



# Gastrointestinal ecosystem and immunological responses in pigs after weaning fed liquid diets containing whey permeates fermented with different LAB

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# Outline:

- › Backgrounds
- › Objectives of study
- › Experimental design
- › Findings



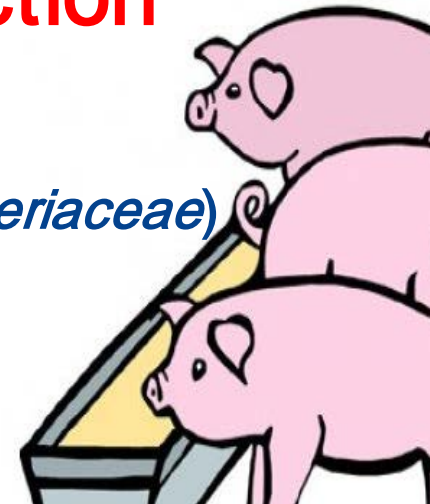
# Backgrounds

## › Feeding liquid diet:

» » » Keep high and regular feed and water intake post-weaning

« « « **Risk for enteropathogenic infection when trough system is used**

(soaking period allows proliferation of *enterobacteriaceae*)



# Backgrounds

## › Whey permeate (WP):

- » » » Byproduct of cheese-making ≈ rich in **lactose**
- » » » Potentially **synbiotic fermented product** that may be added to the liquid diet:
  - Prevent the overgrowth of *enterobacteriaceae* during feeding
  - Exert both **prebiotic** and **probiotic** effect





# Backgrounds

» » » Beneficial effects of fermented products  
for gut health  $\approx$  lactic acid bacteria (LAB)

« « « The effect of LAB  $\approx$  species and strain  
specific



# Objective of study

- › Investigate the effect of feeding liquid diets containing WP fermented with different LAB species on GIT microbial populations and mucosal immune responses of *E. coli* F4 infected pigs after weaning

## Hypotheses:

Feeding fermented-WP may balance gut microbiota and modulate mucosal immunity of pigs in response to ETEC invasion

The effect of fermented-WP on gut microbiology and immunology may depend on the species of LAB used to ferment WP



# Composition of the experimental diets (%)

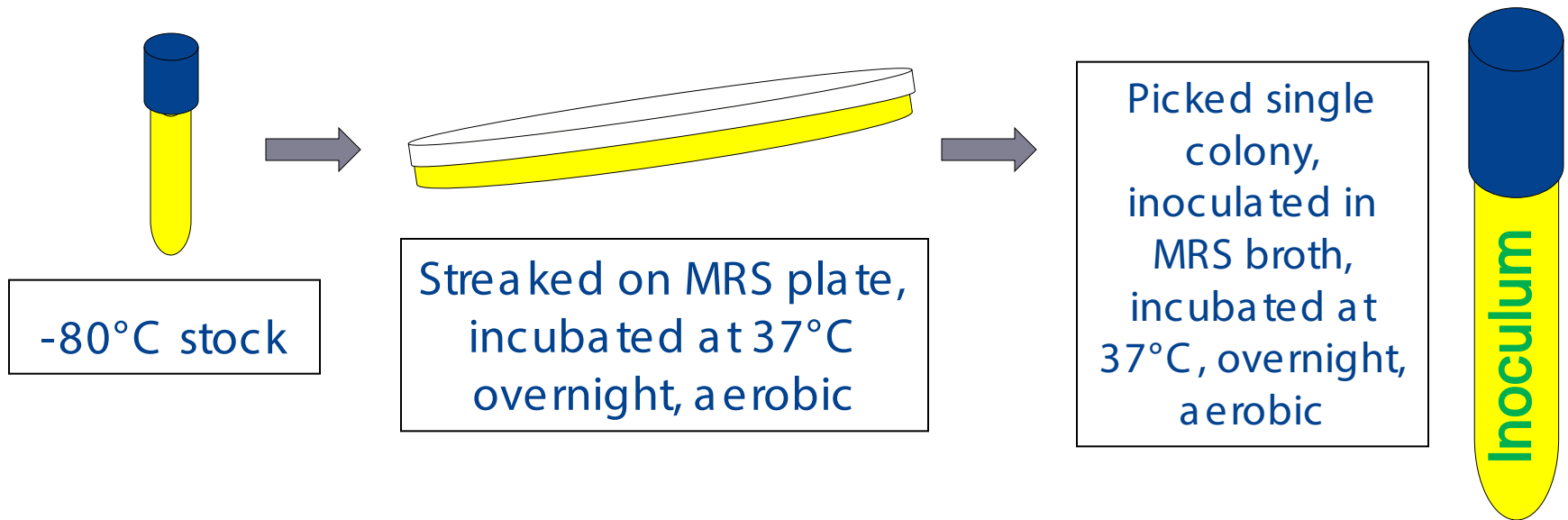
Items	Control	WP groups
WP (Variolac 830)	0	#
Barley	20.000	20.000
Wheat	48.200	41.200
Dehulled toasted soybean meal	16.690	17.610
Animal fat	3.000	3.000
Soy protein concentrate	3.000	3.250
Potato protein	5.000	5.000
Other*	4.110	3.940

**#WP included in the diet = 64 g WP per kg diet**

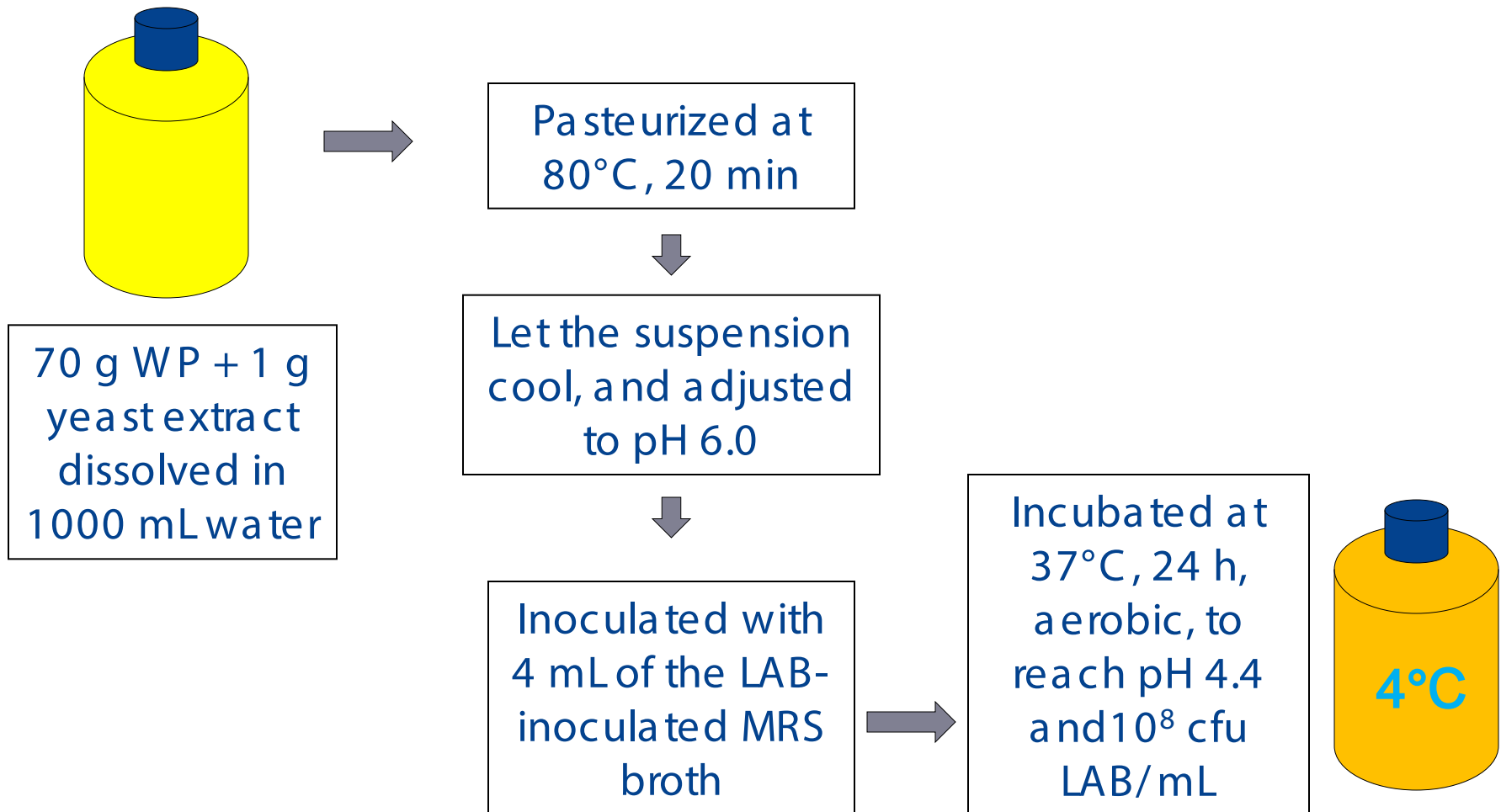
\*L-Lysine HCL, DL-Methionine, L-Threonine, L-Tryptophan, L-Valine, Monocalcium phosphate, Calcium carbonate, 38% Ca, Sodium chloride, Natrphos 5000 (100g/t), Vitamin and mineral premix



