONE 1									MILESTONE 2									MILESTONE 3									MILESTONE 4									MILESTONE 5								

Work Packages

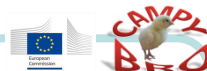
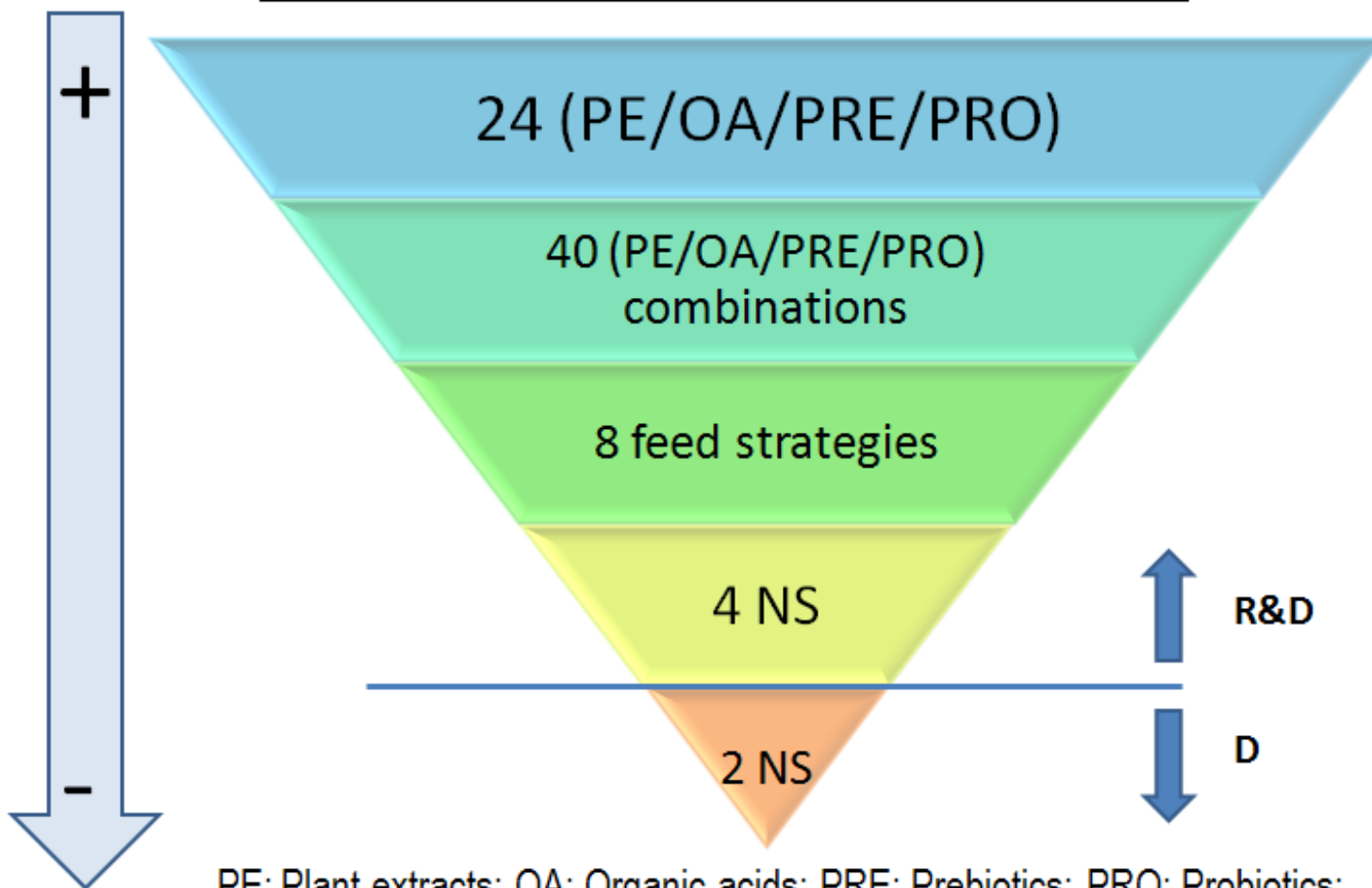


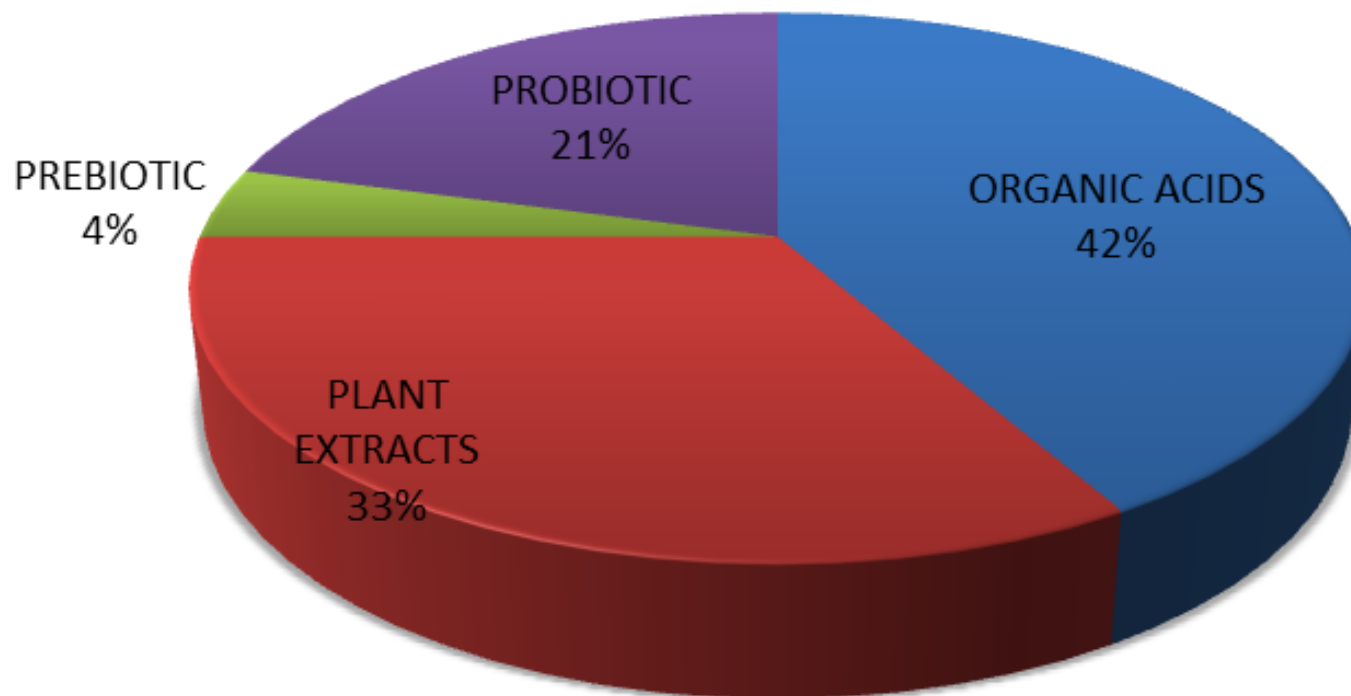
Figure 1.4.1. Selective pressure procedure to detect to best product or strategy with anti *Campylobacter* effect



PE: Plant extracts; OA: Organic acids; PRE: Prebiotics; PRO: Probiotics;
NS: Nutritional Strategies;

R&D: Research and development; D: Demonstration

Families of products tested

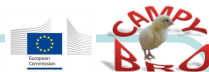


Additive suppliers



	Treat.	Composition	Supplier	Dosage
EXPEU.01a	T1	CONTROL (C)	--	--
	T2	Caprylic and Capric Acids	Silo s.p.a.	6,000ppm
	T3	Monoglycerids of Caprylic and Capric Acids	Silo s.p.a.	8,000ppm
EXPEU.01b	T1	CONTROL (C)		--
	T2	Garlicon (Garlic-based extract)	DOMCA	800ppm
	T3	GalliPro (B. subtilis)	Chr. Hansen	500ppm
EXP.EU02	T1	CONTROL (C)		--
	T2	Monoglycerides (Monobutylin, Monocaprylin, Monocaprin and Monolaurin)	Silo s.p.a.	0.3 %
	T3	60% T2+ 40% of a mixture of organic acids (formic acid+ amonium formate, sodium formate, lactic acid).	Silo s.p.a.	0.5 %
	T4	Crina Poultry Plus (Essential oil components including thymol, eugenol and piperine + Benzoic acid)	DSM	300 ppm
	T5	FB (a mixture of herbal substances and essential oils)	DELACON	2,000 ppm
EXP.EU04	T1	CONTROL (C)		--
	T2	Crina Poultry Plus (Essential oil components including thymol, eugenol and piperine + Benzoic acid)	DSM	300ppm
	T3	FB (a mixture of herbal substances and essential oils)	DELACON	750ppm
	T4	Levucell SB (Probiotic, Saccharomyces cerevisiae)	LALLEMAND	50ppm
	T5	PRPW-1182 (a mixture of organic acids and essential oils)	PERSTOP	5,000ppm
EXP.EU05	T1	CONTROL (C)		--
	T2	Monoglycerides (Monopropionin, Monobutylin, Monocaprylin, Monocaprin and Monolaurin)	Silo s.p.a.	0.5% (0 to 21 d) 0.25% (21 to 42 d)
	T3	60% T2+ 40% of a mixture of organic acids (formic acid+ amonium formate, sodium formate, potasium sorbate).	3F Technology, S.L.	1% (0 to 21 d) 0.5% (21 to 42 d)
	T4	AviP*-Protect CJ Calcium propionate, Sorbic acid, Flavouring compounds	VETAGRO	3,000ppm
	T5	FormaXOL™ (mixture of flavouring compounds)	KEMIN	5,000ppm

