Effect of fermented whole-crop cereals with or without supplementing inoculant in finishing pigs

Division of Animal, Horticultural and Food Sciences

Major in Animal Science

Chang Hee, Lee

INDEX

STEP 01 INTRODUCTION

STEP 02 MATERIAL AND METHODS

STEP 03 RESULTS

STEP 04 CONCLUSIONS

STEP

01

INTRODUCTION

- Background
- Barley, Wheat
- Non starch polysaccharides
- Fermentation of feed
- Objective

Background

- ✓ **The main raw materials for pigs‘ feed are mostly imported** (100% for corn and more than 70% for soybean meal).
- ✓ **Stable raw materials should be sought**

Barley, Wheat

Barley

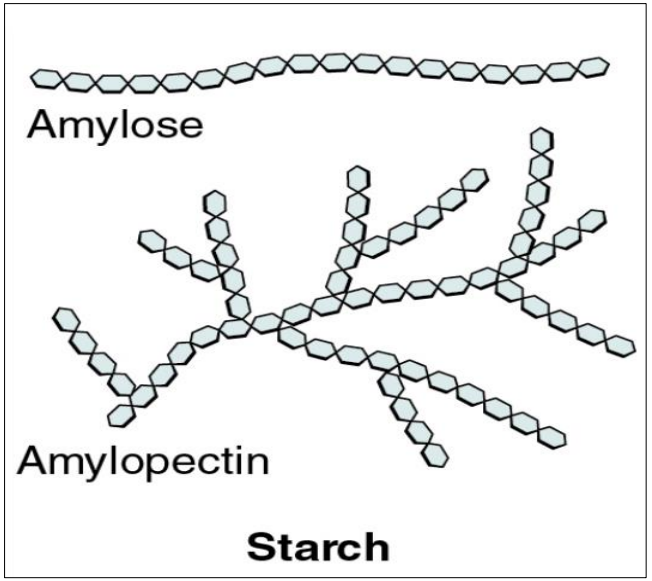
Wheat

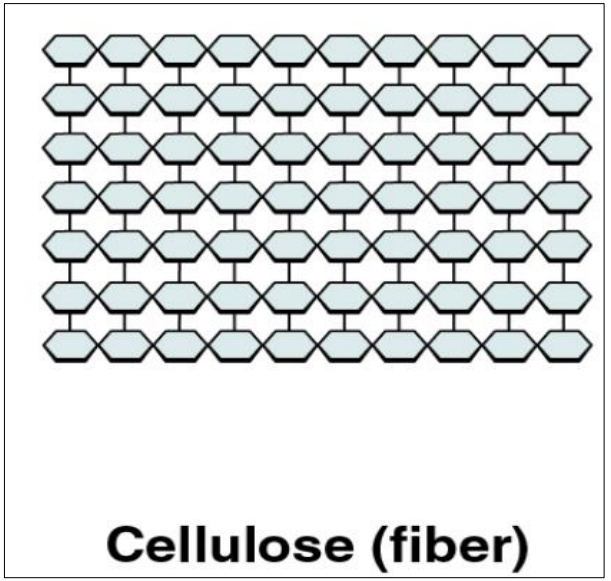
- ✓ **Barley and wheat are major winter-idle crops with high yields in Korea.**
- ✓ **For Korean climate and region, studies on varieties of barley and wheat with high productivity and nutrient contents have been studied([1,2,3,4,5]).**
- ✓ **However, a non starch polysaccharides is contained in whole crop cereal**

Song et al., 2017; Kim et al., 2015; Lee et al., 2016; Kim et al., 2007; Park et al., 2008

Non starch polysaccharides (NSP)

- NSP is also known as dietary Fiber.
- Pigs lack the fiber-degrading enzymes in the small intestine and are difficult to digest and absorb, this can have a negative effect on productivity.





