Starch digestibility impact on the performance of broilers

Sebastian A. Kaczmarek

Poznan University of Life Sciences, Poznan, Poland;

- High digestibility
  - for poultry

	Basal		Basal + Amylase[1]		
Day:	Starch total tract digestibility:				Diet *P*-value
	Mean	CV[2] (%)	Mean	CV (%)	
7	0.968	2.41	0.976	0.92	0.0199
9	0.974	1.14	0.986	0.39	<0.0001
11	0.978	0.89	0.985	0.31	<0.0001
14	0.973	0.48	0.986	0.32	<0.0001
16	0.982	0.95	0.987	0.31	0.0008
18	0.970	1.07	0.987	0.32	<0.0001
21	0.979	0.62	0.985	0.77	<0.0001
23	0.976	0.93	0.986	0.8	<0.0001
25	0.978	1.21	0.984	0.52	0.0005
28	0.968	4.97	0.976	1.02	0.2006
30	0.962	1.4	0.975	1.23	<0.0001
32	0.976	1.16	0.980	0.76	0.0173
35	0.976	1.04	0.980	0.79	0.0079
37	0.969	1.13	0.978	1.08	<0.0001
39	0.963	1.62	0.976	0.84	<0.0001
42	0.972	1.29	0.979	0.78	0.0004
7–42	0.973	2.41	0.982	0.92	<0.0001

(Bassi et al., 2023)

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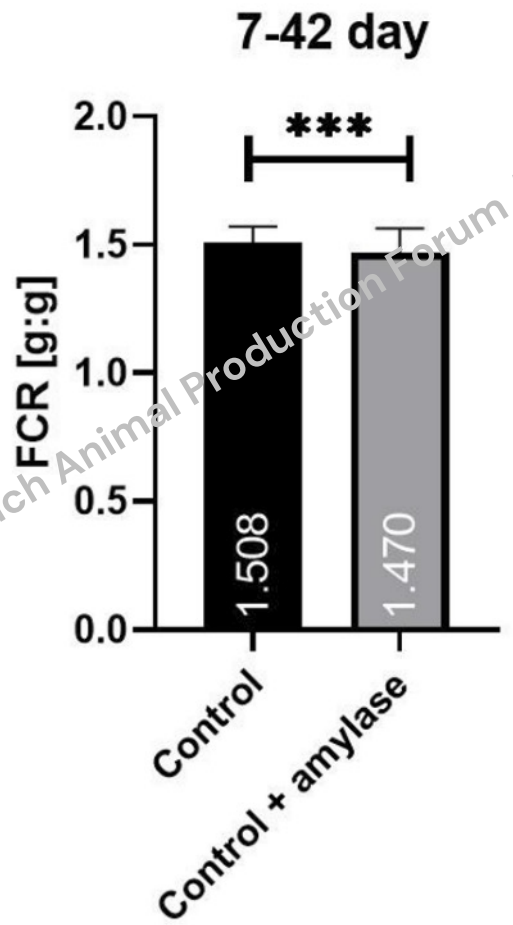

(Bassi et al., 2023)

Starch

- Maize starch – 14.8 MJ/kg (3535 kcal/kg) (INRA Tables)
- „1%" = 35.4 kcal

	Starter		
	%		
SBM	30.58	31.2	35.16
Wheat	30.0	59.49	-
Maize	21.02	-	57.1
Rye	5.0	-	-
SFM	5	1	-
Other			
Starch	35	37	37.5
MJ from starch	**5.18**	**5.5**	**5.6**
kcal	**1237**	**1314**	**1338**

Over 40 % ME

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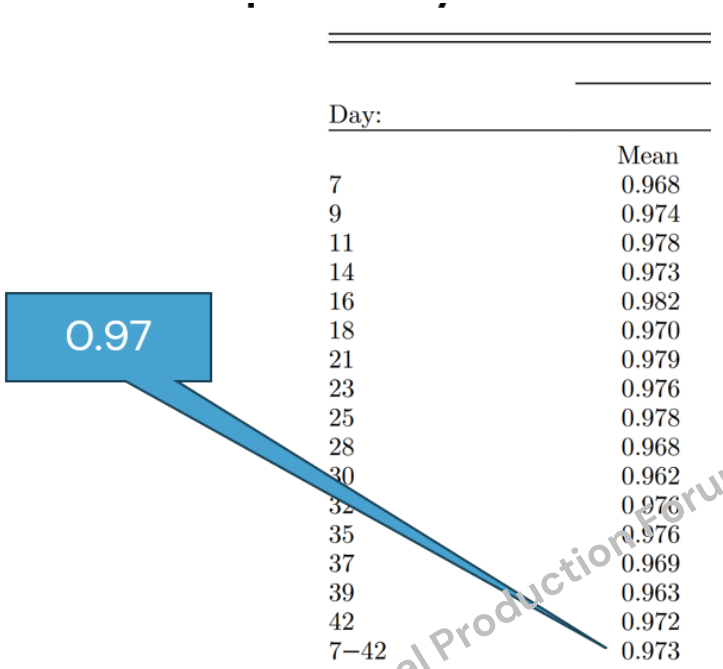

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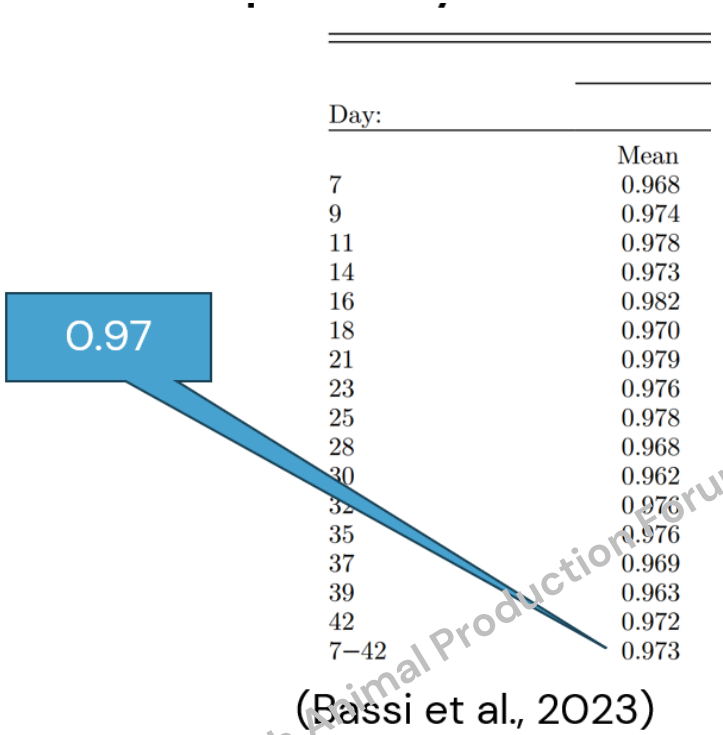