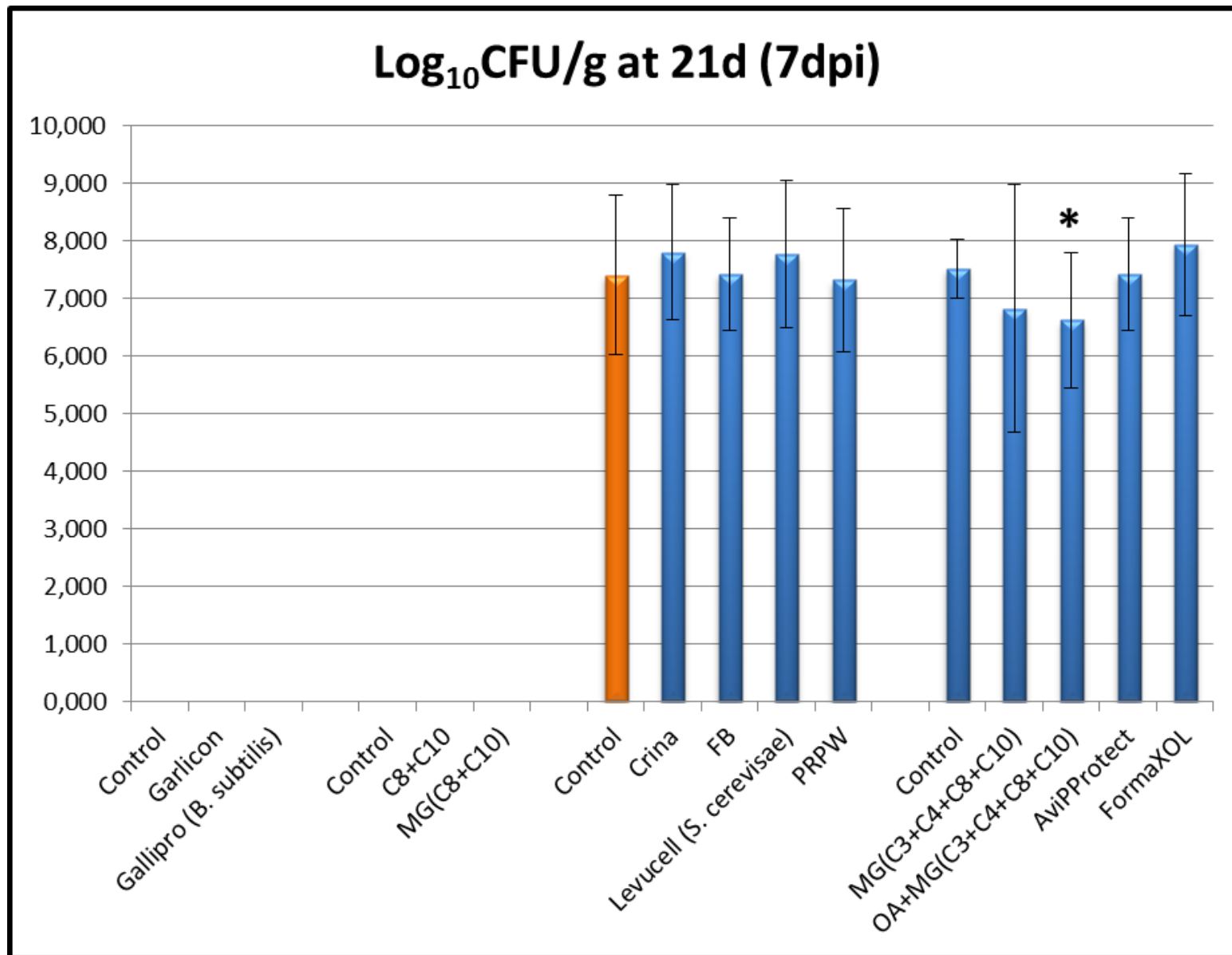
Material and methods



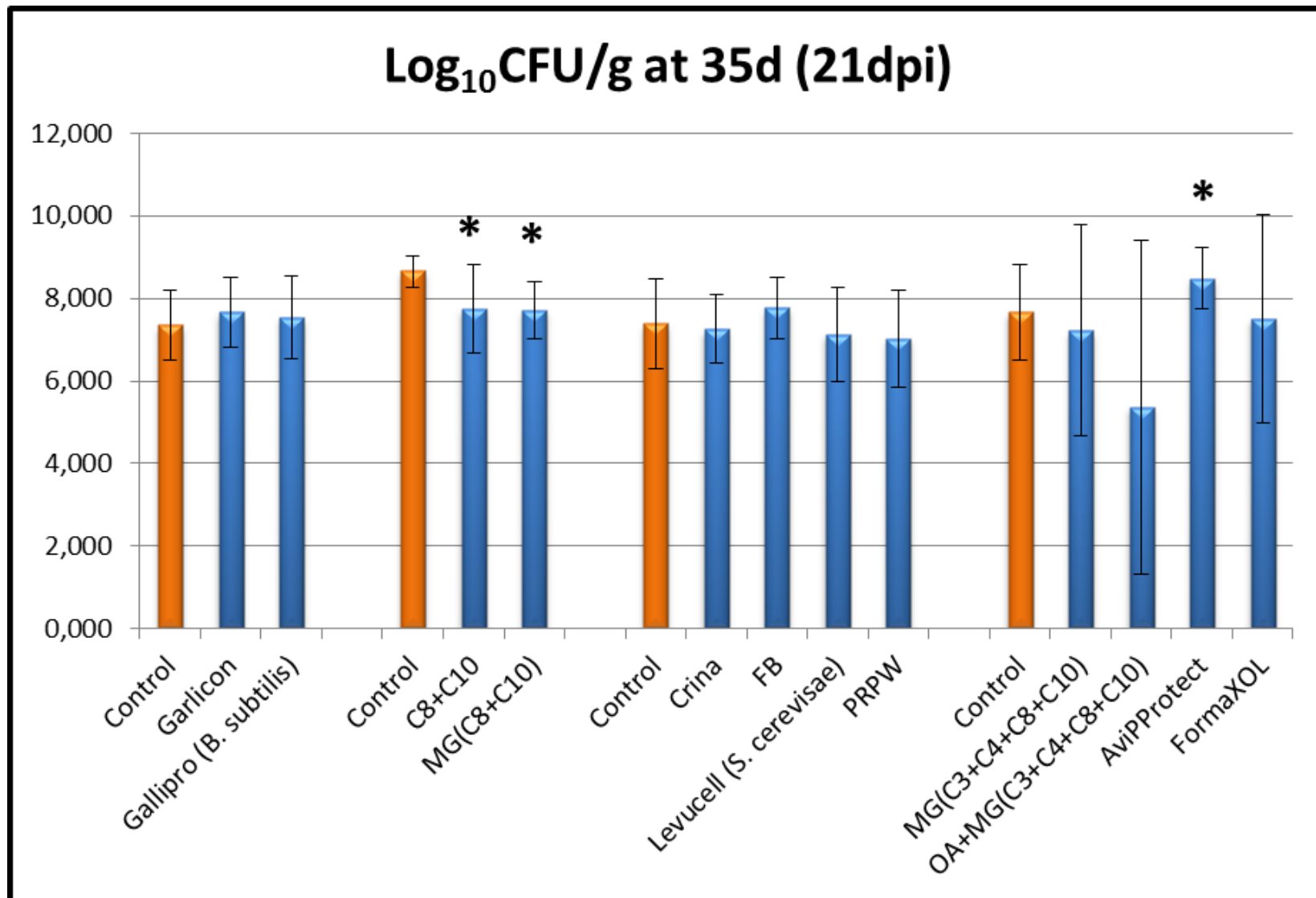
- ✓ **Experimental design**
 - ✓ **3-5 treatments**
 - ✓ **Control diet**
 - ✓ **2-4 Additives per trial**
 - ✓ **5 trials (trial EXP.EU02 had to be repeated)**
 - ✓ **All diets in mash form**