Fermentation of feed

Silage

NSP reduce by fermentation (Jørgensen et al., 2010)

➡ *Positive effects of utilization as feed*

1

Growth performance
([1,2,3])

2

Nutrient digestibility
([4,5])

3

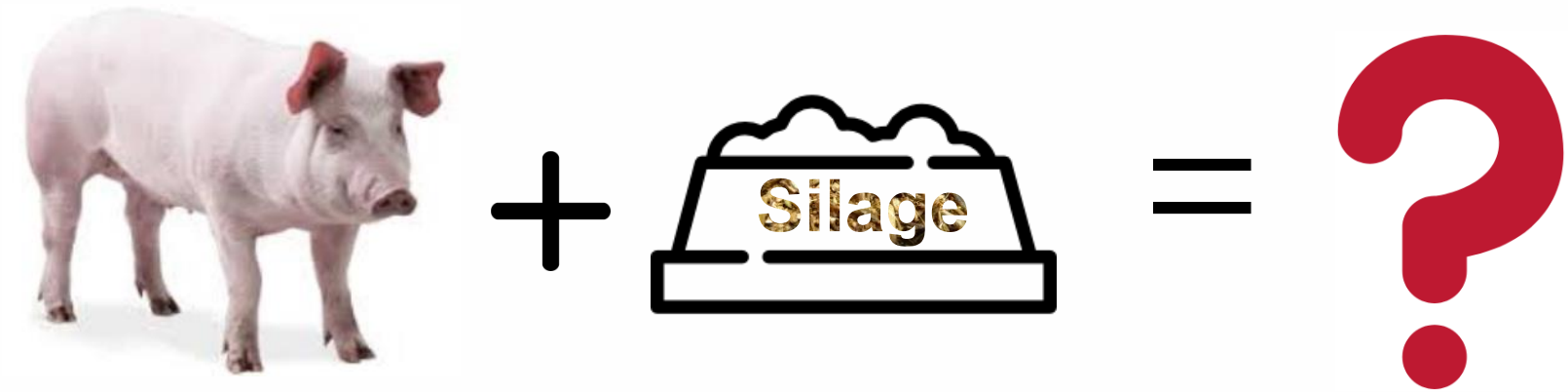
Fecal microbiota
([6,7])

[1]Skrede *et al*., 2001; [2]Brooks, 2008; [3]Jørgensen *et al*., 2010, [4]Hu et al. 2008,[5]Urriola *et al*., 2013,[6]van Winsen *et al*., 2001,[7]Lee *et al,* 2016

Objective

The objective of this experiment..

To determine the effect of fermented whole crop cereal supplementing inoculants on palatability and performance in finishing pigs.