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1298

Over 40 % ME

- Maize starch – 14.8 MJ/kg (3535 kcal/kg) (INRA Tables)
- „1%" = 35.4 kcal

High digestibility = good performance

	Starter		
	%		
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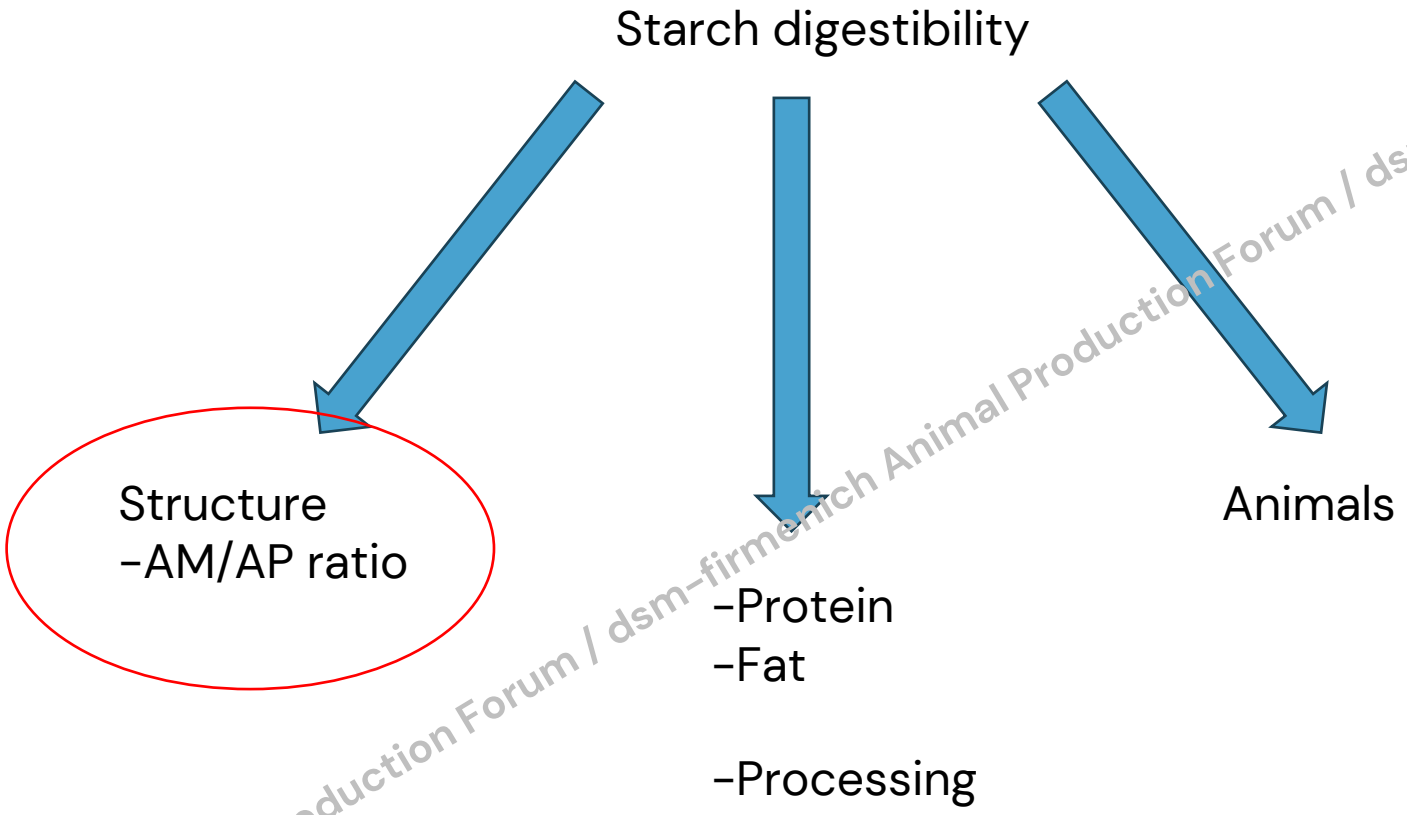
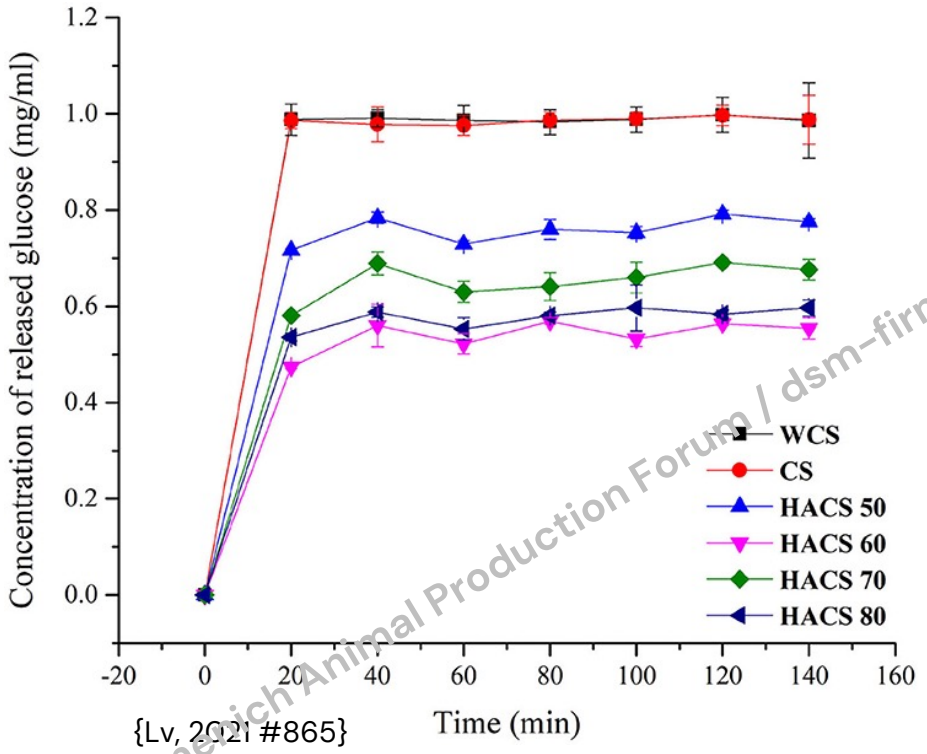
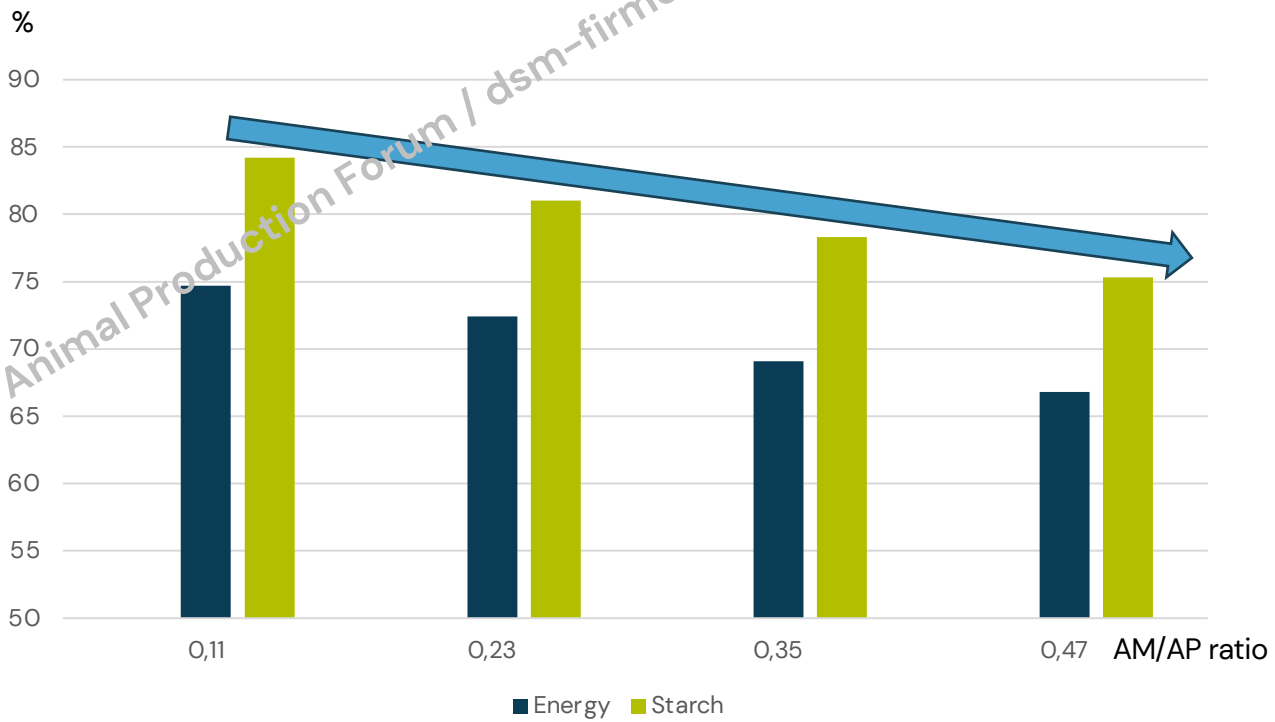