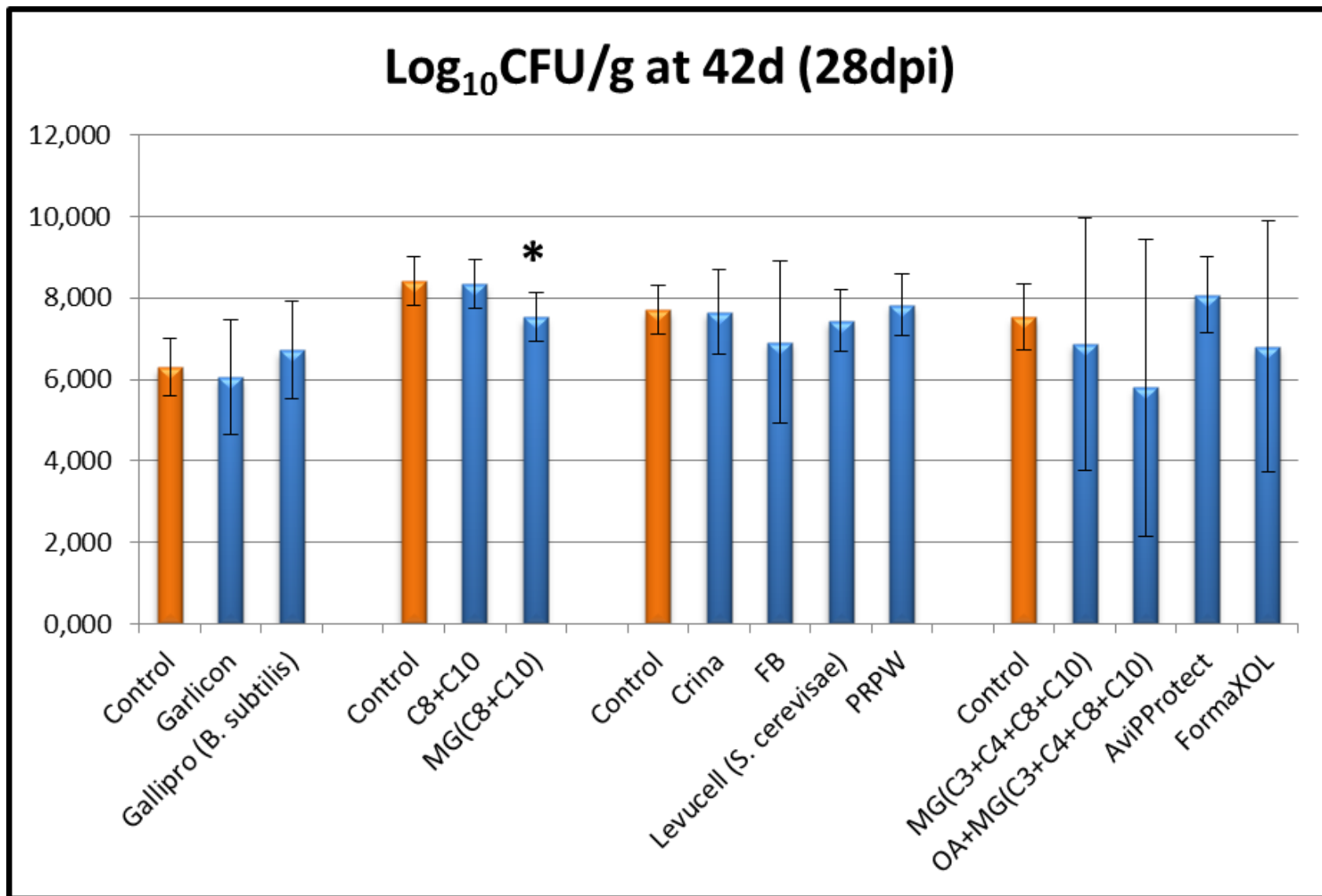
Results at 21d



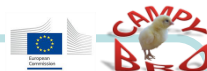
Results at 35d



Results at 42d

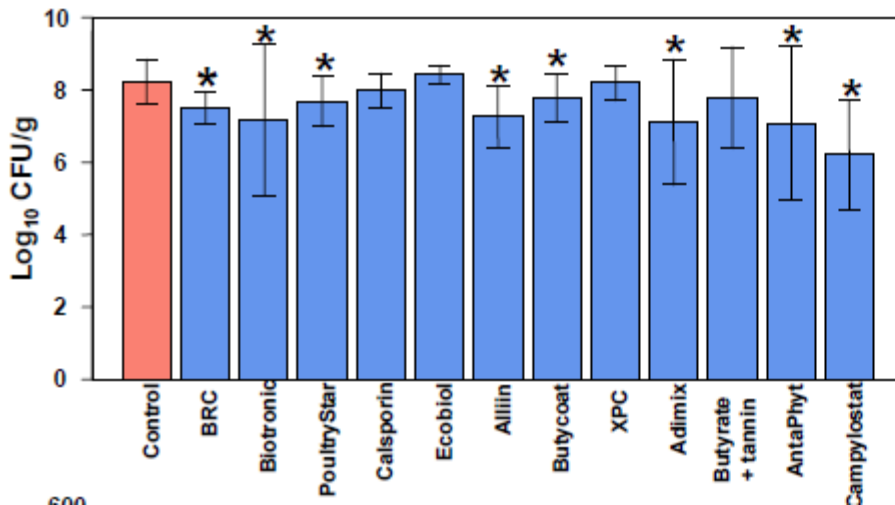
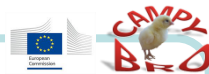


Results in anses



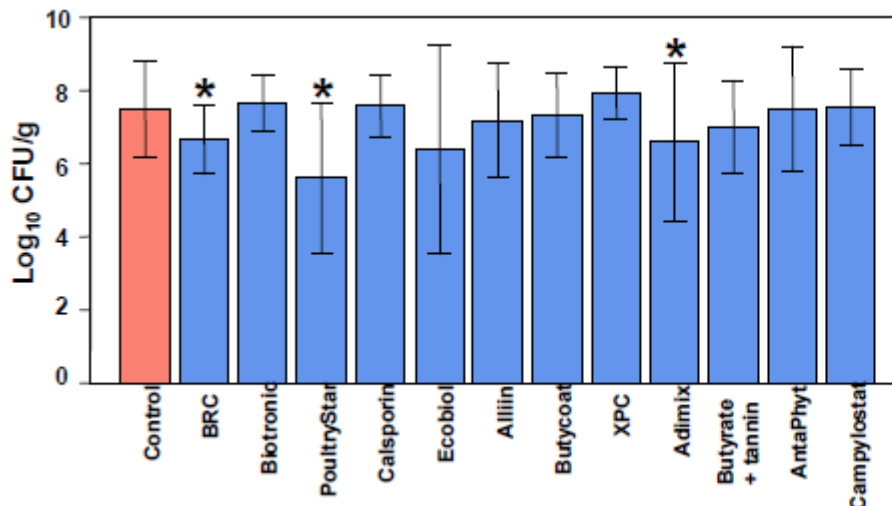
Product	Composition	Supplier	Dose ^a
PoultryStar	Multi-species probiotic	Biomin	0.100% (wt/wt)
Biotronic Top3	Organic acids mixture	Biomin	0.100% (wt/wt)
Lactobutylin BRC	Monoglyceride mixture	Silo	0.600% (wt/wt)
Ecobiol	Probiotic	Norel	0.100% (wt/wt)
Calsporin	Probiotic	ORFFA	0.010% (wt/wt)
Excential Alliin Plus	Plant extract	ORFFA	0.100% (wt/wt)
Excential Butycoat	Organic acid	ORFFA	0.100% (wt/wt)
XPC	Prebiotic	Diamond V	0.125% (wt/wt)
Adimix 30 coated	Organic acid	Nutriad	0.300% (wt/wt)
Calcium Butyrate + Tannin extract	Organic acid + Plant extract	Impextraco Power –Protection range	0.150% (wt/wt) in starter 0.100% (wt/wt) in grower 0.100% (wt/wt) in finisher
AntaPhyt	Plant Extract	Dr. Eckel	0.100% (wt/wt)
Campylostat	Organic acid Mixture + Monoglycerides	3F Technology	4.500% (wt/wt)

Results in anses: 14 and 35d



Campylobacter contamination

- No treatment was able to prevent the contamination
- 8 dietary treatments significantly decreased the colonization:
 - Max Log reduction with Campylostet = 2.02
- Higher reductions gave higher variability



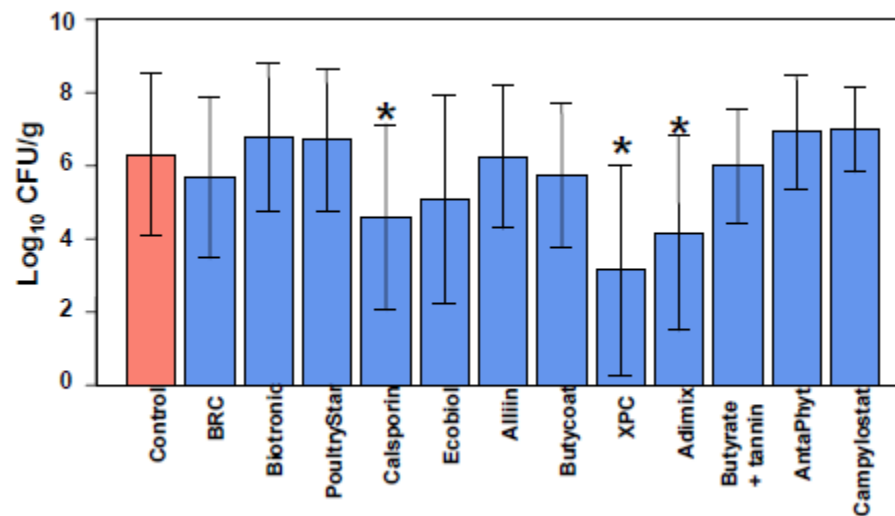
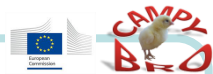
Campylobacter contamination

3 dietary treatments were still have a significant effect

- BRC: Log reduction = 0.85
- Adimix: Log reduction = 0.90
- PoultryStar: Log reduction = 1.88

Efficient treatments presented a great variability (> 2 Log)

Results in anses: 42d



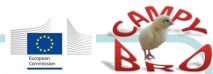
Campylobacter contamination

3 dietary treatments were still have a significant effect:

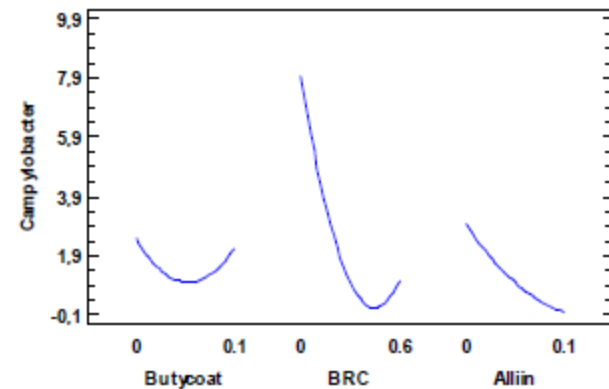
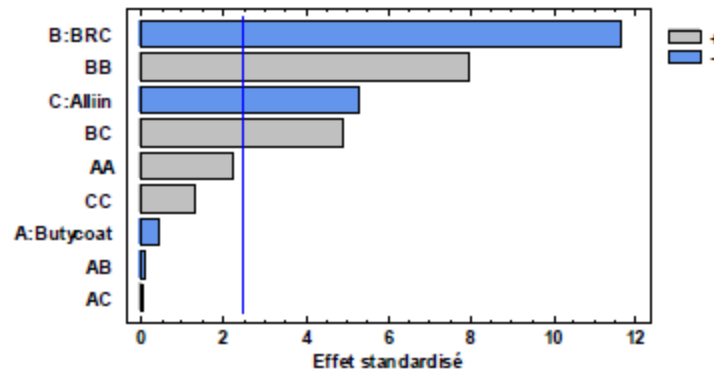
- Calsporin: Log reduction = 1.70
- Adimix: Log reduction = 2.13
- XPC: Log reduction = 3.17