STEP

02

Material and Methods

- Whole-crop cereal for experiment
- Experimental design
- Sampling and analysis

Producing fermented whole crop wheat and barley with inoculum

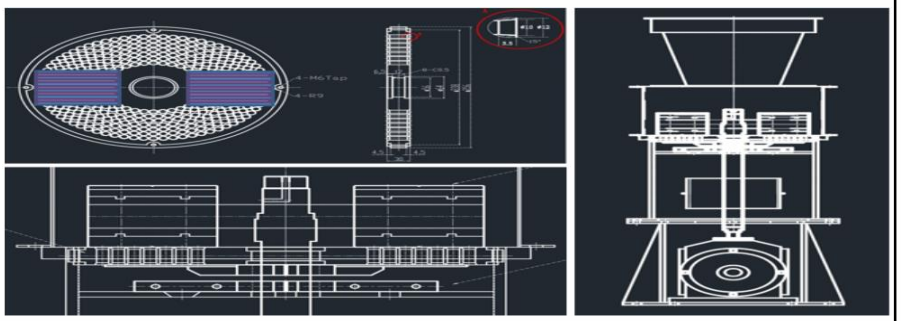
Whole-crop cereal for experiment

Saessal

Geumgang

- Harvest time: 35 and 40 days after heading

Crushing device for whole crop silage

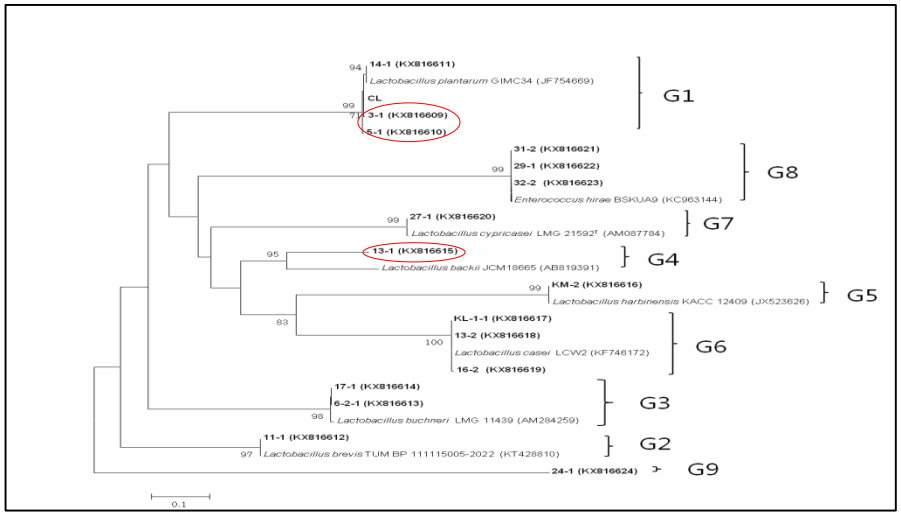


- Ground in hammer mill under 5-mm screen

- ✓ Barley and wheat were harvested respectively at 35 and 40 days after heading when total digestible nutrients and dry matter contents were high.
- ✓ They were ground to pass under 5-mm screen by crushing device.

Producing fermented whole crop wheat and barley with inoculum

Inoculated microorganism



- **Inoculum was treated (*lactobacillus* 3-1, 5-1, 13-1)**

- **Stablization on fermentation period (60 days)**

- ✓ Three strains similar to *lactobacillus plantarum* were selected according to antimicrobial activity.
- ✓ Microbial inoculants were diluted 100 times in ground-water, sprayed evenly on whole crop cereal and sealed.

An Optimum Harvest Time for Making Grinded Silage of Barley and Wheat for Whole Crop

Tae-Hwa Song, Chon-Sik Kang, Young-Keun Cheong, Jong-Ho Park and Tae-Il Park*
National Institute of Crop Science, RDA, WanJu-gun, 55365, Korea.

Chemical composition and feed value of whole crop silage

Chemical composition (%)	Varieties					
	Barley			Wheat		
	A	B	ref.	A	B	ref.
Moisture	66.8	65.9	61.5[11)]	63.0	60.2	57.6[11)]
Crude protein	2.57	2.45	6.1[10)]	2.28	2.43	5.8[10)]
Ether extract	1.62	1.61	—	1.44	1.27	—
Crude fiber	9.61	8.95	—	10.08	10.99	—
Crude ash	2.06	2.01	—	1.75	1.75	—
NDF	18.25	16.94	42.1[10)]	18.02	19.49	43.2[10)]
ADF	10.13	9.52	21.8[10)]	10.44	11.23	22.0[10)]
Lignin	1.10	1.01	—	1.26	1.46	—
Cellulose	9.04	8.51	—	9.18	9.77	—
DMD	81.00	81.48	71.9[10)]	80.76	80.15	71.8[10)]
TDN	80.90	81.38	71.7[10)]	80.65	80.03	71.5[10)]
RFV	412.9	447.5	160.4[9)]	416.9	382.6	152.0[9)]

* NDF : Neutral detergent fiber, ADF : Acid detergent fiber, DMD : dry matter digestibility, TDN : Total digestible nutrition, RFV : Relative feed value, A: not-add fermenter, B : add fermenter, [9, 10, 11)] Cited values from reference.

A: Before ensiling, B: After ensiling

- ✓ There was no difference in the contents of NDF and ADF in whole crop cereal after fermentation

Isolation and characterization of lactic acid bacteria for use as silage additives

Yu-Mi Ro, Gwan-Hyeong Lee, InCheol Park, Wan-Gyu Kim, Byeong-Hak Han, Jaehong You, and Jae-Hyung Ahn*

Agricultural Microbiology Division, National Institute of Agricultural Sciences, Rural Development Administration (RDA), Wanju 55365, Republic of Korea