- AM is more resistant to be digested
  - Energy and starch digestibility

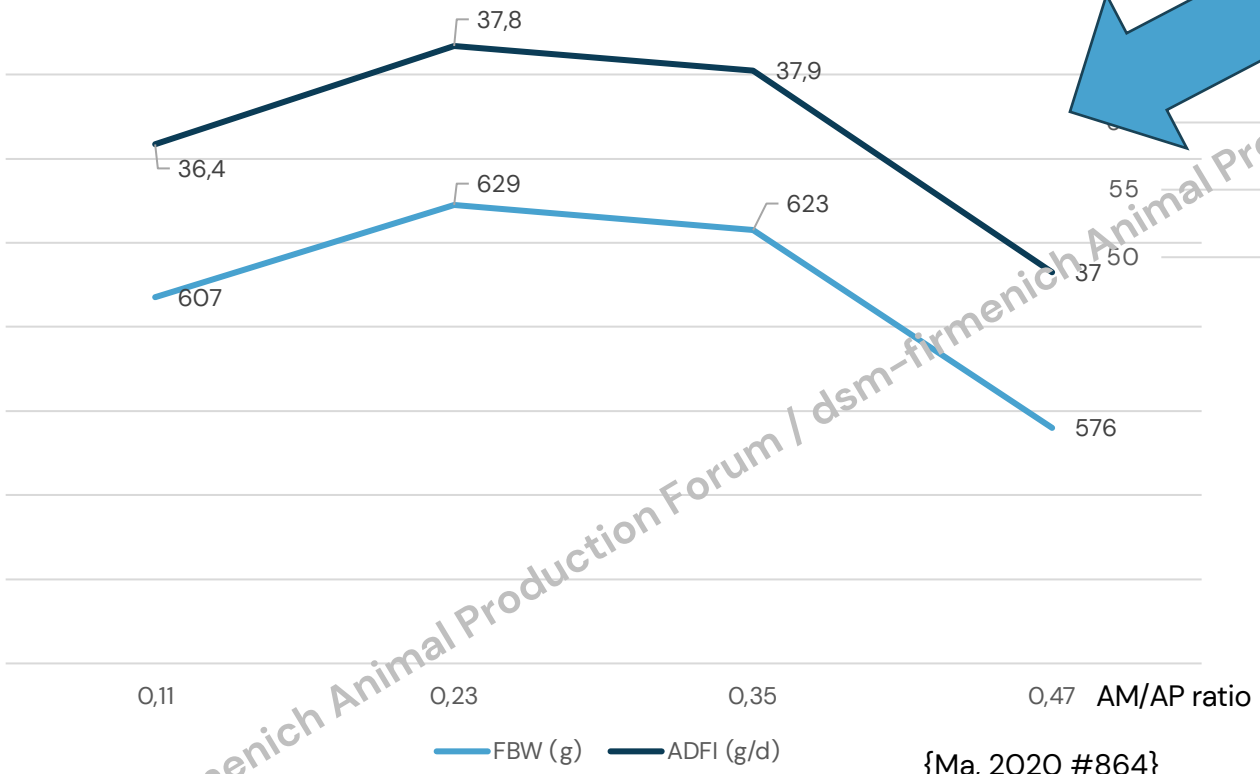


{Lv, 2021 #865}



{Ma, 2020 #864}

AM/AP



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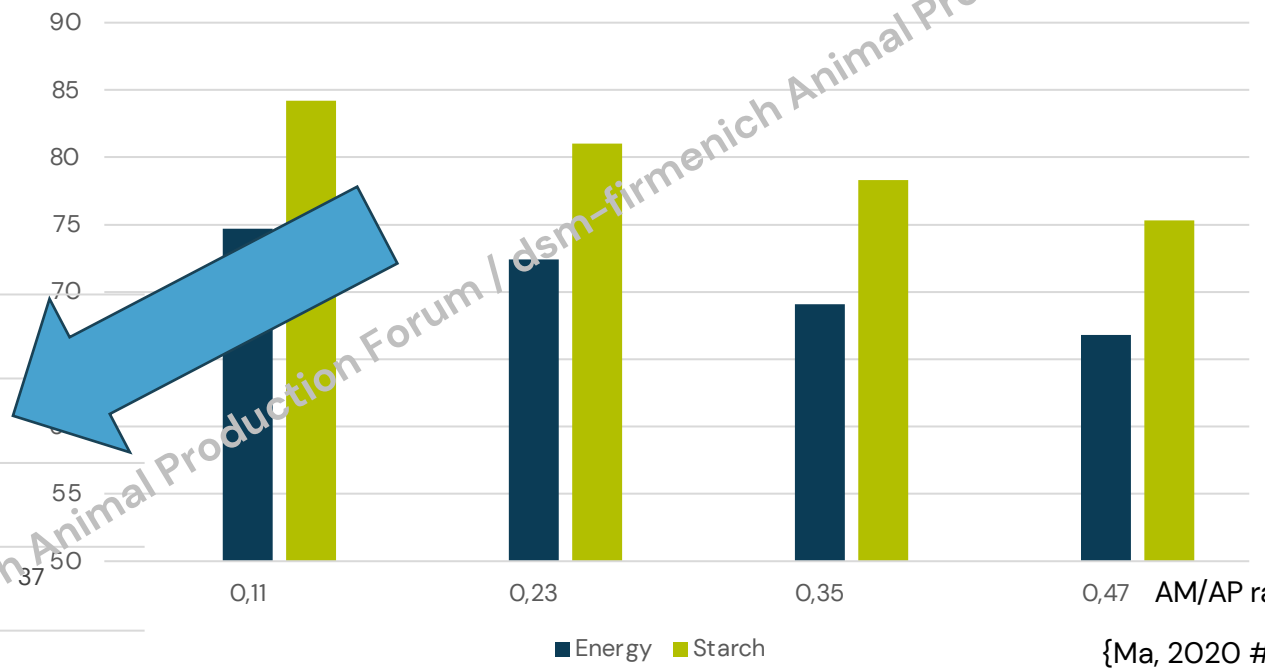

