



The XVII International Silage Conference
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Solid-state fermentation of Lupin (*Lupinus albus*) meal bio-processed with *Lactobacillus plantarum* and supplemented in aqua-diets.

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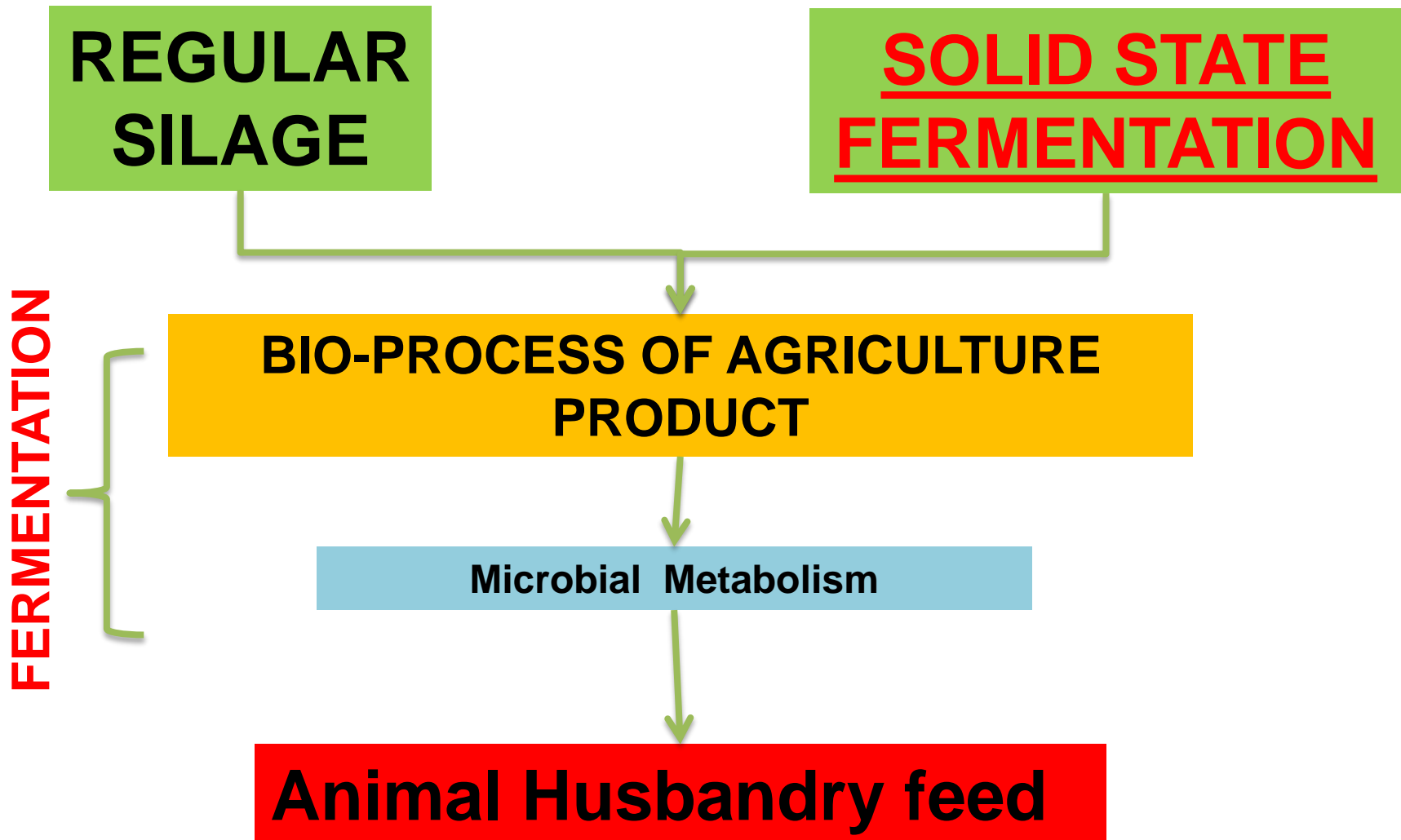