# Preparation of inoculum

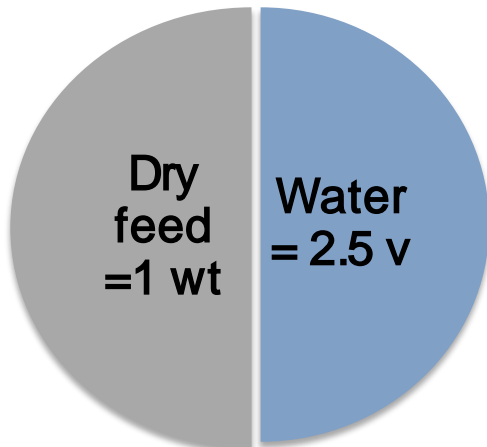


# Preparation of fermented WP

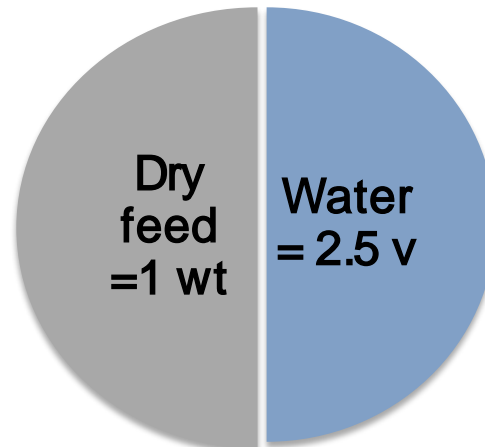


# Preparation of diets

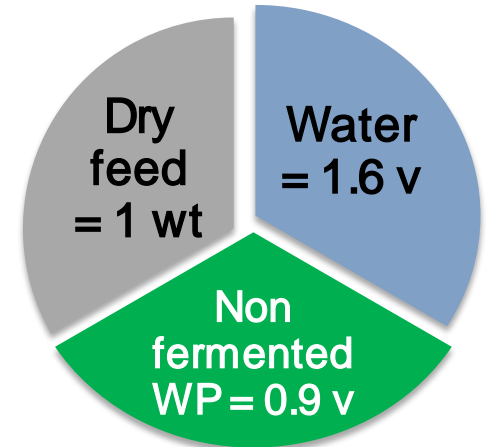
Immediately before feeding



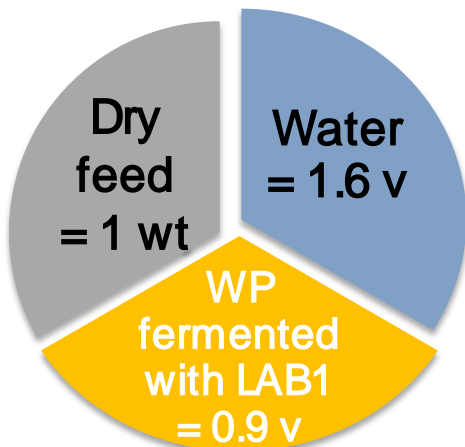