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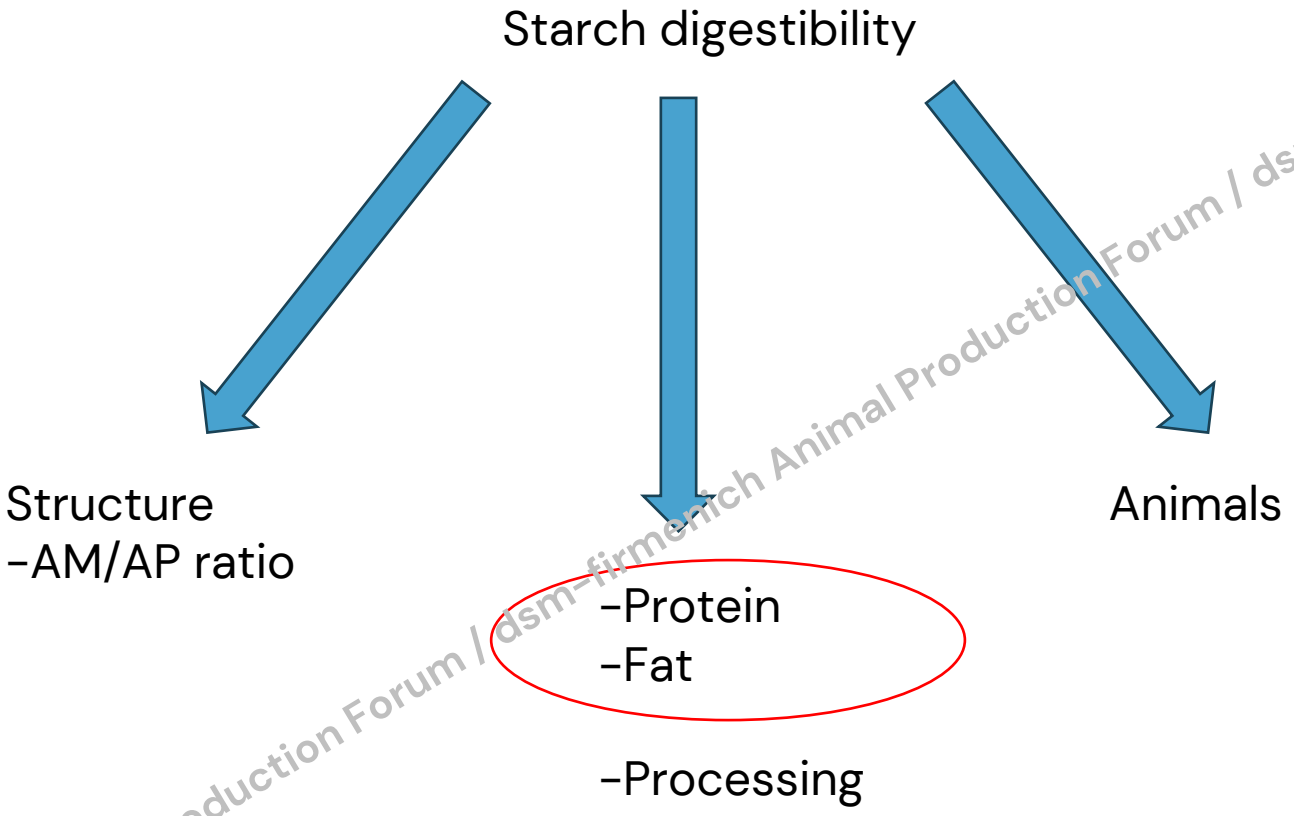
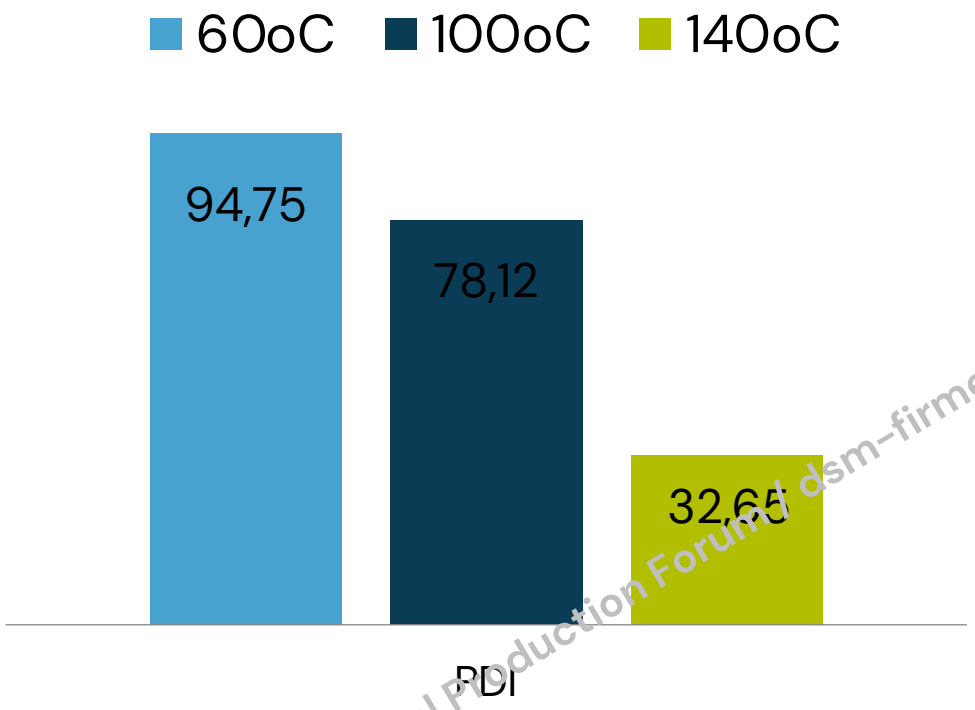
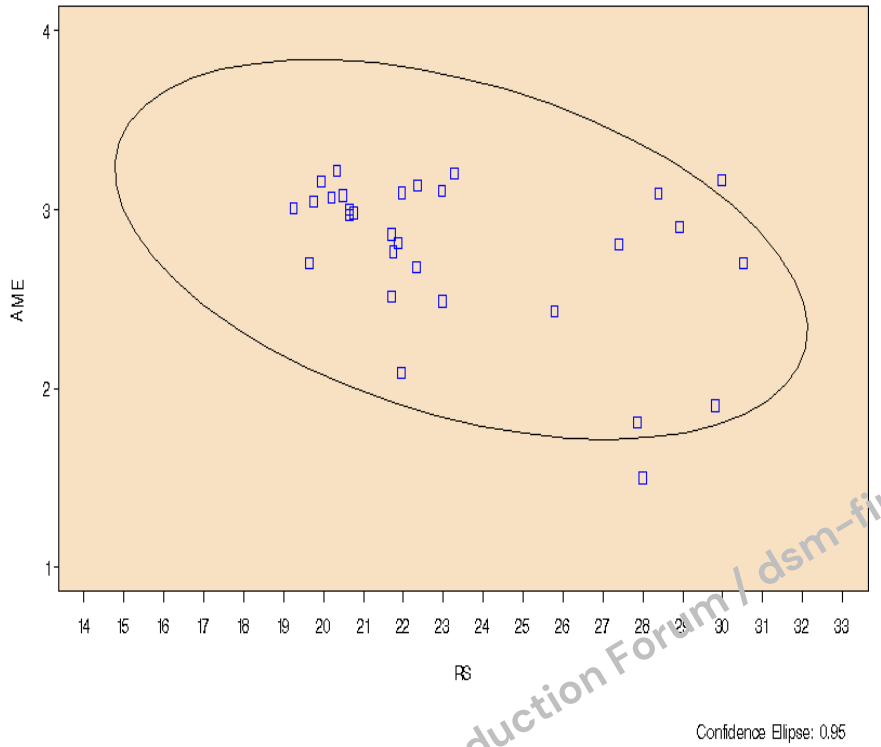
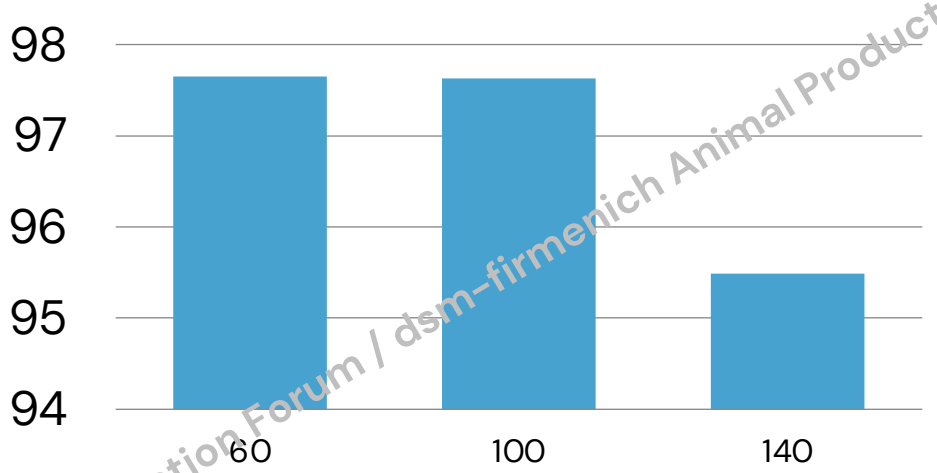