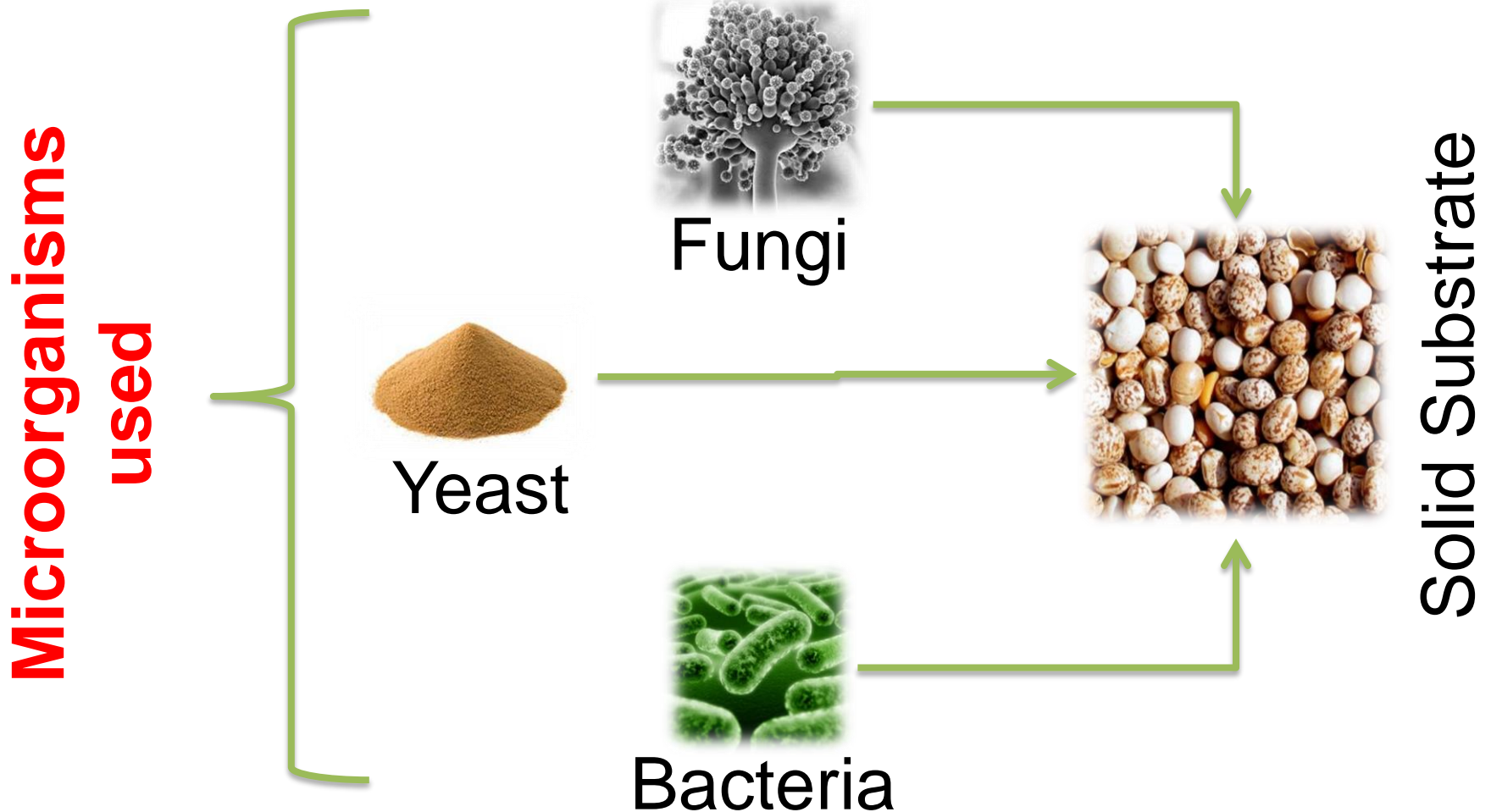
OUTLINE

1. Background of Solid State Fermentation (SSF) of plant meals
2. Effects of SSF in Lupin (*Lupinus albus*) meal with *Lactobacillus plantarum*.
3. Supplementation of Solid State Fermented Lupin (*L. albus*) meal in Aqua-feeds.

DO THEY HAVE SOMETHING TO DO?



1. Background of Solid State Fermentation (SSF).



Metabolites production of *Lactobacillus plantarum* during fermentation.

- ✓ Bacteriocins
- ✓ Lactic acid
- ✓ Acetic acid
- ✓ Other metabolites

They will enrich and modify biochemical composition of surrounding environment (e.g. acidification and antimicrobial peptides production).



Protein source for aqua-feeds.