But high variability whatever is the treatment

Results in anses

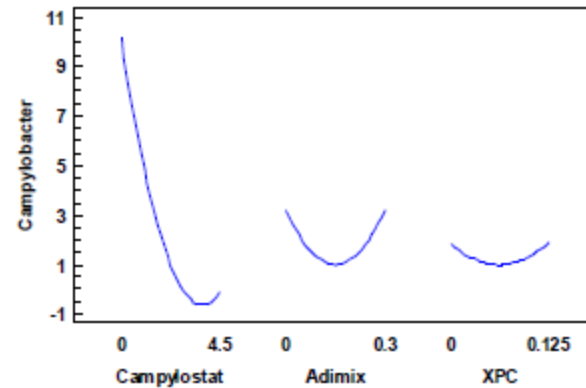
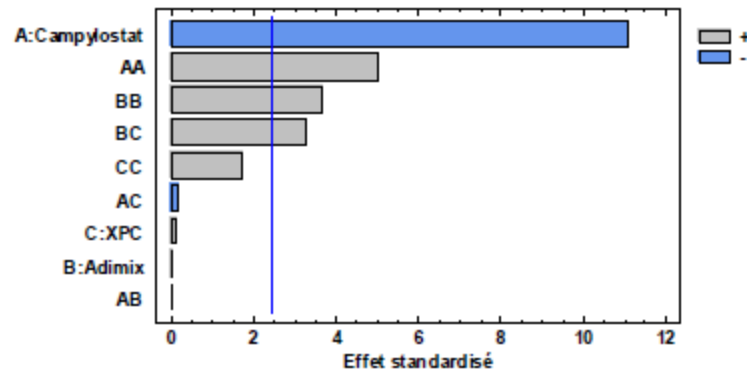
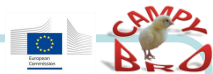


➤ Butycoat – BRC - Alliin



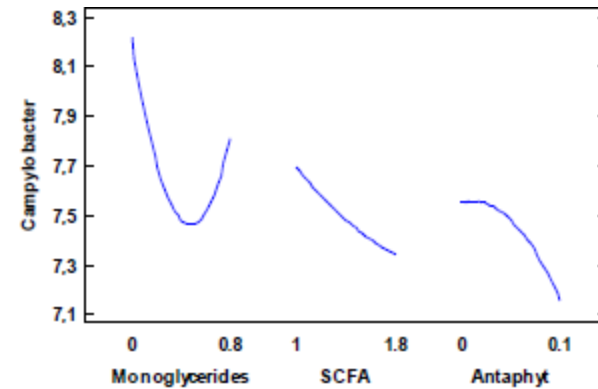
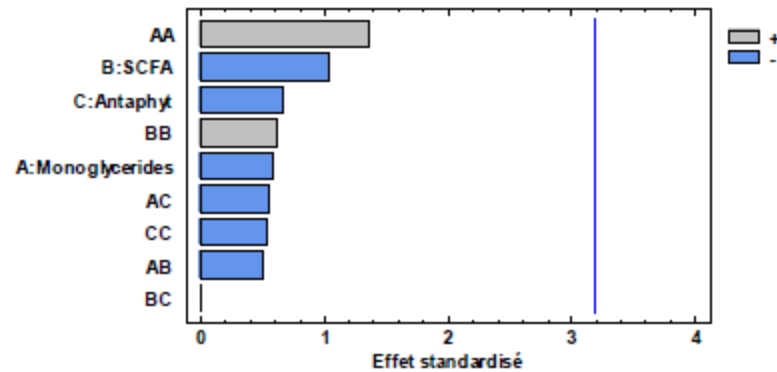
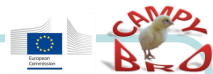
Source	Somme des carrés	DDL	Moyenne quadratique	Rapport F	Proba.
A:Butycoat	0,093025	1	0,093025	0,20	0,6703
B:BRC	63,1584	1	63,1584	135,93	0,0000
C:Alliin	13,0833	1	13,0833	28,16	0,0018
AA	2,3232	1	2,3232	5,00	0,0667
AB	0,0025	1	0,0025	0,01	0,9439
AC	0,00121	1	0,00121	0,00	0,9610
BB	29,3698	1	29,3698	63,21	0,0002
BC	11,2241	1	11,2241	24,16	0,0027
CC	0,759704	1	0,759704	1,64	0,2482
Erreur totale	2,7879	6	0,46465		
Total (corr.)	116,3	15			

Results in anses



Source	Somme des carrés	DDL	Moyenne quadratique	Rapport F	Proba.
A:Campylostat	106,193	1	106,193	122,80	0,0000
B:Adimix	0,00100833	1	0,00100833	0,00	0,9739
C:XPC	0,0160167	1	0,0160167	0,02	0,8962
AA	21,5472	1	21,5472	24,92	0,0025
AB	0,000225	1	0,000225	0,00	0,9877
AC	0,02304	1	0,02304	0,03	0,8757
BB	11,6558	1	11,6558	13,48	0,0104
BC	9,38561	1	9,38561	10,85	0,0165
CC	2,607	1	2,607	3,01	0,1332
Erreur totale	5,18865	6	0,864775		
Total (corr.)	153,99	15			

Results in anses



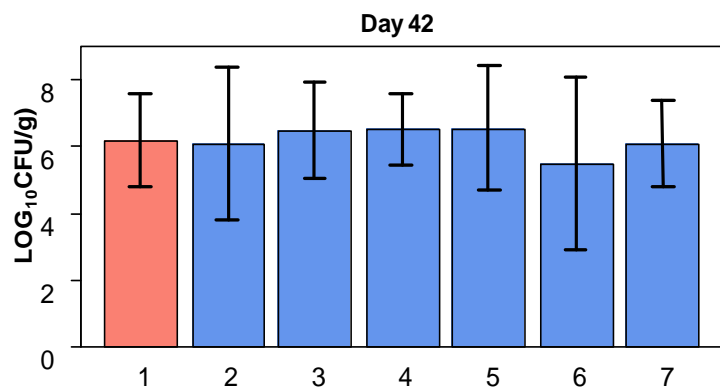
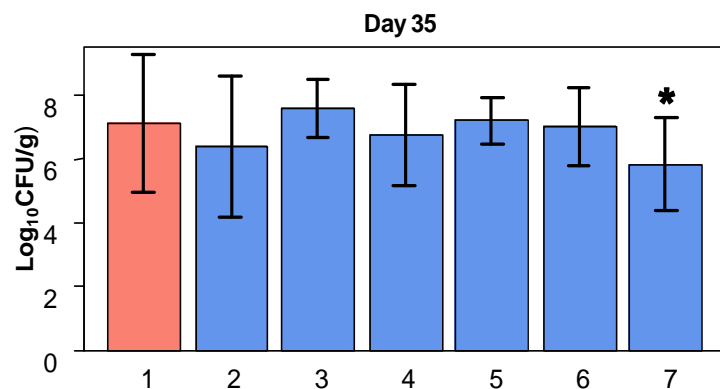
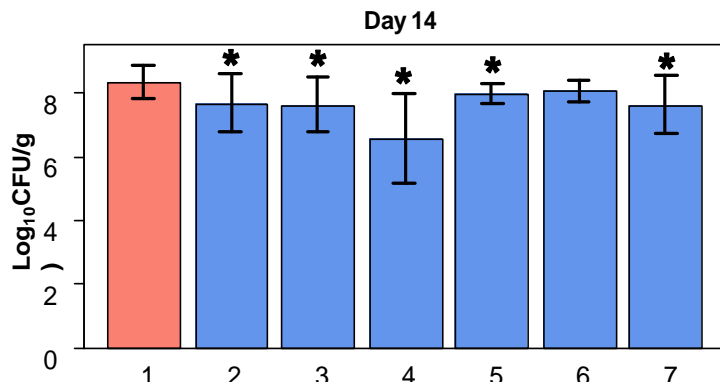
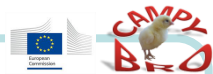
Source	Somme des carrés	DDL	Moyenne quadratique	Rapport F	Proba.
A:Monoglycerides	0,073605	1	0,073605	0,35	0,5941
B:SCFA	0,223224	1	0,223224	1,07	0,3767
C:Antaphyt	0,0921108	1	0,0921108	0,44	0,5536
AA	0,378075	1	0,378075	1,82	0,2706
AB	0,0529	1	0,0529	0,25	0,6490
AC	0,06241	1	0,06241	0,30	0,6222
BB	0,0805787	1	0,0805787	0,39	0,5780
BC	0,00000333333	1	0,00000333333	0,00	0,9971
CC	0,057526	1	0,057526	0,28	0,6356
Test de manque d'adéquation	0,7788	3	0,2596	1,25	0,4303
Erreur pure	0,624875	3	0,208292		
Total (corr.)	4,40034	15			

Additive suppliers



Product mixture	Composition	Supplier	Dose ^a
Lactobutylin BRC + Calsporin	Monoglyceride mixture ^b Probiotic (<i>B. subtilis</i>)	Silo s.p.a ORFFA	0.600% (wt/wt) 0.010% (wt/wt)
Excential Alliin Plus + Calsporin	Plant extract Probiotic (<i>B. subtilis</i>)	ORFFA ORFFA	0.100% (wt/wt) 0.010% (wt/wt)
Monoglycerides + Calsporin	Monoglyceride mixture ^c Probiotic (<i>B. subtilis</i>)	Silo s.p.a ORFFA	0.800% (wt/wt) 0.010% (wt/wt)
Adimix 30 coated + Excential Alliin Plus + Calsporin	Organic acid (butyric acid) Plant extract Probiotic (<i>B. subtilis</i>)	Nutriad ORFFA ORFFA	0.300% (wt/wt) 0.100% (wt/wt) 0.010% (wt/wt)
Adimix 30 coated + PoultryStar	Organic acid (butyric acid) Probiotic (Multi-species)	Nutriad Biomim	0.300% (wt/wt) 0.100% (wt/wt)
Lactobutylin BRC + XPC + PoultryStar	Monoglyceride mixture ^b Prebiotic-like (yeast product) Probiotic (Multi-species)	Silo s.p.a Diamond V Biomim	0.600% (wt/wt) 0.125% (wt/wt) 0.100% (wt/wt)