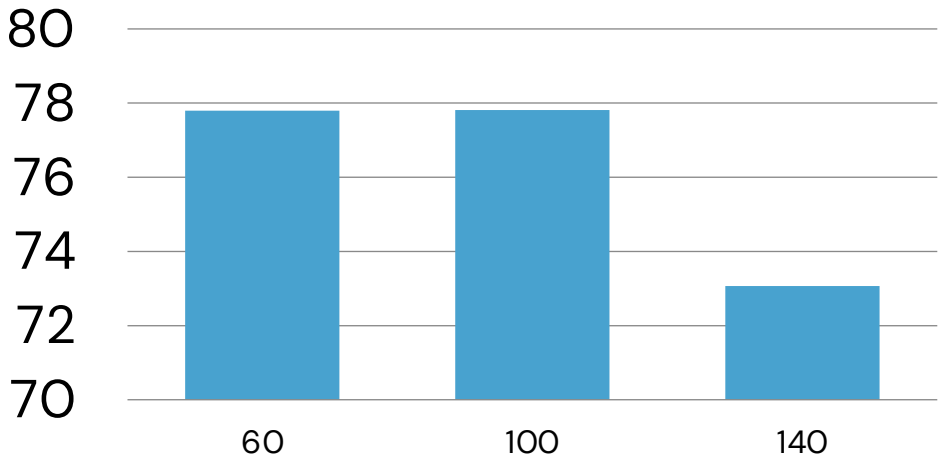
Grain hardness	Drying (°C)	RS (g/100 g)	PS (g/100 g)
Soft	60	22.50	94.38
Soft	100	24.84	78.21
Soft	140	26.76	32.79
Vitreous	60	23.51	90.75
Vitreous	100	26.36	72.88
Vitreous	140	27.76	25.15
Pooled s.e.m.		0.457	5.72
Model *P*		<0.001	<0.001
	Main effects		
Soft		24.70	68.46
Vitreous		25.88	62.95
	60	23.00	92.56
	100	25.60	75.55
	140	27.26	28.97
Hardness		<0.05	<0.05
Drying		<0.001	<0.001
	Interaction terms		
Hardness × drying		n.s.	n.s.