**INF-WP-**



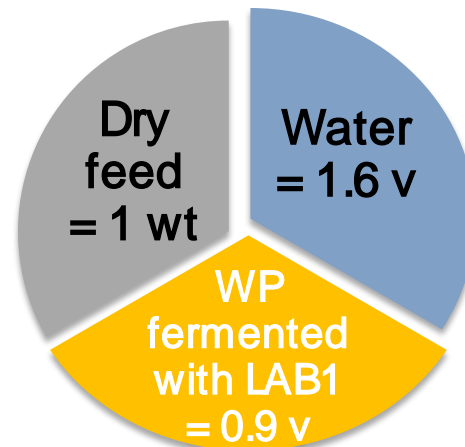
**INF+WP-**



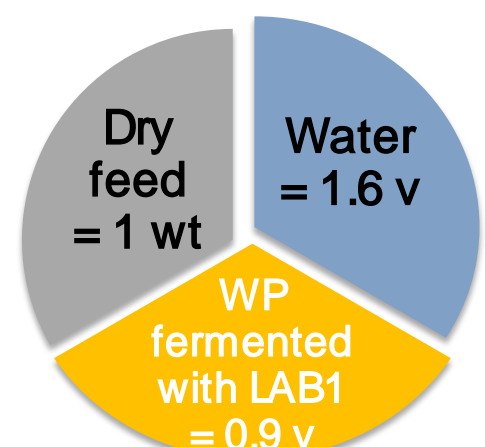
**INF+WP+**



**INF+WP+LAB1**



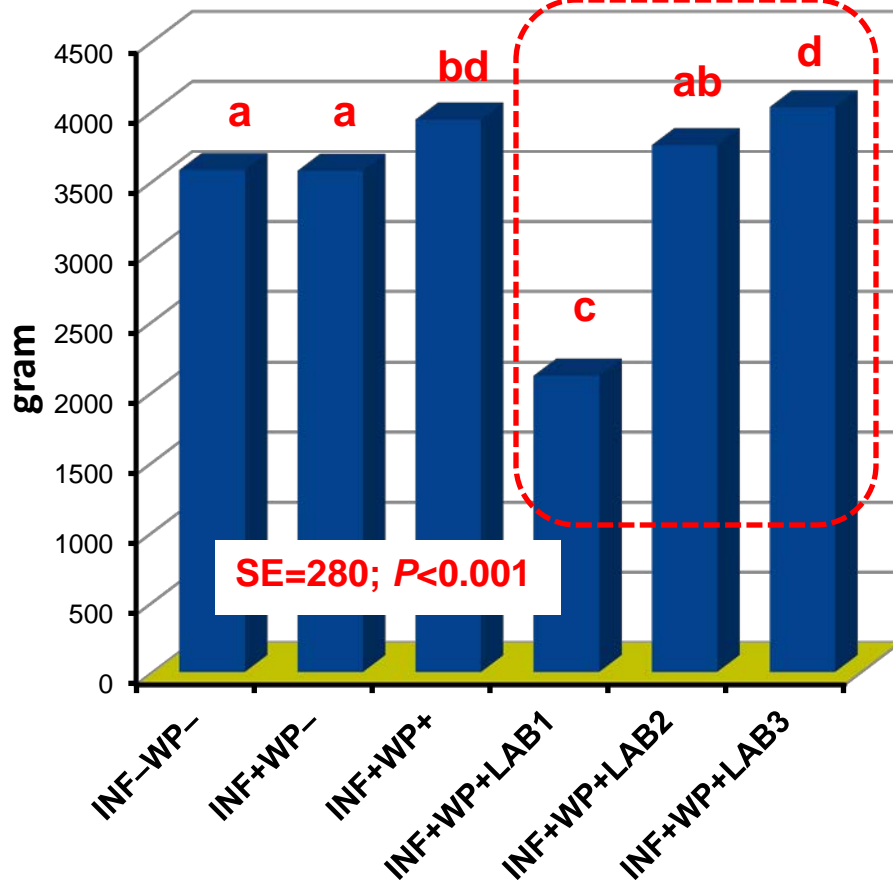
**INF+WP+LAB2**



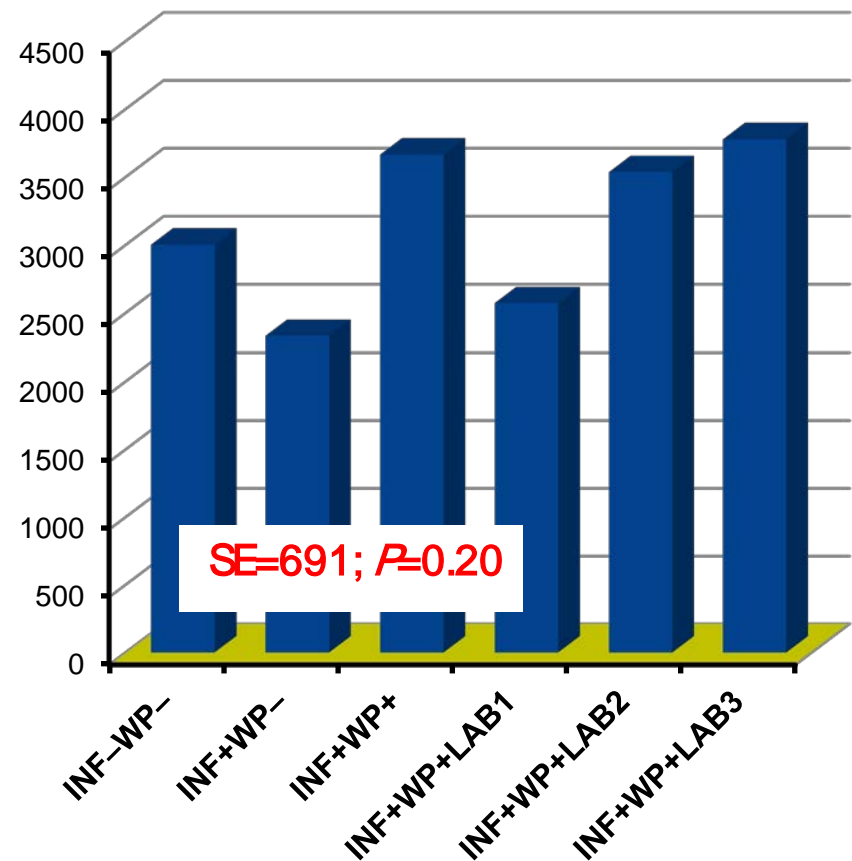
**INF+WP+LAB3**

# Performance of pigs

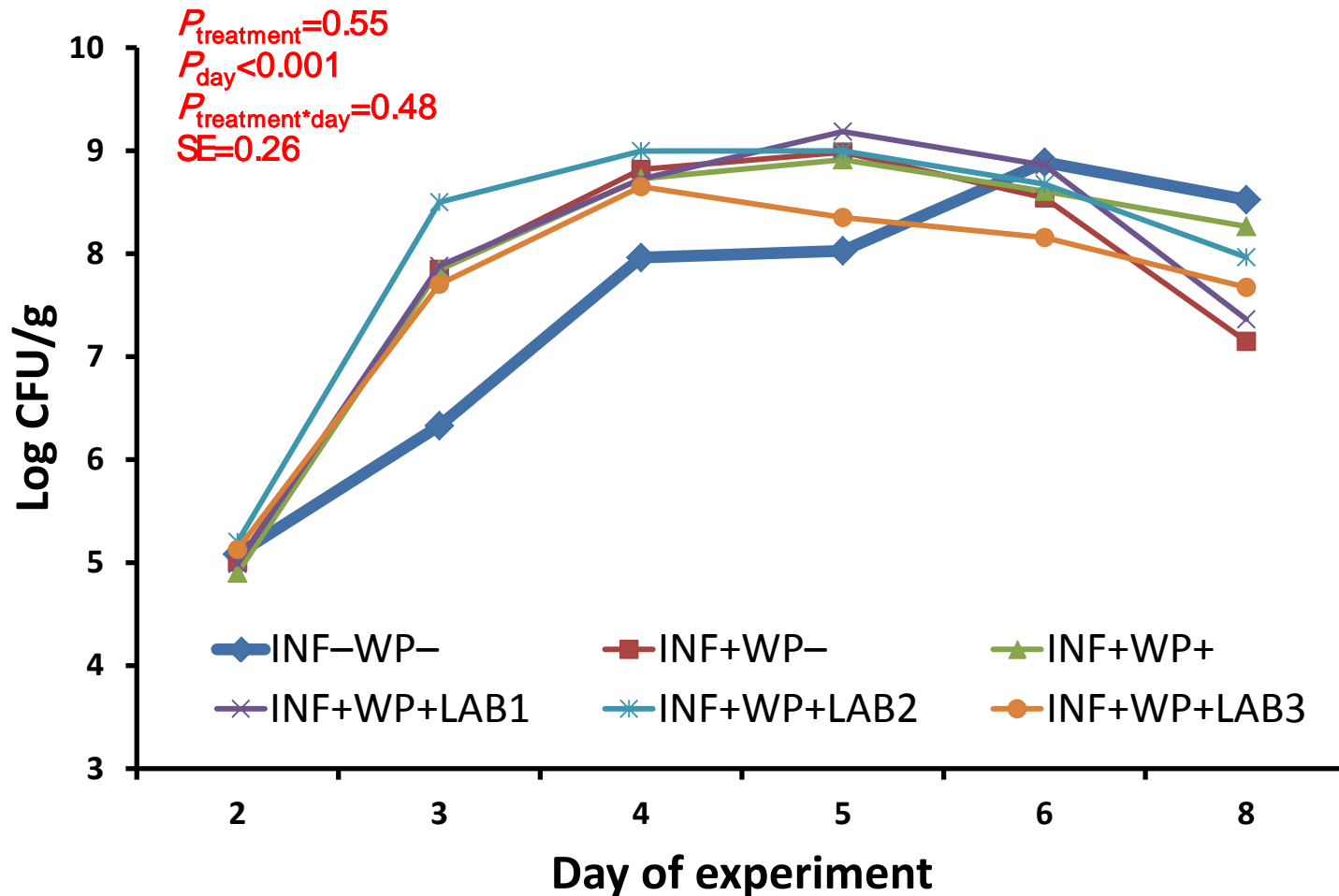