Results anses



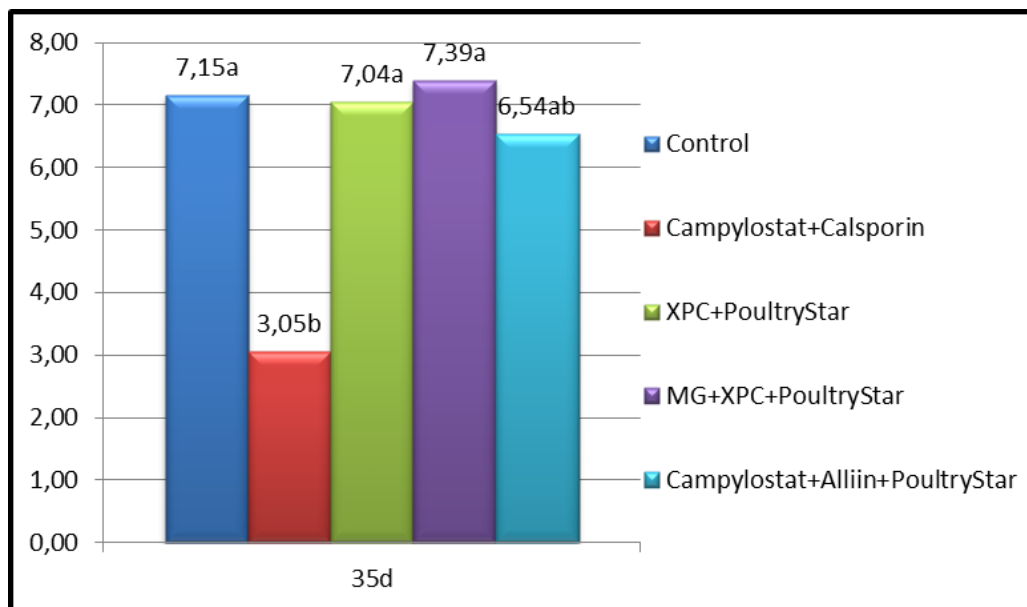
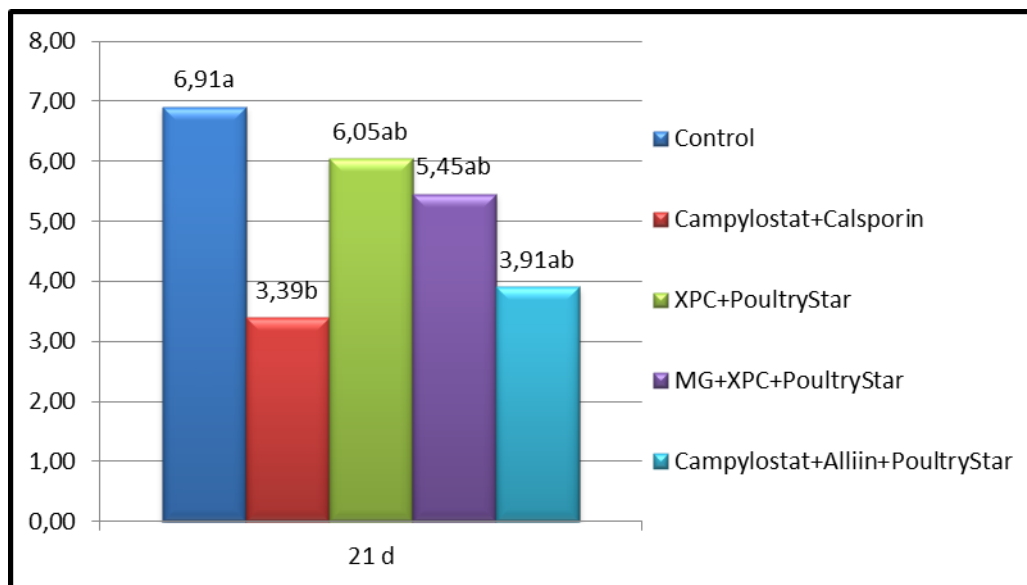
- 1, Control;
- 2, Lactobutylin BRC + Calsporin;
- 3, Excential Alliin Plus + Calsporin;
- 4, Monoglycerides + Calsporin;
- 5, Adimix 30 coated + Excential Alliin Plus + Calsporin;
- 6, Adimix 30 coated + PoultryStar;
- 7, Lactobutylin BRC + XPC + PoultryStar

Additive suppliers

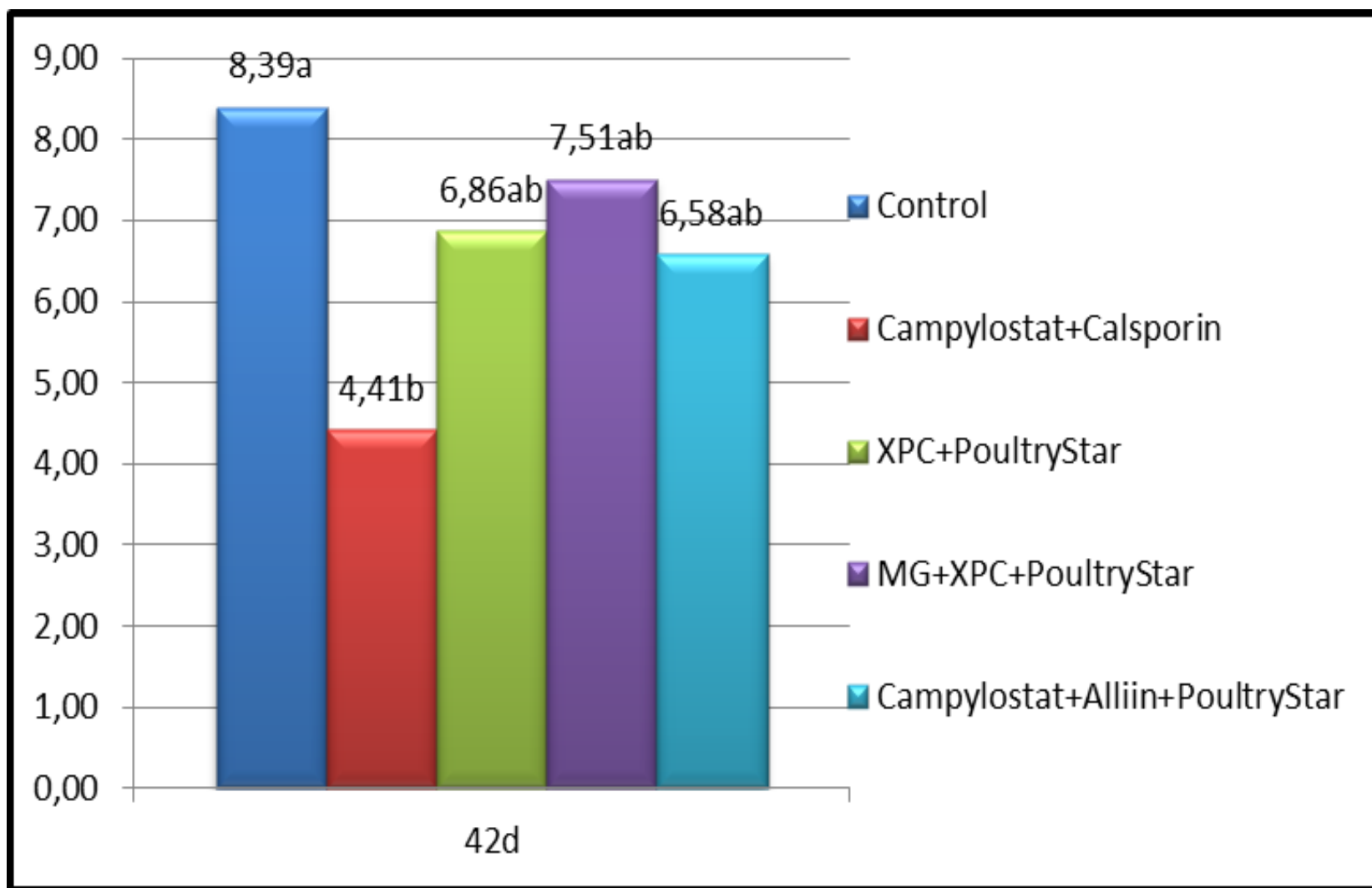
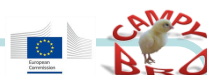


Treat.	Composition	Composition	Supplier	Dosage
T1	CONTROL			--
T2	T1 + Campylostat (2.5%) + Calsporin (100ppm)	Organic acids+Monoglycerides ^a Probiotic. (<i>B. subtilis</i>)	3F Technology, S.L. ORFFA	2.5%(wt/wt) 100ppm
T3	T1 + XPC (0.125%) + Poultrystar (0.1%)	Prebiotic (yeast product) Probiotic (Multi-species)	Diamond V Biomim	0.125% (wt/wt) 0.1% (wt/wt)
T4	T1 + Monoglycerides (0.8%) + XPC (0.125%) + Poultrystar (0.1%)	Monoglycerides ^b Prebiotic (yeast product) Probiotic (Multi-species)	Silo s.p.a. Diamond V Biomim	0.8% (wt/wt) 0.125% (wt/wt) 0.1% (wt/wt)
T5	T1 + Campylostat (2.5%) + Excential Alliin Plus (0.1%) + Poultrystar (0.1%)	Organic acids+Monoglycerides ^a Plant extract Probiotic (Multi-species)	3F Technology, S.L. ORFFA Biomim	2.5%(wt/wt) 0.1% (wt/wt) 0.1% (wt/wt)

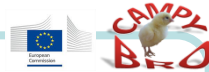
Results at 21-35d



Results at 42d



Log paradox...