Starch ileal digestibility

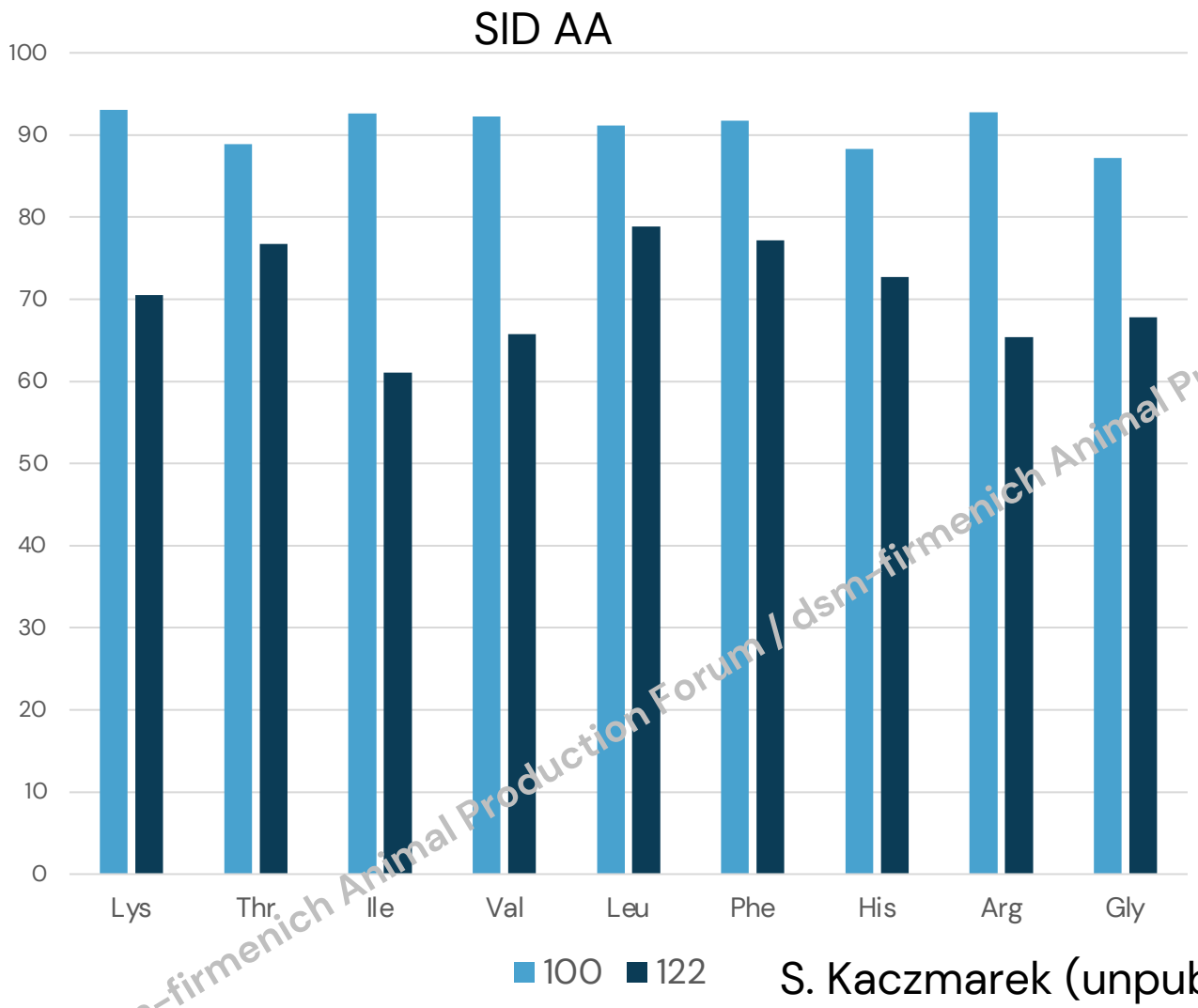


Crude protein ileal digestibility



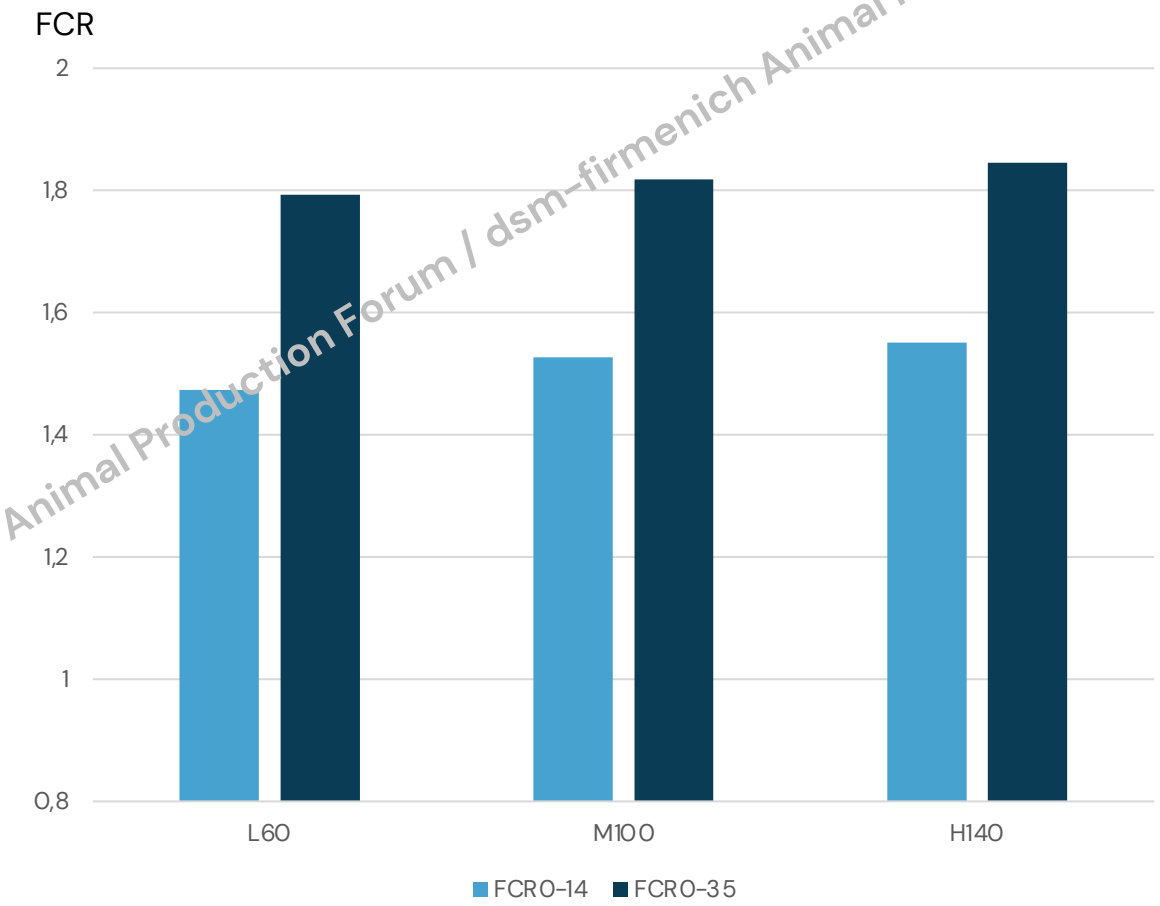
(Kaczmarek et al., 2014)