Feed intake, d1-11



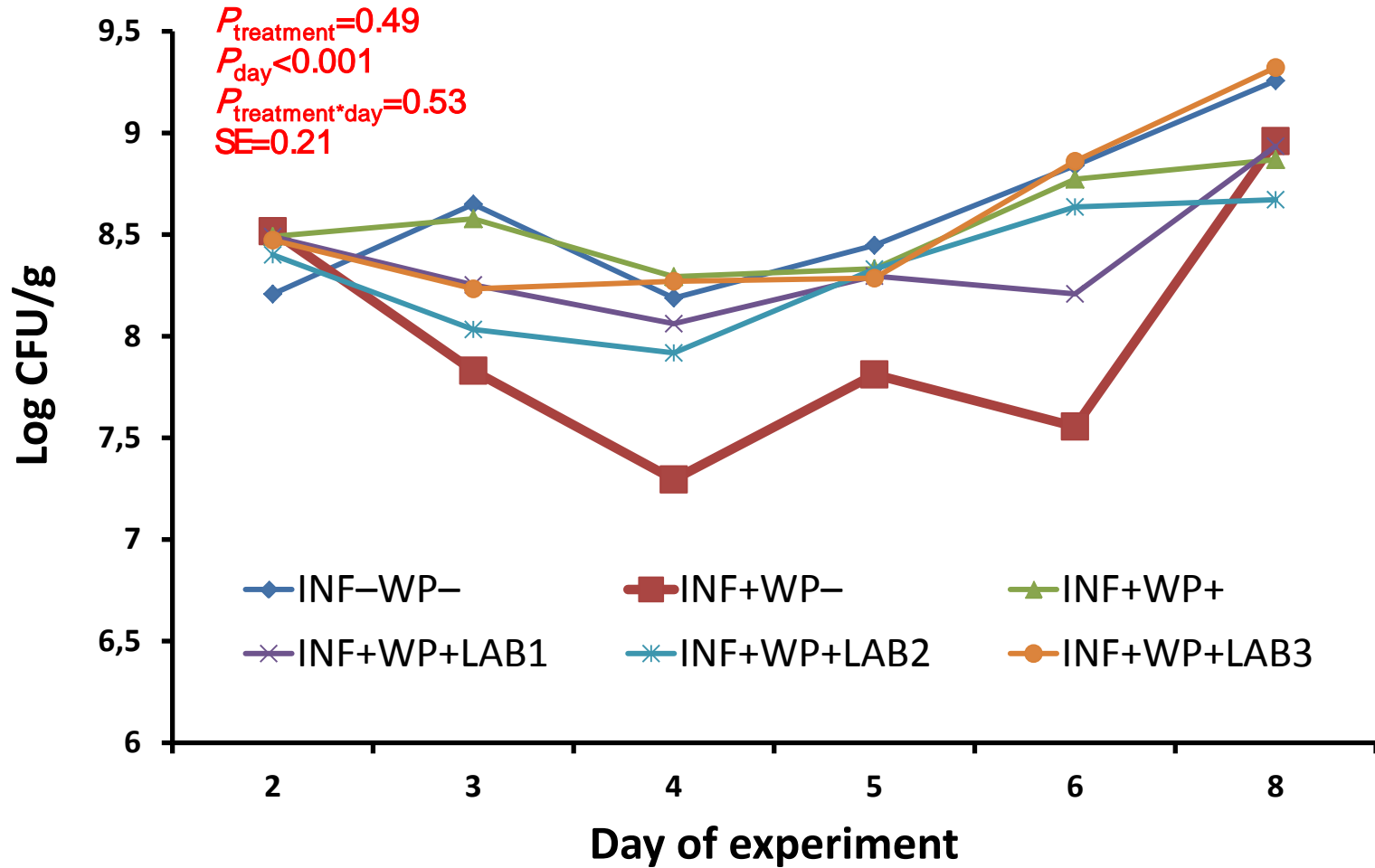
Weight gain, d1-11

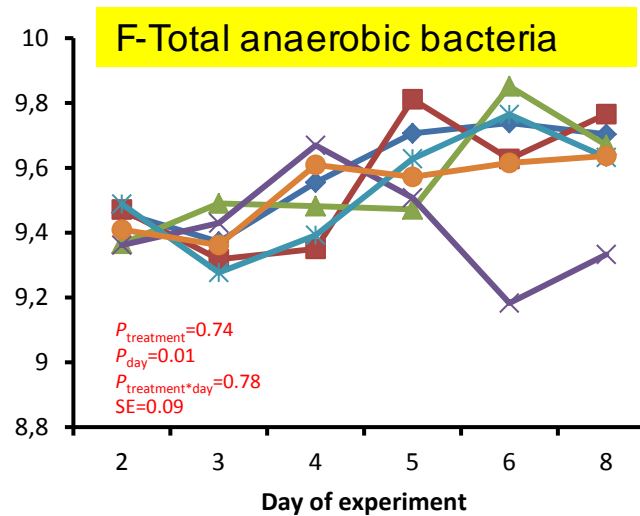
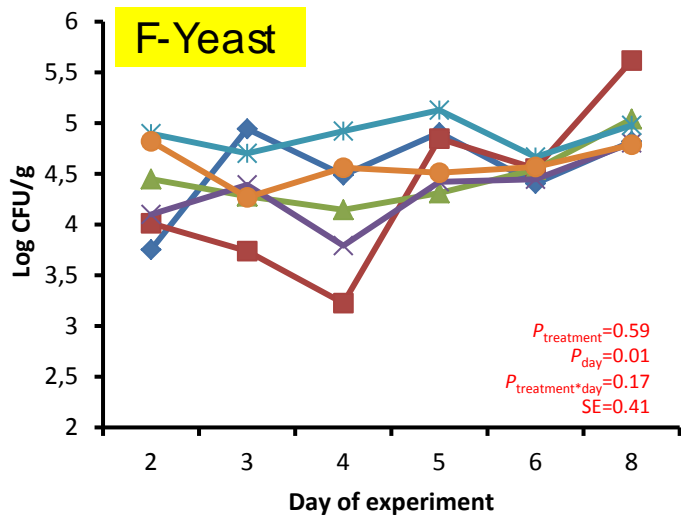
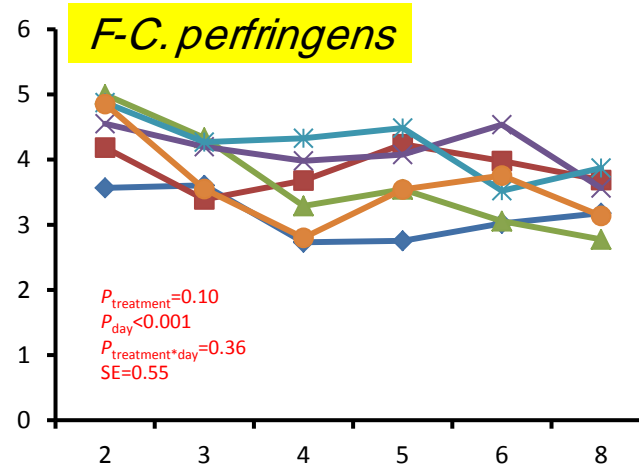
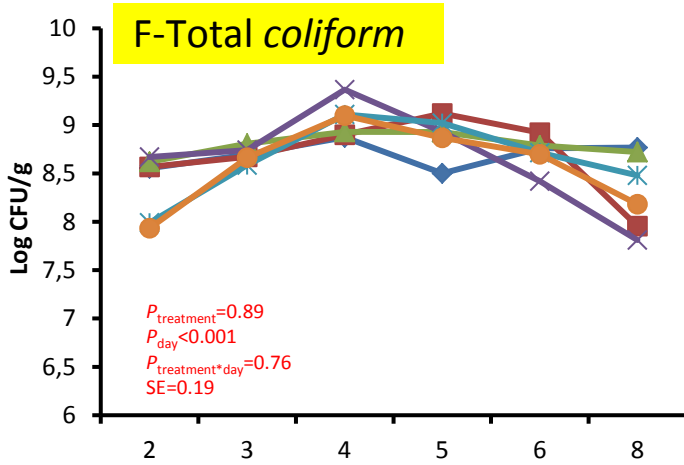