CFU/g	Log ₁₀ CFU/g
1.000.000.000	9,00
100.000.000	8,00
10.000.000	7,00
1.000.000	6,00
100.000	5,00
10.000	4,00
1.000	3,00
100	2,00

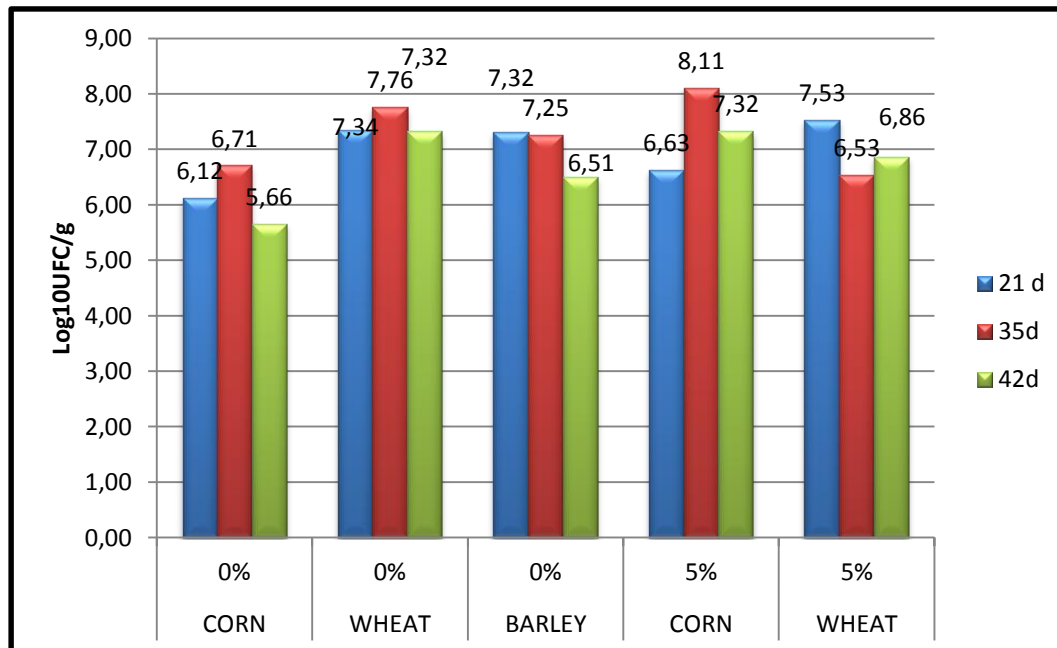
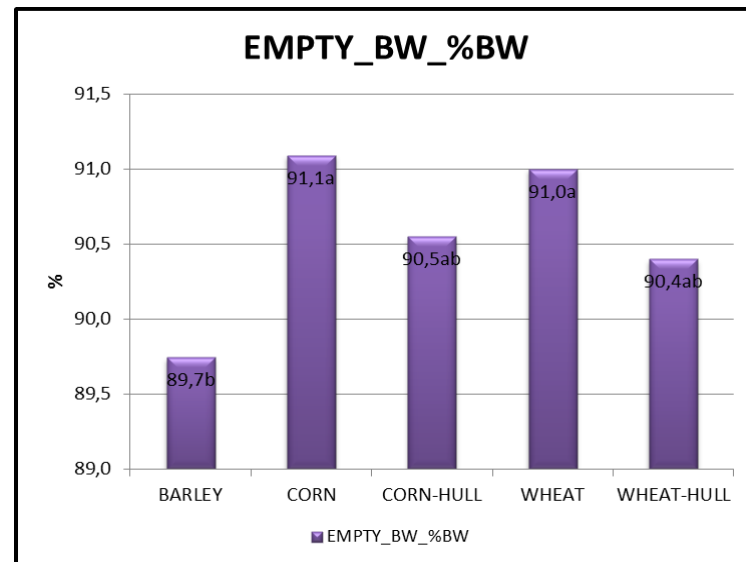
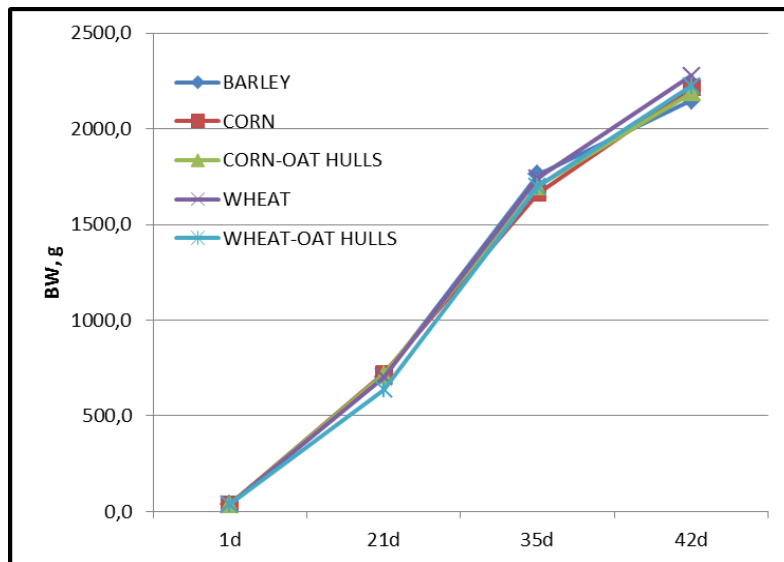
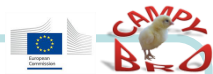
CFU/g	Log ₁₀ CFU/g	Dif Log ₁₀ CFU/g	Dif CFU/g
1.000.000.000	9,00		
500.000.000	8,70	0,30	500.000.000
250.000.000	8,40	0,30	250.000.000
100.000.000	8,00	0,40	150.000.000
50.000.000	7,70	0,30	50.000.000
25.000.000	7,40	0,30	25.000.000
10.000.000	7,00	0,40	15.000.000
5.000.000	6,70	0,30	5.000.000
1.000.000	6,00	0,70	4.000.000
500.000	5,70	0,30	500.000
100.000	5,00	0,70	400.000
50.000	4,70	0,30	50.000
10.000	4,00	0,70	40.000
5.000	3,70	0,30	5.000
1.000	3,00	0,70	4.000

Material and methods

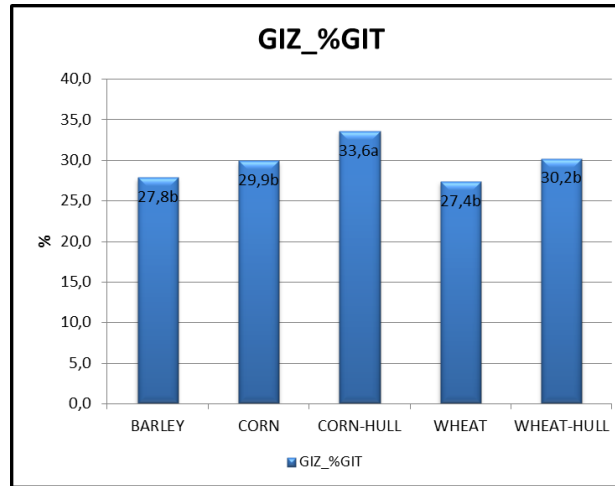
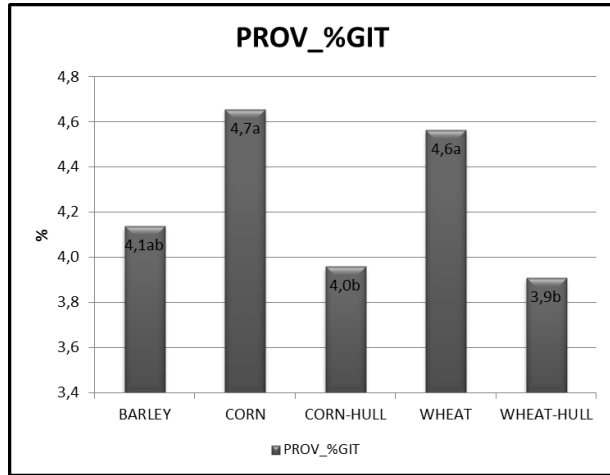


	Treat.	Composition
EXP.03	T1	Corn-based diet presented as mash
	T2	Wheat-based diet presented as mash
	T3	Barley-based diet presented as mash
	T4	Corn-based diet presented as mash + 5% of oat hulls (by dilution)
	T5	Wheat-based diet presented as mash + 5% of oat hulls (by dilution)
EXP.06	T1	Wheat ground at Ø2mm screen size-based diet presented as mash
	T2	Wheat ground at Ø2mm screen size-based diet presented as pellets
	T3	Wheat ground at Ø5mm screen size-based diet presented as mash
	T4	Wheat ground at Ø5mm screen size-based diet presented as pellets
EXP.07	T1	Wheat-based diet presented as mash
	T2	Wheat-based diet presented as mash + 7.5% from 0-21d and 15% from 21 to 42d of whole wheat
	T3	Wheat-based diet presented as mash + 7.5% from 0-21d and 15% from 21 to 42d of whole wheat + 5% of oat hulls
EXP.08	T1	Wheat-based diet presented as mash
	T2	Wheat-based diet presented as mash + 7.5% from 0-21d and 15% from 21 to 42d of whole wheat
	T3	Wheat-based diet presented as mash + 15% from 0-21d and 30% from 21 to 42d of whole wheat
	T4	Wheat-based diet presented as pellets
	T5	Wheat-based diet presented as pellets + 7.5% from 0-21d and 15% from 21 to 42d of whole wheat
	T6	Wheat-based diet presented as pellets + 15% from 0-21d and 30% from 21 to 42d of whole wheat