Isolation media and sources of the selected lactic acid bacterial strains

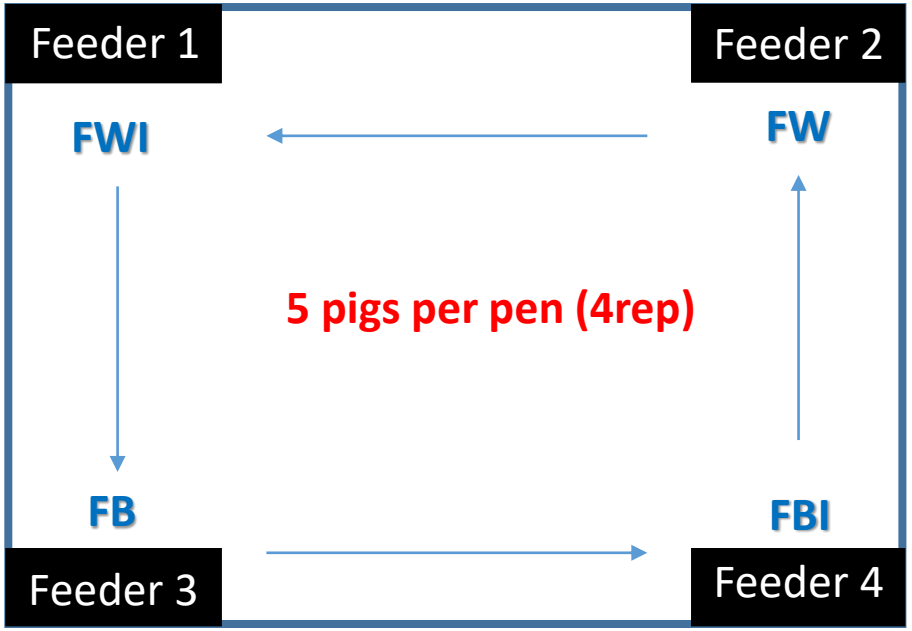
Strain	Medium used	Isolation site	Isolation source
14-1	LBS	Chungju, Chungcheongbuk-do	Rice straw silage
5-1	MRS	Chuncheon, Gangwon-do	Rice straw silage
3-1	MRS	Icheon, Gyeonggi-do	Rice straw silage
11-1	MRS	Chuncheon, Gangwon-do	Rye silage
6-2-1	MRS	Chuncheon, Gangwon-do	Corn silage
17-1	LBS	Chuncheon, Gangwon-do	Rice straw silage
13-1	MRS	Chuncheon, Gangwon-do	Cow dung
KM-2[a]	MRS	Sacheon, Gyeongsangnam-do	Culture medium[a]
16-2	LBS	Chungju, Chungcheongbuk-do	Rice straw silage
13-2	MRS	Chuncheon, Gangwon-do	Cow dung
KL-1-1[a]	LBS	Sacheon, Gyeongsangnam-do	Culture medium[a]
27-1	MRS	Icheon, Gyeonggi-do	Rice straw silage
32-2	LBS	Chungju, Chungcheongbuk-do	Cow dung
31-2	LBS	Icheon, Gyeonggi-do	Cow dung
29-1	MRS	Boeun, Chungcheongbuk-do	Cow dung
24-1	LBS	Icheon, Gyeonggi-do	Rice straw silage

[a] Donated by a farmer

Experiment 1 (palatability trial)

1. Experiment animal :20 finishing pigs (LYD, average body weight of 82.3 kg)

2. Experiment design: 4 treatment, 5 pigs per pen (4 rep)



To evaluate palatability

- ✓ On every weeks at 9:00am, experimental diets from each feeder were rotated to different feeder
- ✓ Feed consumption was recorded on a pen basis to calculate feed intake.

3. Experimental diets (All treatments replaced 1% of the corn rate of the diets with whole crop cereal)

- **FW:** 1% Fermented whole crop wheat without inoculum
- **FWI:** 1% Fermented whole crop wheat with inoculum
- **FB:** 1% Fermented whole crop barley without inoculum
- **FBI:** 1% Fermented whole crop barley with inoculum

Experiment 2 (feeding trial)

Experiment design

20 finishing pigs (LYD,
average body weight of 75.8kg)

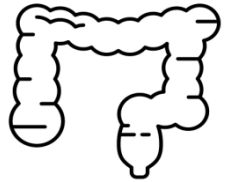
(5 rep, 1 pigs per pen)

- **FW** = 1% fermented wheat without inoculum
- **FWI** = 1% fermented wheat with inoculum
- **FB** = 1% fermented barley without inoculum
- **FBI** = 1% fermented barley with inoculum