# Faecal-haemolytic *E. coli*



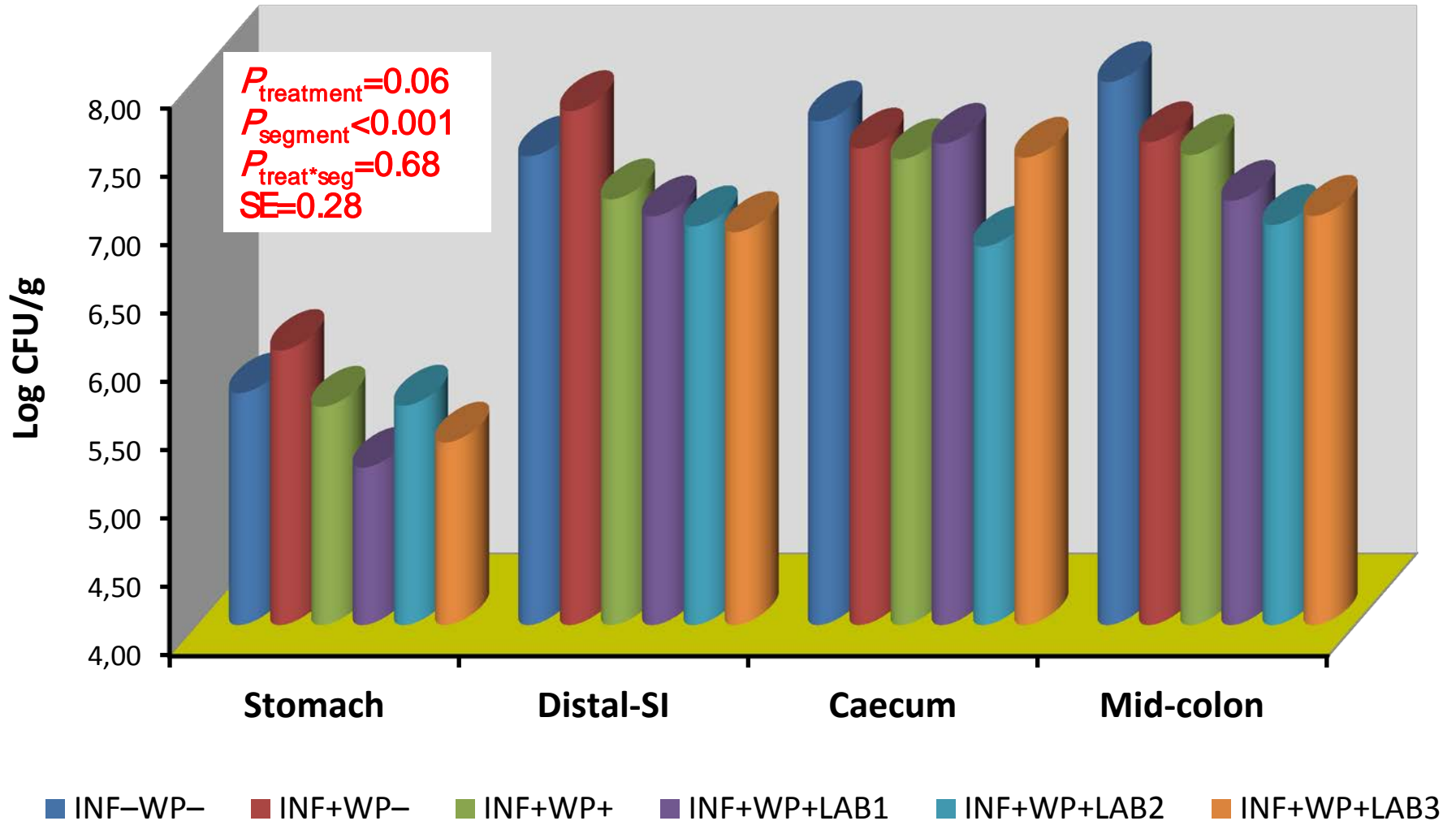
# Faecal-LAB





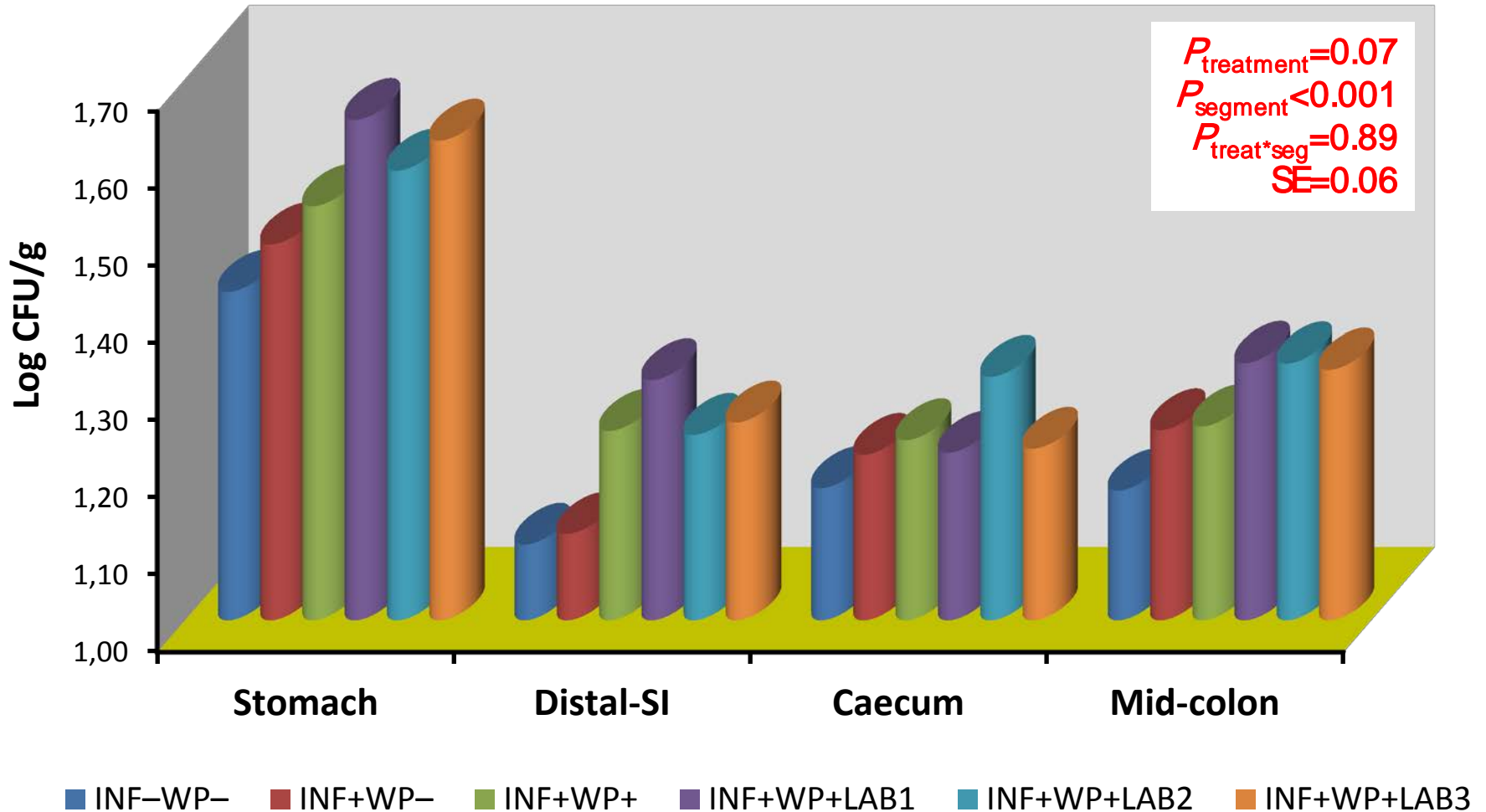
- INF-WP-
- INF+WP-
- INF+WP+
- INF+WP+LAB1
- INF+WP+LAB2
- INF+WP+LAB3

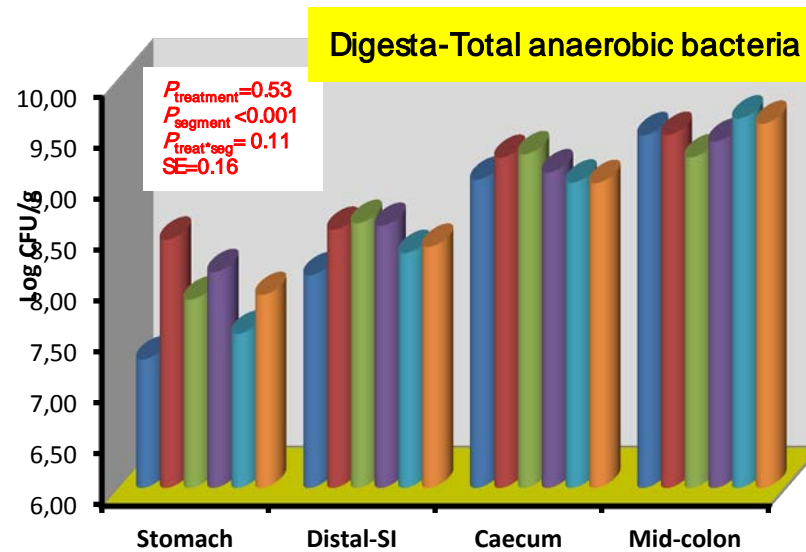
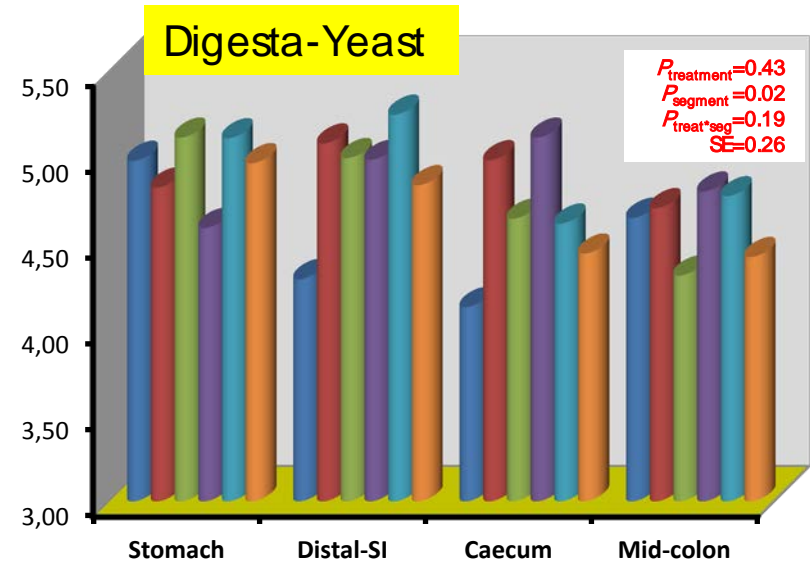
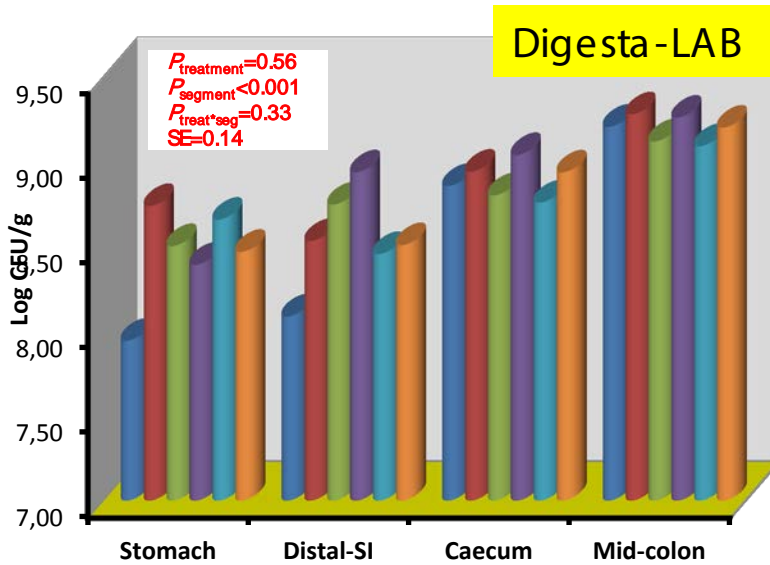
# Digesta -total *coliform*