FISH MEAL

Vs

PLANT MEAL

- ✓ High protein content
- ✓ Excellent amino acid profile
- ✓ High palatability

- ✓ Acceptable nutrient profiles
- ✓ **Antinutrients**

- ✓ Increased global consumption
- ✓ High production costs
- ✓ Limited availability

- ✓ Cheap production costs
- ✓ Highly available

RAW LUPIN MEAL | PLANT MEAL

EFFECTS OF SSF IN Plant Meals



Anti-nutrients	FIBER	+	-
	SAPONINS	+	-
	OLIGOSACÁRIDES	+	-
Nutrients	PROTEIN		→
	AMINO ÁCIDOS		→
	FATTY ACIDS		→

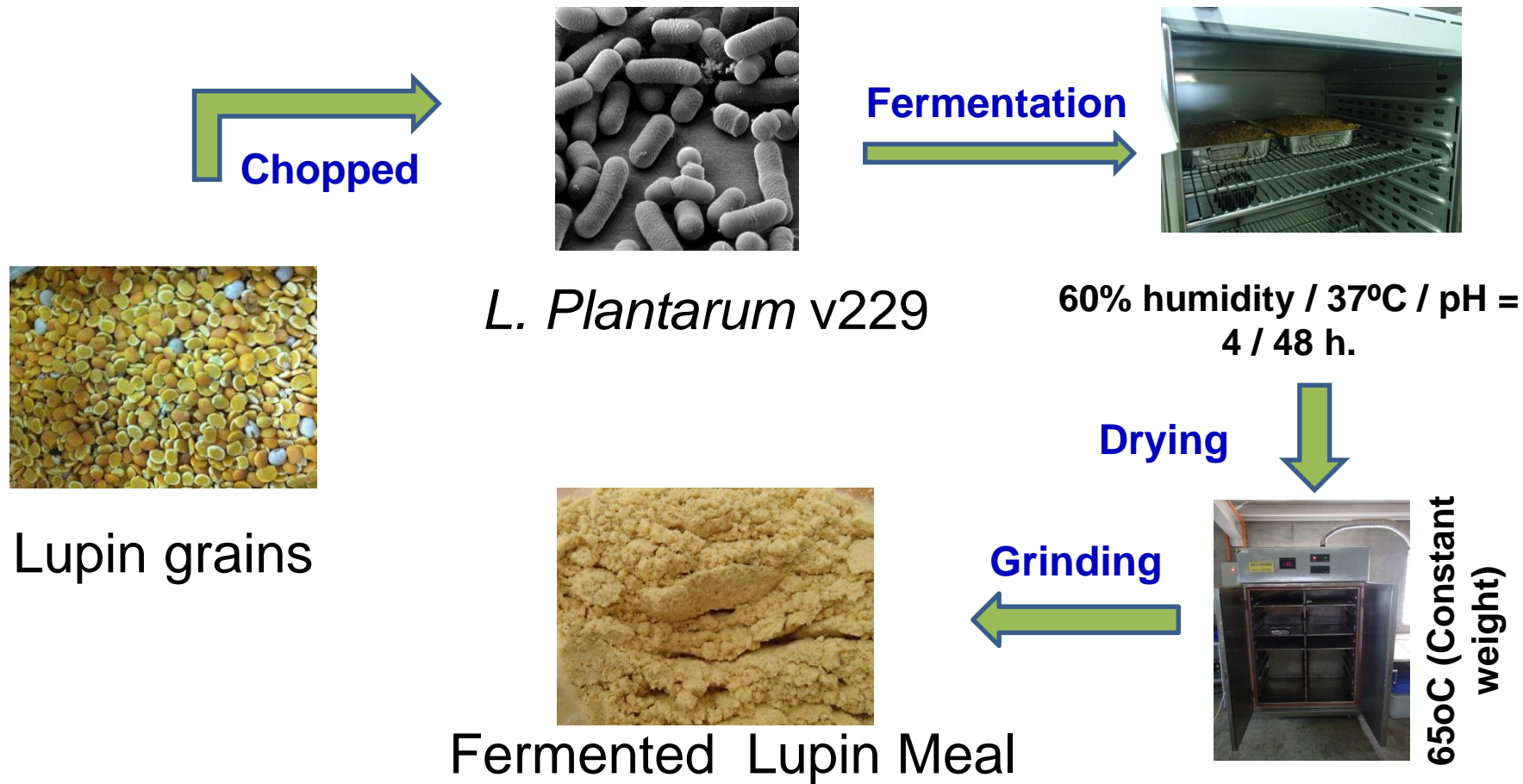


OBJECTIVE

Present study is aimed to assess effects of Solid State Fermentation – SSF – (with *Lactobacillus plantarum*) in proximal composition and organic acid enrichment of Lupin meal alone and after partially being supplemented in aqua-diets.