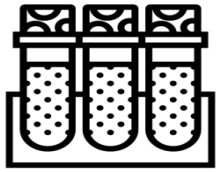
Analysis Items

- ✓ **Growth performance**

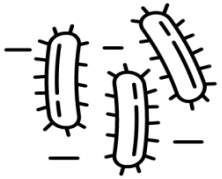
- ✓ **Nutrient digestibility**



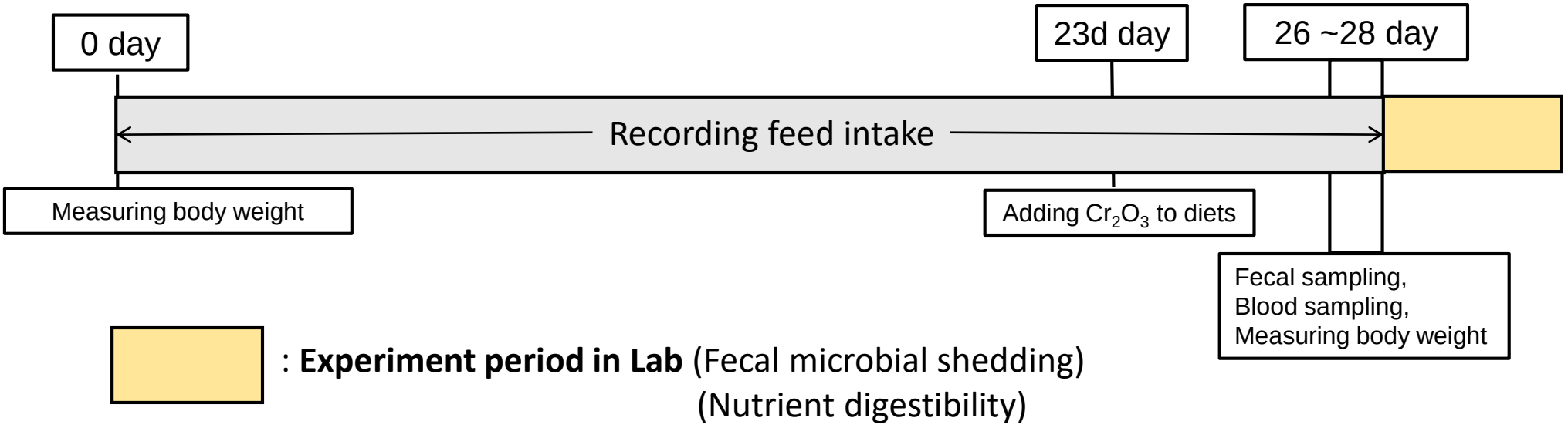
- ✓ **Blood characteristic**



- ✓ **Fecal microbiota**



Experiment 2



Statistical analysis

In this study, all data were analyzed by ANOVA using the general linear model (GLM) procedure of SAS (SAS, 2008).

STEP
03

Results

- Palatability
- Growth performance
- Blood characteristic
- Nutrient digestibility
- Fecal microbial shedding

Results

Table 1. Palatability[1] (Exp. 1)

Items, kg/pen	FWI	FW	FBI	FB	SE[2]	P - value		
						Inoculum	Ingredient	Inoculum × ingredient
ADFI	3.16[a]	3.06[a]	3.13[a]	2.81[b]	0.03	<0.01	<0.01	0.007
Total FI	88.6	85.6	87.6	78.6	0.1			

[1] Data are the means of 4 replicates

[a, b] Means in the same row without a common superscript differ ($p < .05$)

FWI = 1% fermented whole crop wheat diets supplemented with microbial inoculum,
FW = 1% fermented whole crop wheat diets supplemented without microbial inoculum,
FBI = 1% fermented whole crop barley diets supplemented with microbial inoculum,
FB = 1% fermented whole crop barley diets supplemented without microbial inoculum.

[2] Standard error

- ✓ FB group had lowest ADFI compared to other treatments.
- ✓ ADFI was higher in the inoculum treatments than in the non-inoculum treatments.
- ✓ ADFI was higher in wheat treatments than barley treatments.
- ✓ An interactive effect between inoculum and ingredient were observed on ADFI.

Results

Table 2. Growth performance[1] (Exp. 2)

Items, mg/dl	FWI	FW	FBI	FB	SE[2]	P - value		
						Inoculum	Ingredient	Inoculum × Ingredient
Initial BW, kg	76.0	76.2	75.6	75.4				
Final BW, kg	104.5	108.4	107.4	104.5	2.02	0.431	0.331	0.214
ADG	1.02	1.15	1.14	1.04	0.21	0.115	0.213	0.445
ADFI	2.43	2.49	2.40	2.47	0.11	0.311	0.441	0.391
G:F	0.42	0.46	0.47	0.42	0.05	0.245	0.221	0.204

[1] Date are the means of 4 replicates
BW = body weight, ADG = average daily gain, ADFI = average daily feed intake
FWI = 1% fermented whole crop wheat diets supplemented with microbial inoculum, FW = FWI + without microbial inoculum,
FBI = 1% fermented whole crop barley diets supplemented with microbial inoculum, FB = FBI + without microbial inoculum.
[2] Standard error

- ✓ In growth performance, there were no significant difference in final BW, ADG, ADFI and G:F among all treatments.