Maize AA digestibility – difference method



S. Kaczmarek (unpublished)

- Drying at high temp. = negative performance



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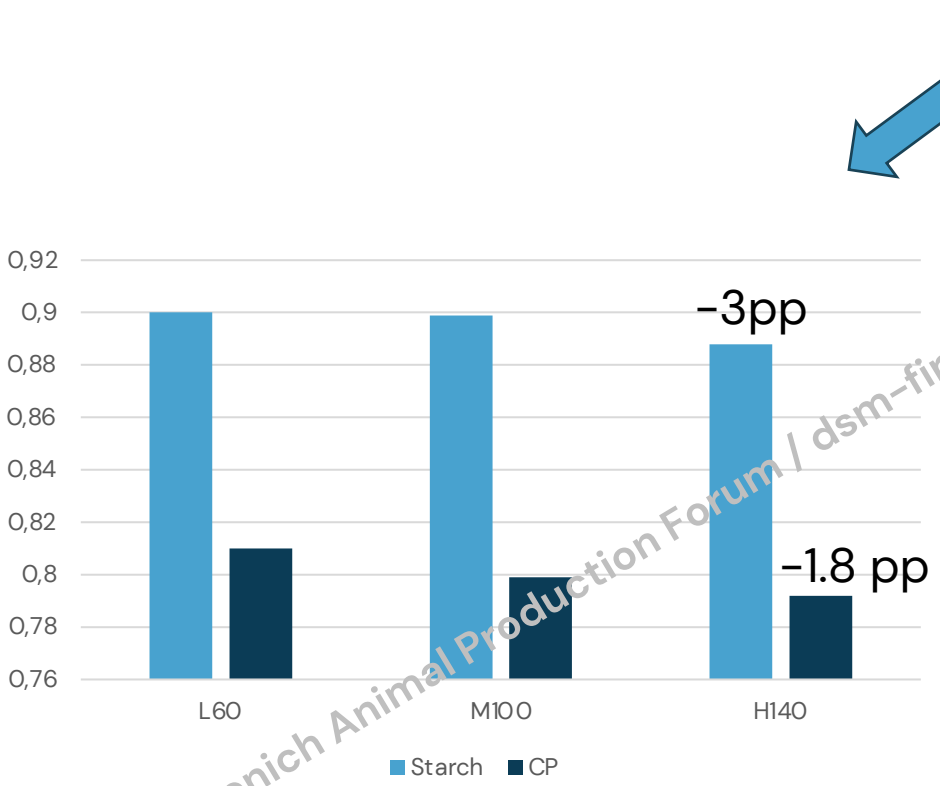
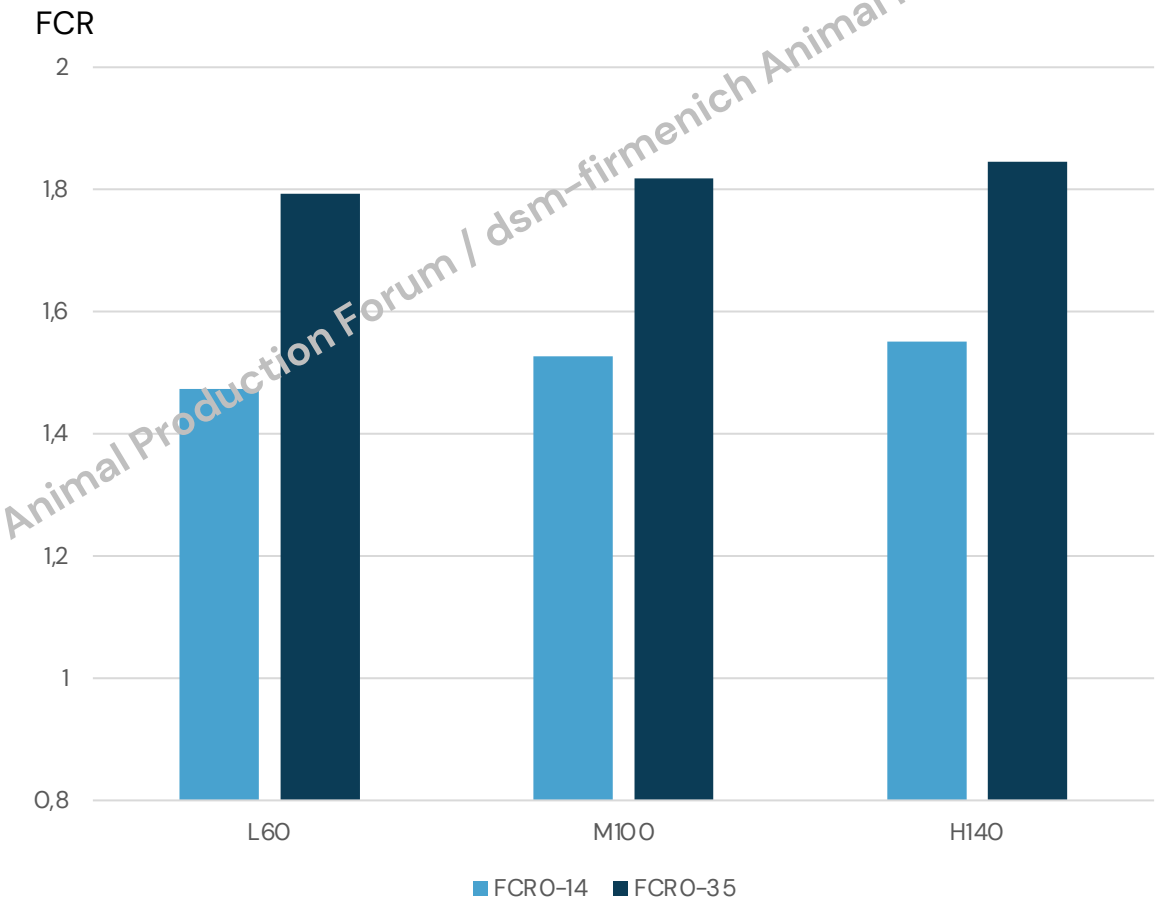




(Kaczmarek et al., 2014)

- starch granules also contain
  - proteins
  - Lipids (Crow 2000)
    - In vitro only

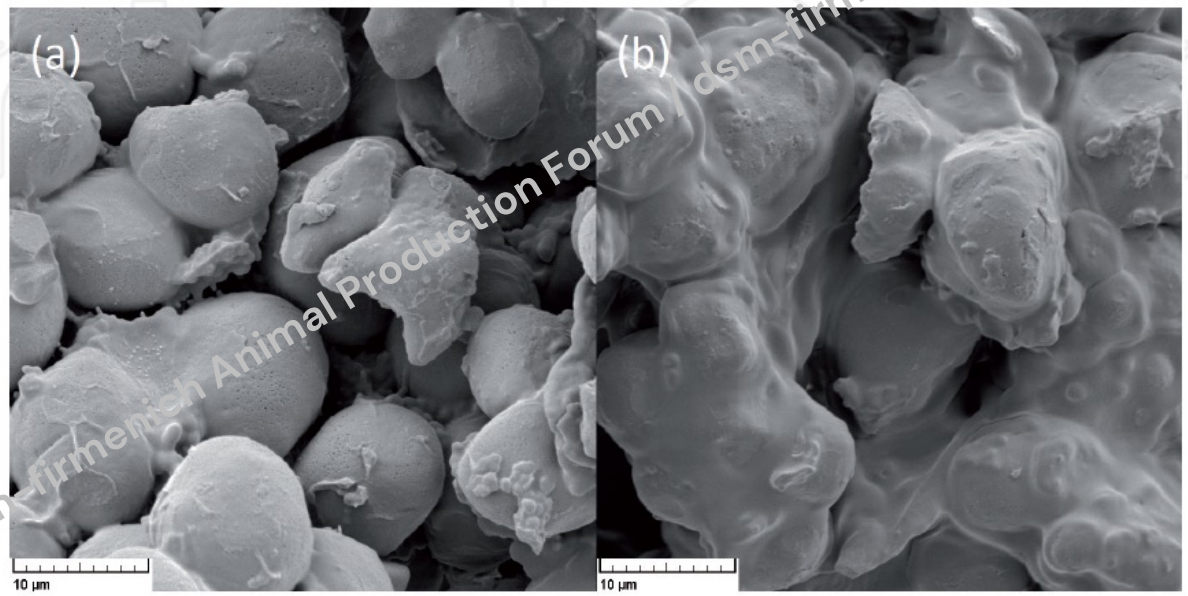
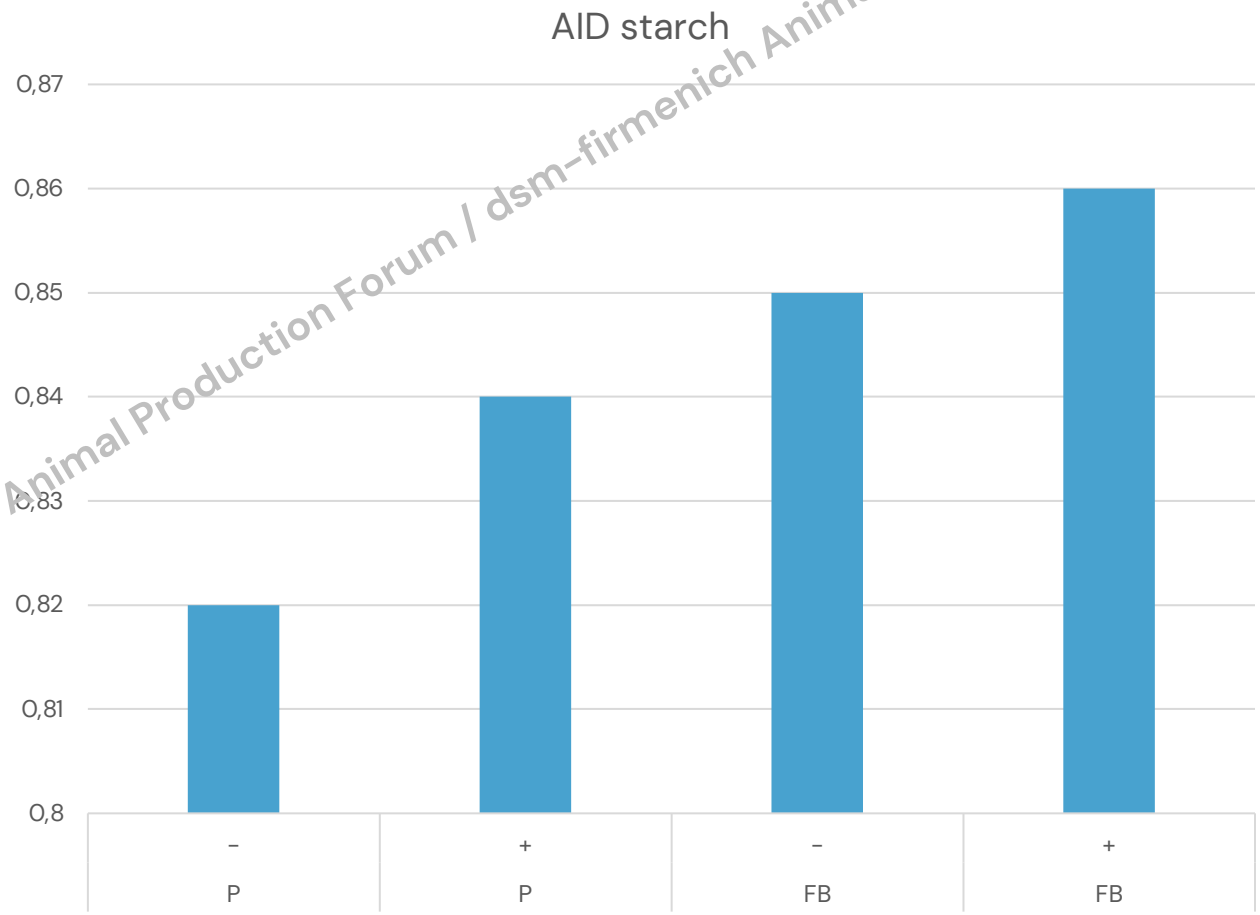