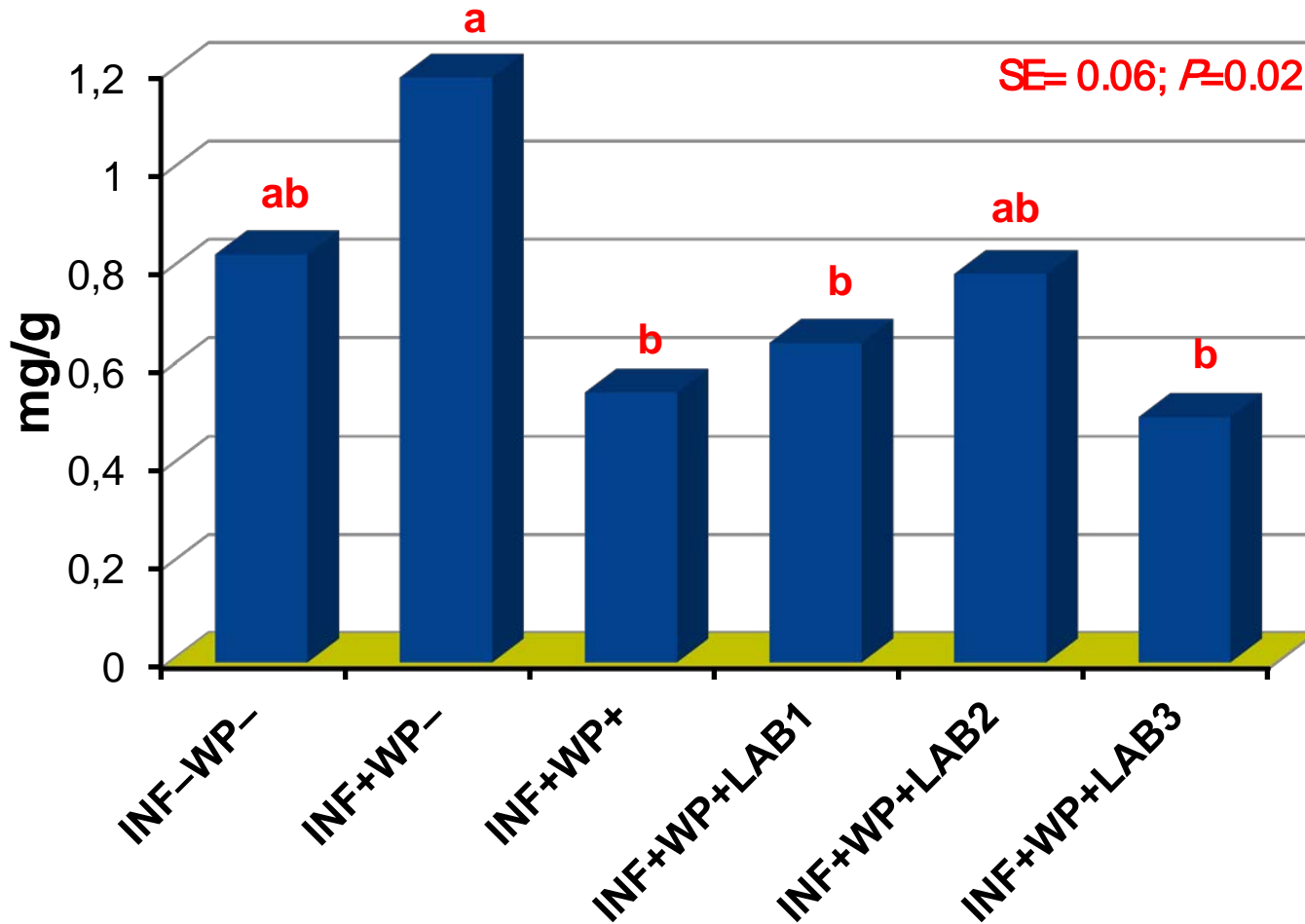


# Digesta - LAB:*coliform* ratio

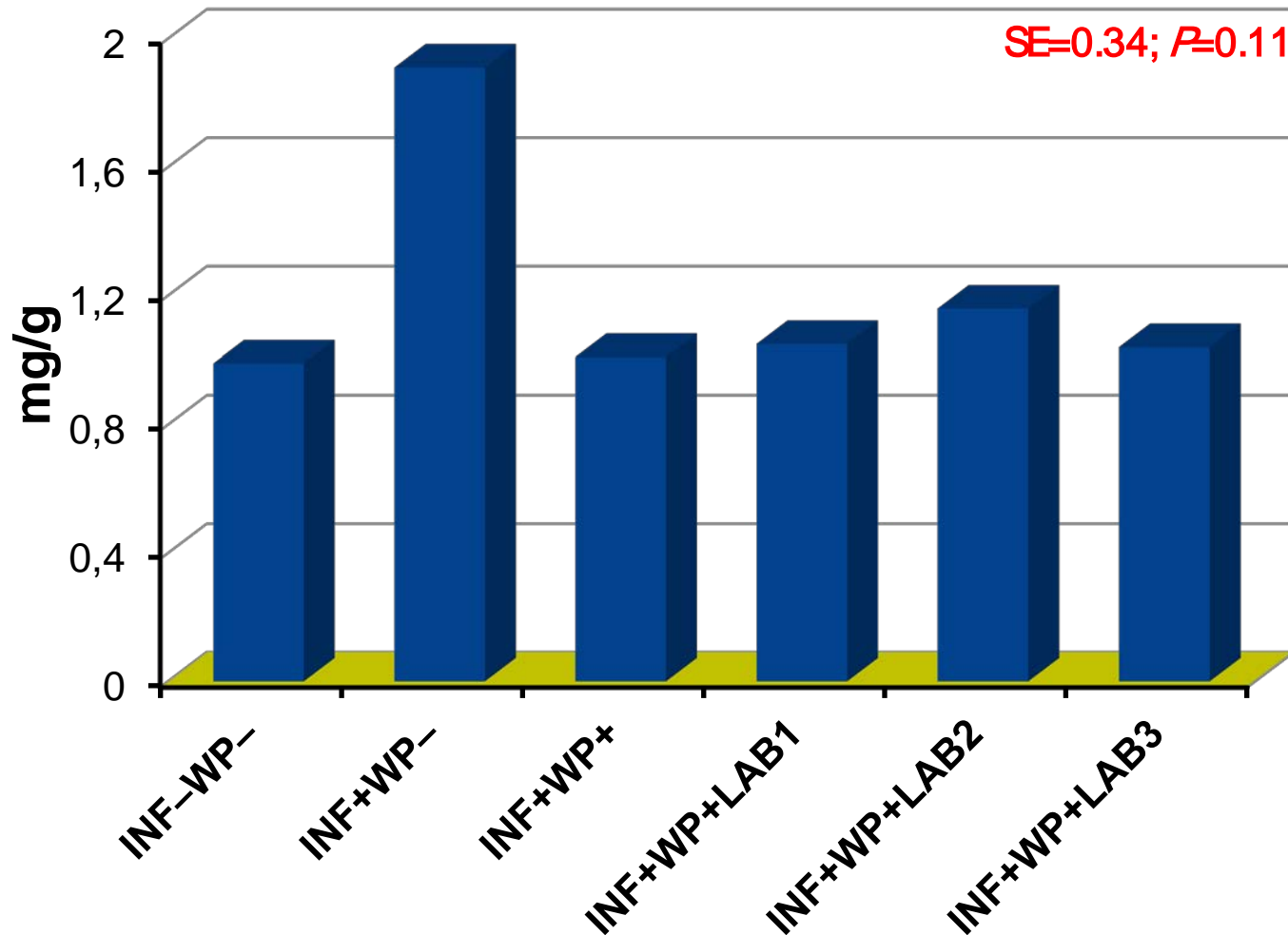




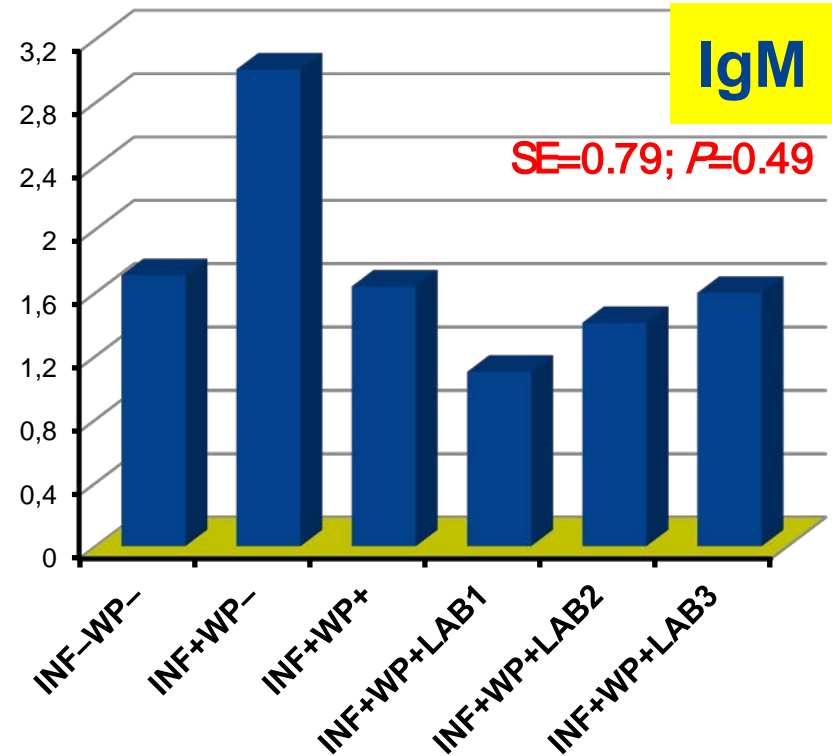