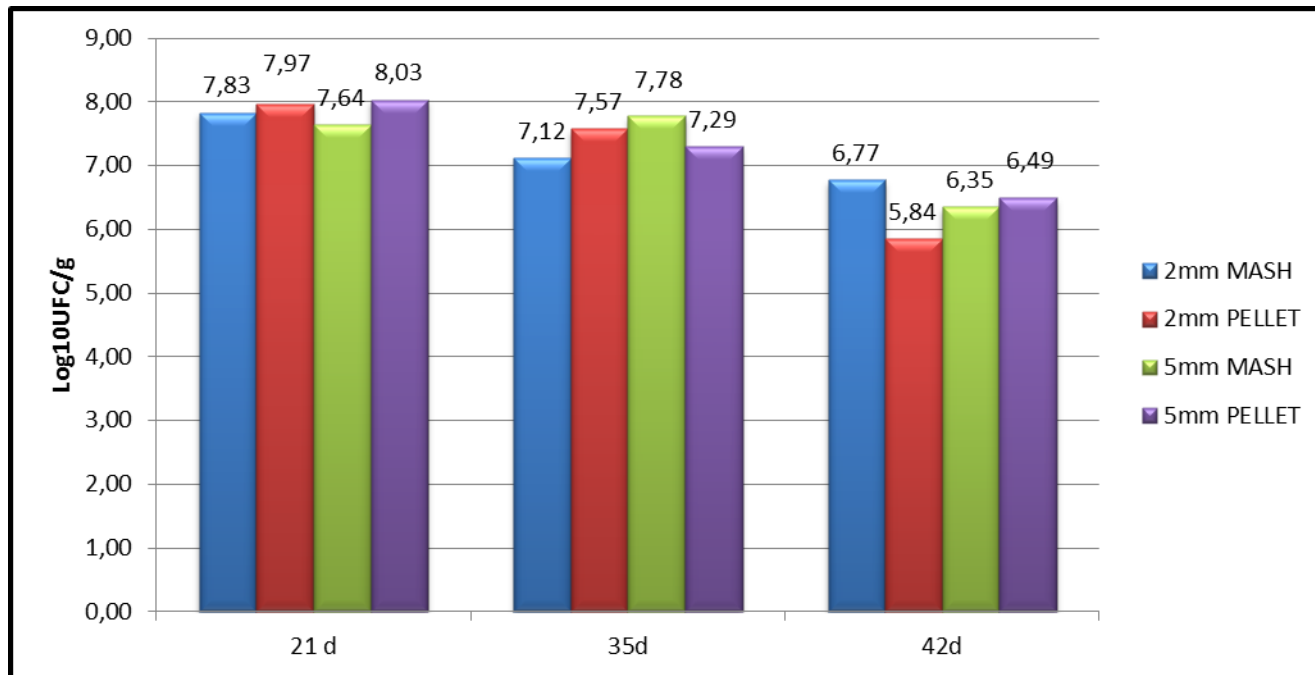
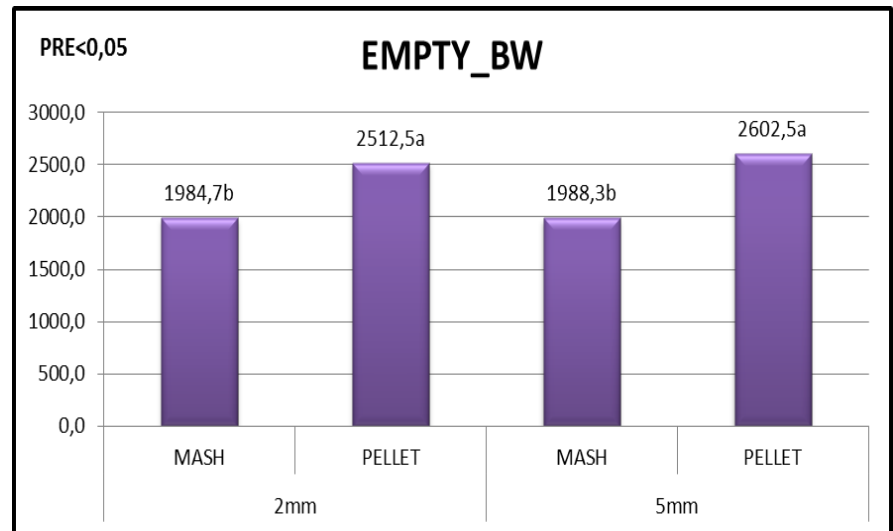
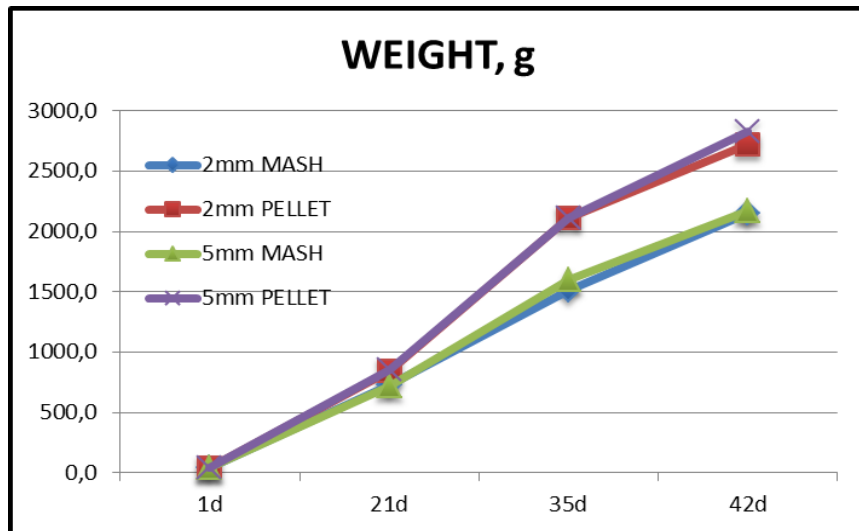
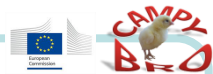
Cereal type & Oat hulls