Results

Table 3. Nutrient digestibility[1] (Exp. 2)

Items, %	FWI	FW	FBI	FB	SE[2]	P – value		
						Inoculum	Ingredient	Inoculum × Ingredient
Dry matter	81.64[a]	80.83[c]	81.10[b]	79.94[d]	0.08	< 0.01	< 0.01	< 0,01
Crude protein	74.67	77.71	76.71	75.07	0.05	0.441	0.249	0.06

[1] Date are the means of 4 replicates
[a, b, c, d] Means in the same row without a common superscript differ ($p < .05$).
FWI = 1% fermented whole crop wheat diets supplemented with microbial inoculum, FW = FWI + without microbial inoculum,
FBI = 1% fermented whole crop barley diets supplemented with microbial inoculum, FB = FBI + without microbial inoculum
[2] Standard error

- ✓ FWI treatments was significantly highest in DM digestibility among treatments.
- ✓ The DM digestibility of the inoculated treatments were significantly higher than non-inoculated treatment.
- ✓ Fermented whole crop wheat showed significantly higher digestibility of DM than fermented whole crop barley.

Results

Table 4. Blood profile[1] (Exp. 2)

Items, mg/dl	FWI	FW	FBI	FB	SE[2]	P - value		
						Inoculum	Ingredient	Inoculum × Ingredient
BUN[3]	12	19	12	9	1.94	0.119	0.412	0.214
Creatinine	1.46	1.36	1.44	1.25	0.41	**0.081**	0.101	0.209
Cholesterol	101	91	93	97	4.09	0.111	0.243	0.405
Triglyceride	37	31	34	35	3.15	0.109	0.304	0.541
Glucose	85	98	79	78	1.92	0.449	0.801	0.641

[1] Date are the means of 4 replicates
FWI = 1% fermented whole crop wheat diets supplemented with microbial inoculum, FW = FWI + without microbial inoculum,
FBI = 1% fermented whole crop barley diets supplemented with microbial inoculum, FB = FBI + without microbial inoculum
[2] Standard error
[3] Blood urea nitrogen

- ✓ The pigs fed diets supplementing with inoculum tended to have a higher creatinine concentration than the pigs fed diets supplementing without inoculum.

Results

Table 5. Fecal microbiota[1] (Exp. 2)

Items, log10/g	FWI	FW	FBI	FB	SE[2]	P - value		
						Inoculum	Ingredient	Inoculum × Ingredient
E.coli	6.1[a]	5.7[b]	5.4[c]	6.2[a]	0.5	0.389	0.824	0.04
Lactobacillus	7.1[a]	6.5[c]	6.7[bc]	6.9[b]	0.6	< 0.01	0.603	< 0.01

[1] Date are the means of 4 replicates
[a, b, c] Means in the same row without a common superscript differ ($p < .05$)
FWI = 1% fermented whole crop wheat diets supplemented with microbial inoculum, FW = FWI + without microbial inoculum,
FBI = 1% fermented whole crop barley diets supplemented with microbial inoculum, FB = FBI + without microbial inoculum
[2] Standard error

- ✓ Inoculum treatment led to an increase in *lactobacillus* count compared to the non-treated group.
- ✓ The number of *lactobacillus* was highest in FWI treatments.

STEP

04

Conclusions

Summary

In palatability,

The addition of fermented microorganism may have a positive effect on palatability.

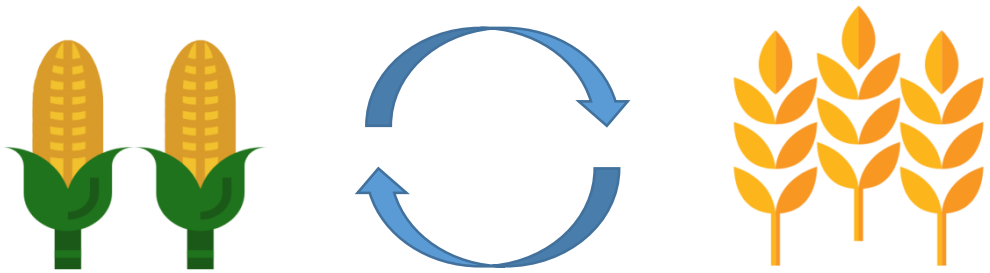
In nutrient digestibility,

fermented whole crop wheat diets had a positive effect on digestibility than fermented whole crop barley diets.

In fecal microbiota,

The number of *lactobacillus* in feces was significantly higher in FWI treatments

Fermented whole crop cereals can be regarded as being able to effectively utilize feeds as alternative material.



Thank you