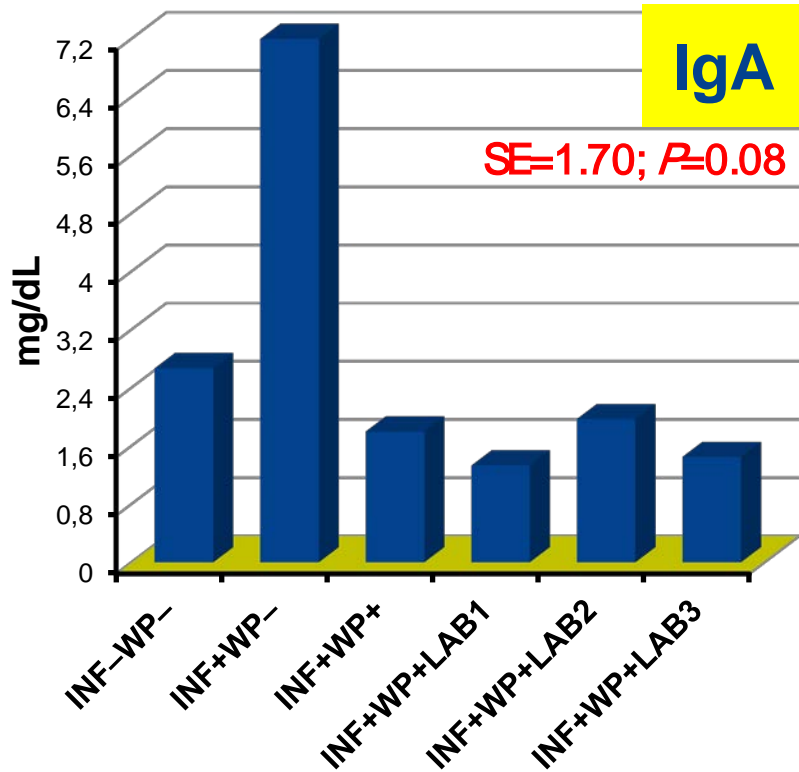
# Mucosal IgA – 90%SI



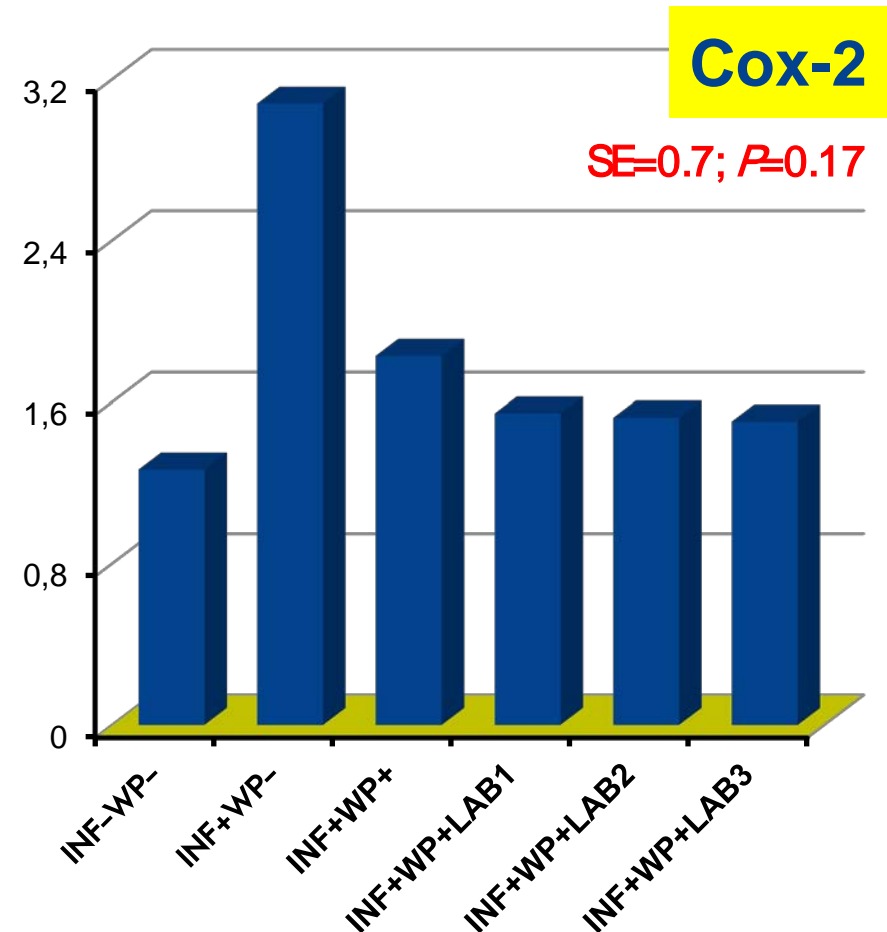
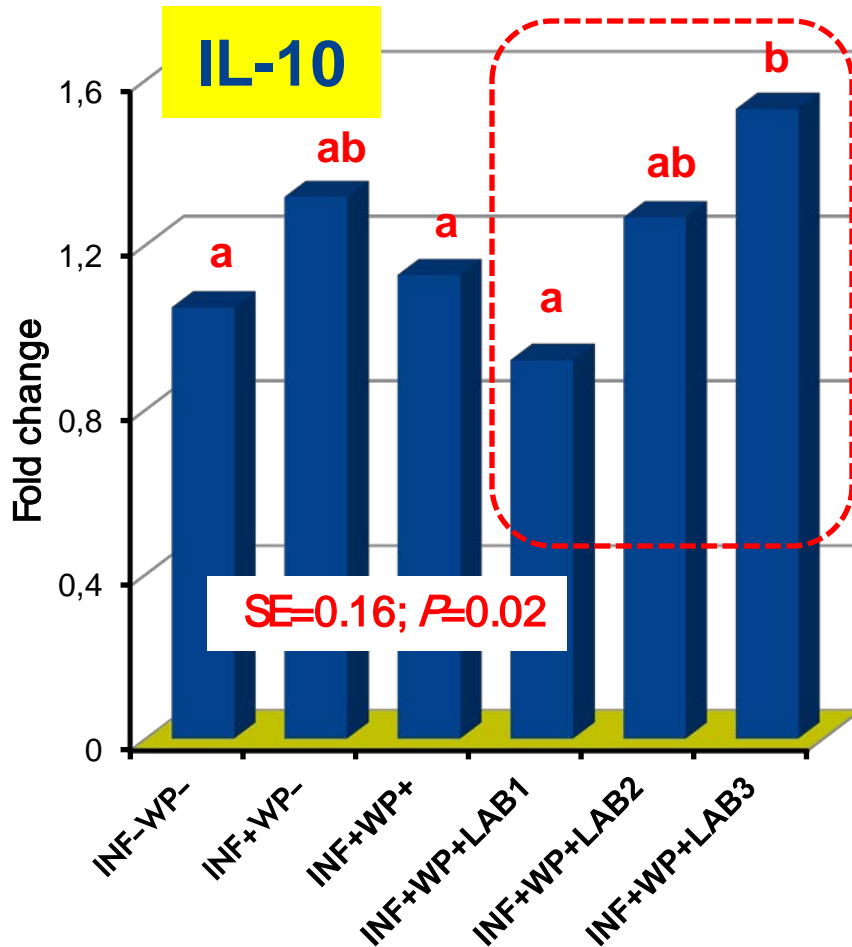
# Mucosa I IgM – 90%SI