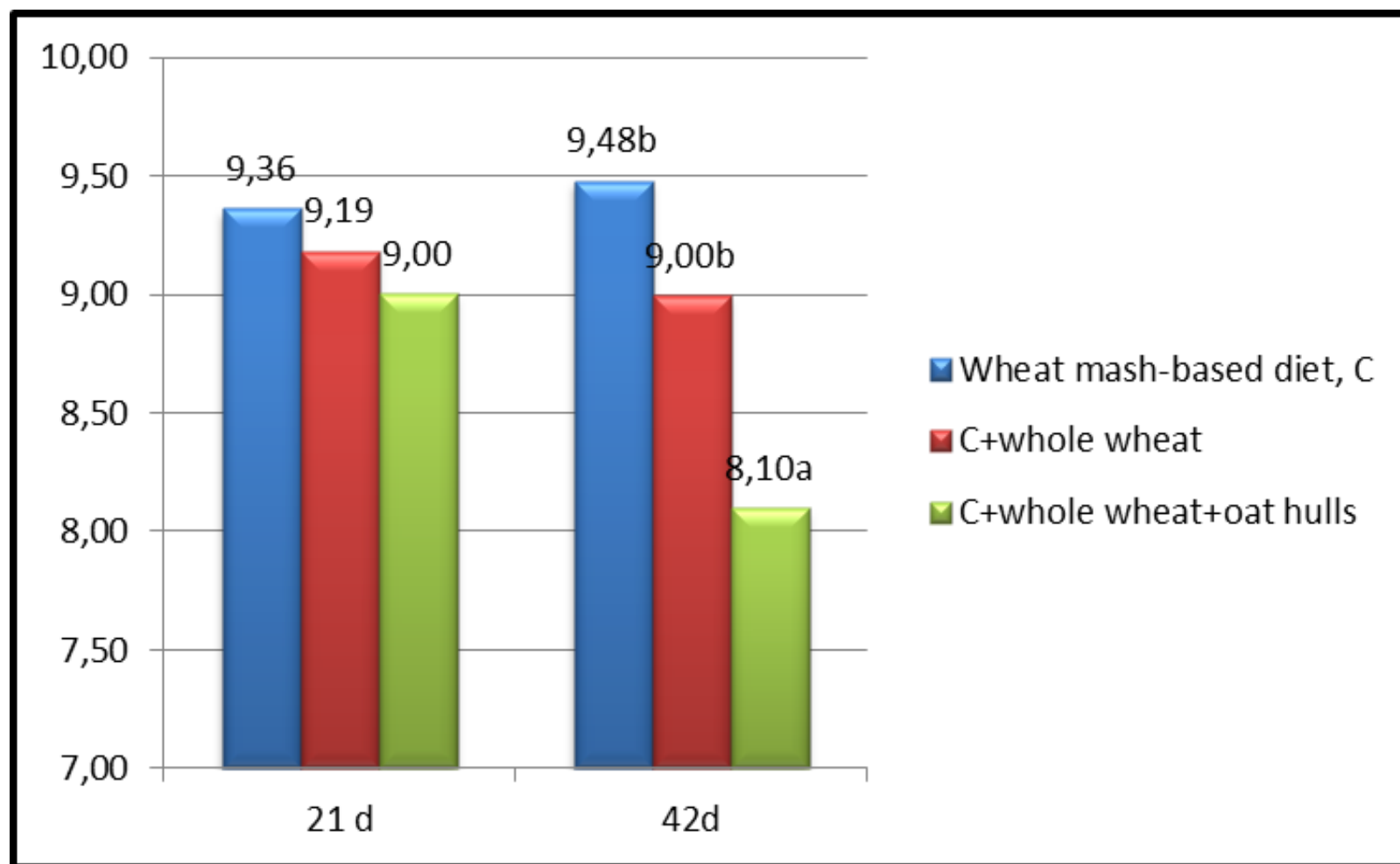
Cereal type & Oat hulls



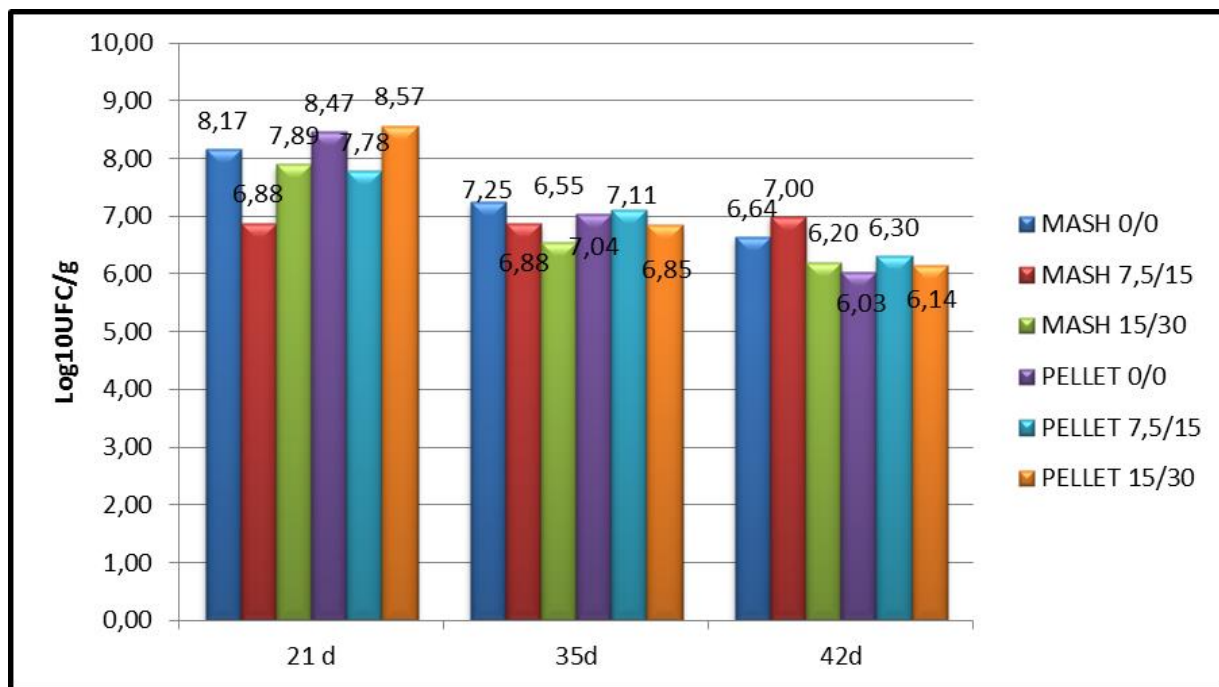
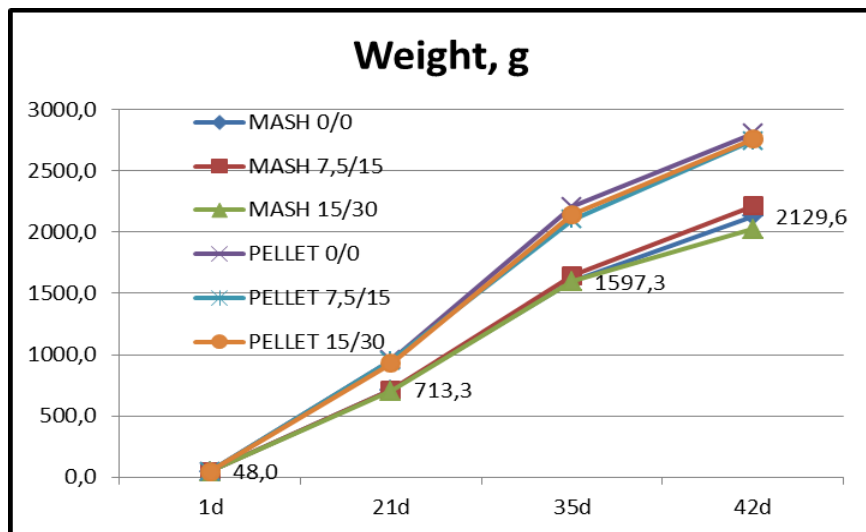
Pelleting and particle size



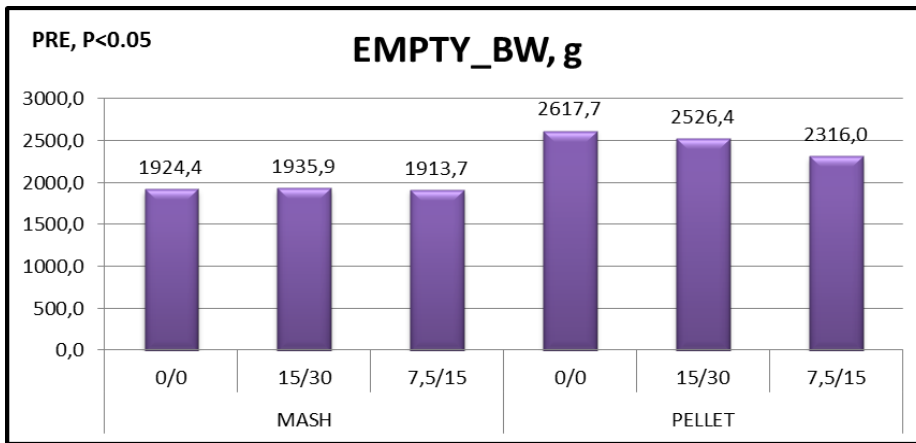
Whole wheat and oat hulls



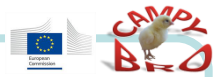
Pelleting and particle size



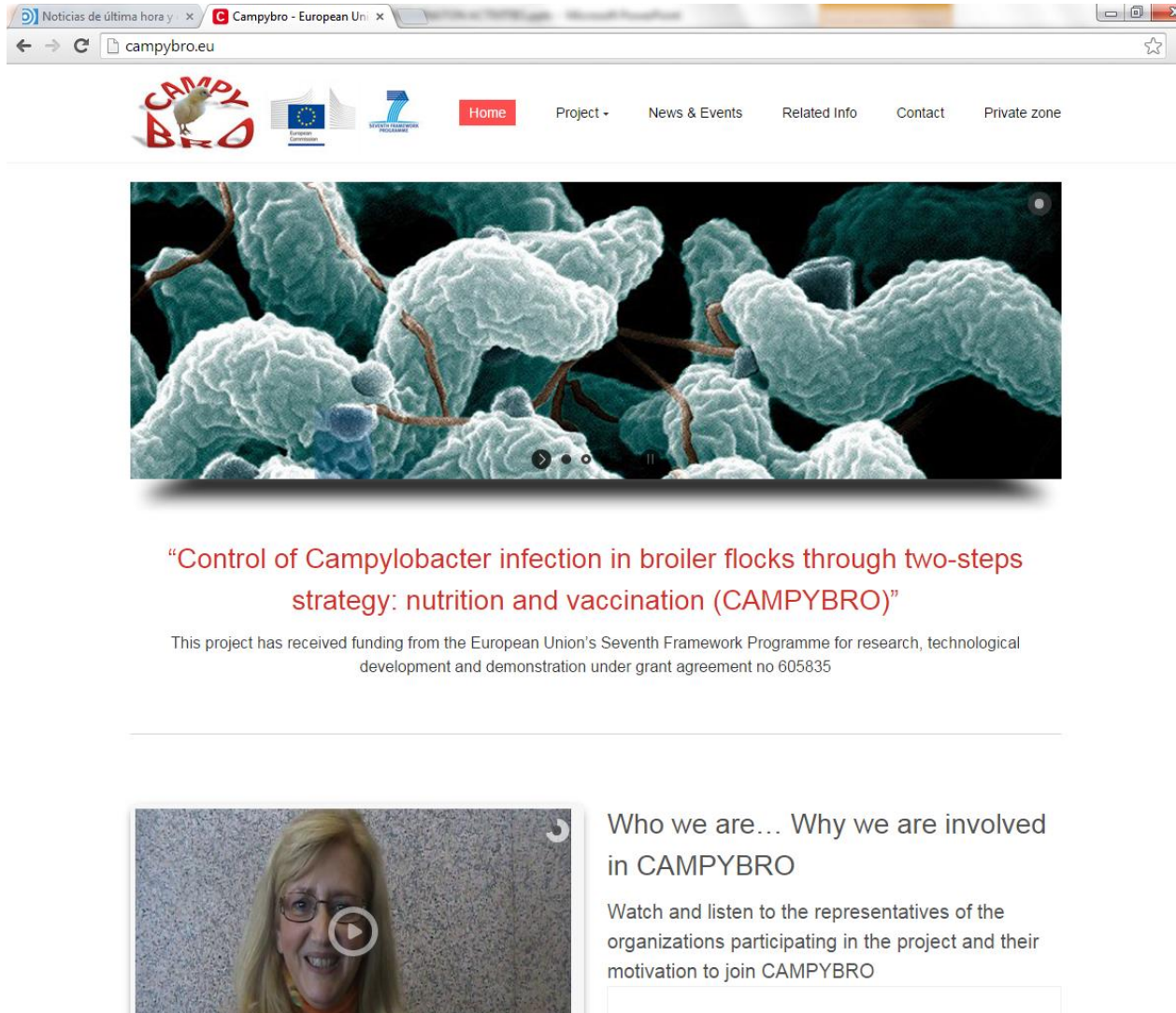
Pelleting and particle size



Dissemination activities



□ www.campybro.eu



The screenshot shows the CAMPYBRO website interface. At the top, there is a navigation bar with the CAMPYBRO logo, the European Union flag, the 7th Framework Programme logo, and links for Home, Project, News & Events, Related Info, Contact, and Private zone. Below the navigation bar is a large video player displaying a microscopic image of bacteria. The video title is "Control of Campylobacter infection in broiler flocks through two-steps strategy: nutrition and vaccination (CAMPYBRO)". Below the video player, there is a text block stating that the project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 605835. At the bottom of the screenshot, there is a video player showing a woman speaking, with the title "Who we are... Why we are involved in CAMPYBRO". Below this video player, there is a text block stating "Watch and listen to the representatives of the organizations participating in the project and their motivation to join CAMPYBRO".

“Control of Campylobacter infection in broiler flocks through two-steps strategy: nutrition and vaccination (CAMPYBRO)”

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 605835

Who we are... Why we are involved in CAMPYBRO

Watch and listen to the representatives of the organizations participating in the project and their motivation to join CAMPYBRO



Questions?