2. Effects of SSF in Lupin (*Lupinus albus*) meal with *Lactobacillus plantarum*.

Methodology of SSF with Lupin & *L. plantarum*





CFU fermentation of Lupin meal

Sampling time	Humidity (%)	CFU
0 hrs.	70	7×10^3
36 hrs.	65	10×10^7
After Drying	6.9	15×10^3



Organic acids of fermented & non fermented lupin meal

	Raw Lupin	SSF Lupin
Lactic acid (mg / g dry matter)	0	62
Citric acid (mg / g dry matter)	13	6
Acetic acid (mg / g dry matter)	4	14

Proximal composition of fermented & non fermented Lupin meal

Parameter	Raw Lupin	SSF Lupin
Dry matter (%)	94	91
Protein (%)	38	41
Ether extract (%)	8	9
Fiber (%)	3	3
Ash (%)	3	3
Non nitrogenous extract (%)	47	45
Total energy (MJ/kg)	20	21

3. Supplementation of Solid State Fermented Lupin (*L. albus*) meal in Aqua-feeds.

Experimental diet formulation

Ingredientes (g kg ⁻¹)	C	L15%	FL 15%	L 30%	FL 30%
Fish meal, LT	56	48	47	40	39
RAW Lupin meal	0	15	0	30	0
SSF Lupin meal	0	0	15	0	30
Starch gel	13	13	13	13	13
Fish oil	8	8	8	8	8
Raps oil	7	7	7	6	6
micronutrient premix	2	2	2	2	2
Marker	1	1	1	1	1
alpha-Cellulose	13	6	7	0	1

C = Contro diet

L15% = diet partially supplemented with 15% of non-fermented lupin meal.

FL15% = diet partially supplemented with 15% of fermented lupin.

L30% = diet partially supplemented with 30% of non-fermented lupin.

FL30% = diet partially supplemented with 30% of fermented lupin.

Proximal composition of experimental diets

Parameter	C	L15%	FL15%	L30%	FL30%	
Dry Matter (%)	95	97	97	95	96	
Protein (%)	40	41	40	41	40	=
Ether extract (%)	21	21	21	20	21	
Fiber (%)	10	6	7	1	2	↓
Ash (%)	12	11	11	10	10	
Nitrogenous free extract (%)	19	22	22	28	28	↑
Total energy (MJ/kg)	21	22	22	22	22	=

Organic acids of experimental diets

	C	L15%	FL15%	L30%	FL30%
Lactic acid (mg / g dry matter)	0	17	10.1	12.9	75.6
Citric acid (mg / g dry matter)	0	0	0.0	4.9	2.2
Acetic acid (mg / g dry matter)	0	5	4.0	4.1	10.4

C = Contro diet

L15% = diet partially supplemented with 15% of non-fermented lupin meal.

FL15% = diet partially supplemented with 15% of fermented lupin.

L30% = diet partially supplemented with 30% of non-fermented lupin.

FL30% = diet partially supplemented with 30% of fermented lupin.



Summary

- ✓ The SSF with *L. plantarum* produced minimum or meaningful differences in proximal composition of fermented lupin meal (alone) or partially supplemented in aqua-diets (15% or 30%).
- ✓ SSF with *L. plantarum* notoriously enrich lupin meal with lactic acid and acetic acid.
- ✓ Partial supplementation level (30%) of fermented lupin meal considerably enriched aqua-diets with lactic and acetic acid.



- ✓ Results of an additional study – not shown in this presentation – (feeding experiment using juveniles of *Salmo salar*), demonstrated that diets supplemented with 15% and 30% of fermented Lupin meal, increased some growth and immune related parameters of Atlantic Salmon (*S. salar*)
- ✓ These benefits can be explained by presence, in experimental diets, of metabolites produced by *L. plantarum* during SSF process, triggering an improving growth and immune response.
- ✓ Feeding experiment results, suggest that acidification of consumed diets, enhances nutrient digestibility and improves intestine's environment favorable for the proliferation of beneficial bacteria in fish gut (hence, immune system is stimulated).



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Obrigado

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Gracias

Thank you

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