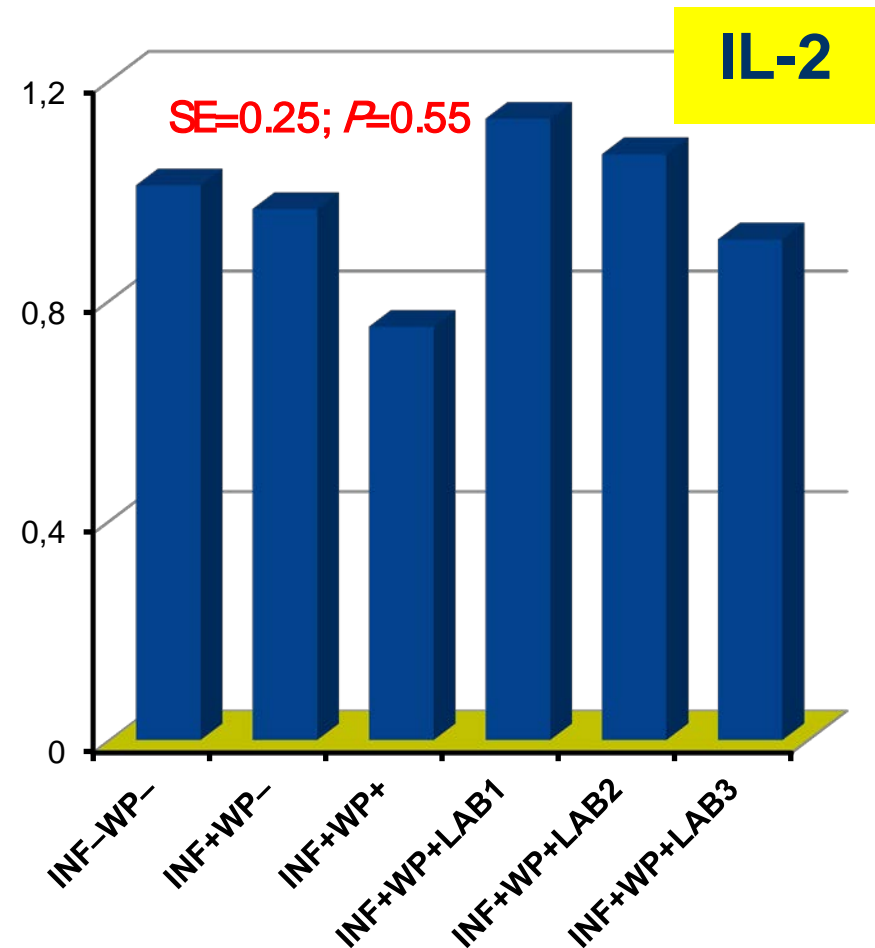
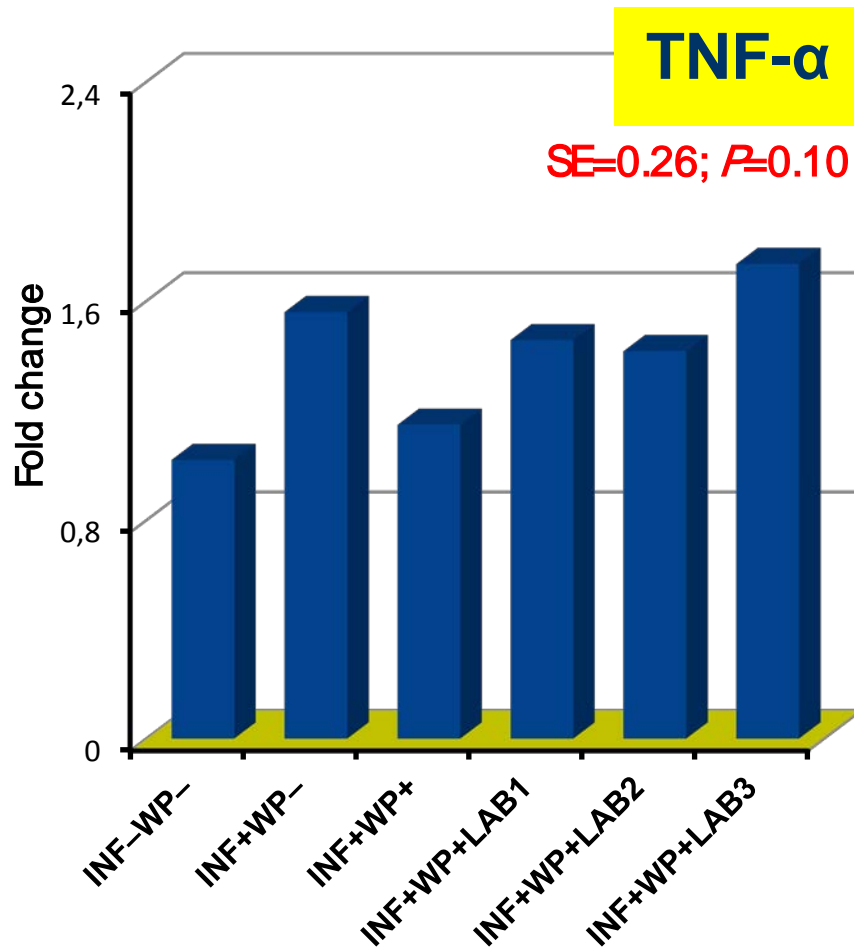
# Biliary IgA and IgM



# Gene expression level



# Gene expression level





# Summary of results

- › Feeding fermented-WP had no sig. impacts on faecal microbial population across the sampling days.
- › Fermented-WP tended to reduce *coliform* bacteria and increase LAB:*coliform* ratio in the GIT digesta, but had no impact on LAB, yeast, and total anaerobic bacteria.
- › Feeding WP or fermented-WP tended to reduce production of IgA and IgM in the distal intestine and bile of the challenged pigs.
- › Treatments had impact on the gene expression level of IL-10, but not on Cox-2, TNF- $\pm$  and IL-2. The effect of LAB on IL-10 seemed to be species dependent.
- › Treatments had no impact on the intestinal dimension of pigs (not shown).



## Discussion of results

- › Higher LAB:*coliform* ratio in digesta of pigs fed fermented-WP was most likely ascribed by the lower counts of *coliform* bacteria.
- >>> Feeding fermented-WP reduced the growth of *coliform* resulting in less immune-stimulation (less Cox-2 expression and IgA and IgM).

Feeding fermented-WP maintained GIT microbial ecosystem and modulated the mucosal immune responses of *E. coli* F4 challenged pigs.

The effect of LAB on host immune systems seems to be species dependent.



# Acknowledgment

- › PhD supervisors: Charlotte Lauridsen, Ph.D. and Bent. B. Jensen, Ph.D. (Aarhus University, Denmark)
- › Sarmauli I. Manurung (National Veterinary Institute, Technical University of Denmark)



**Thank you for your attention**