Figure 3.
Scanning electron micrographs of ground samples of maize hybrids varying in endosperm texture. Larger starch granules with thinner protein layer in the floury endosperm (a) opposite to smaller starch granules with well-developed protein layer in the vitreous endosperm (b). The maize grain endosperm morphological features (starch-protein interactions) were examined visually on 1 mm ground samples using a scanning electron microscope (SEM) (FE-SEM/Mira, Tescan, Brno, Czech Republic) with magnification 5000x.

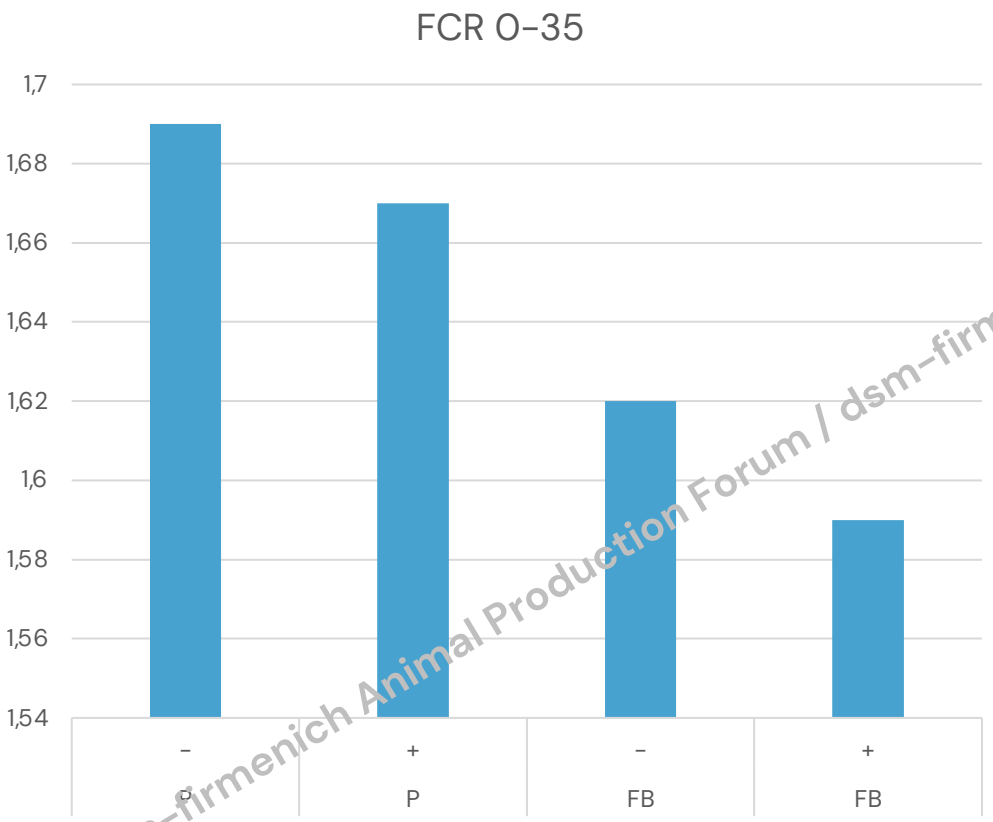
M Duvnjak (in Nitrogen in Agriculture - Physiological, Agricultural and Ecological Aspects)

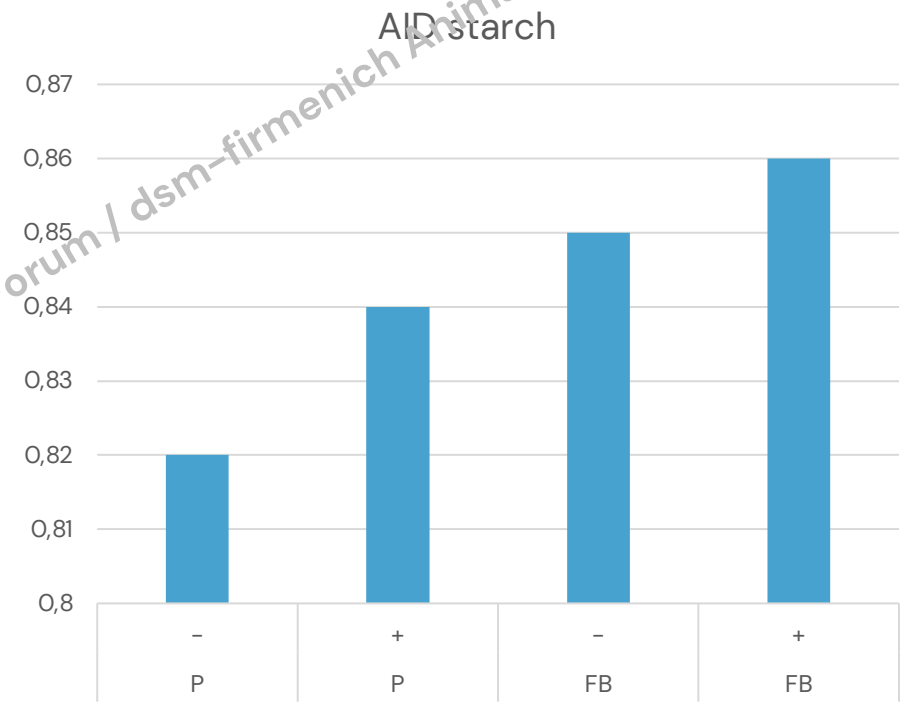
Starch

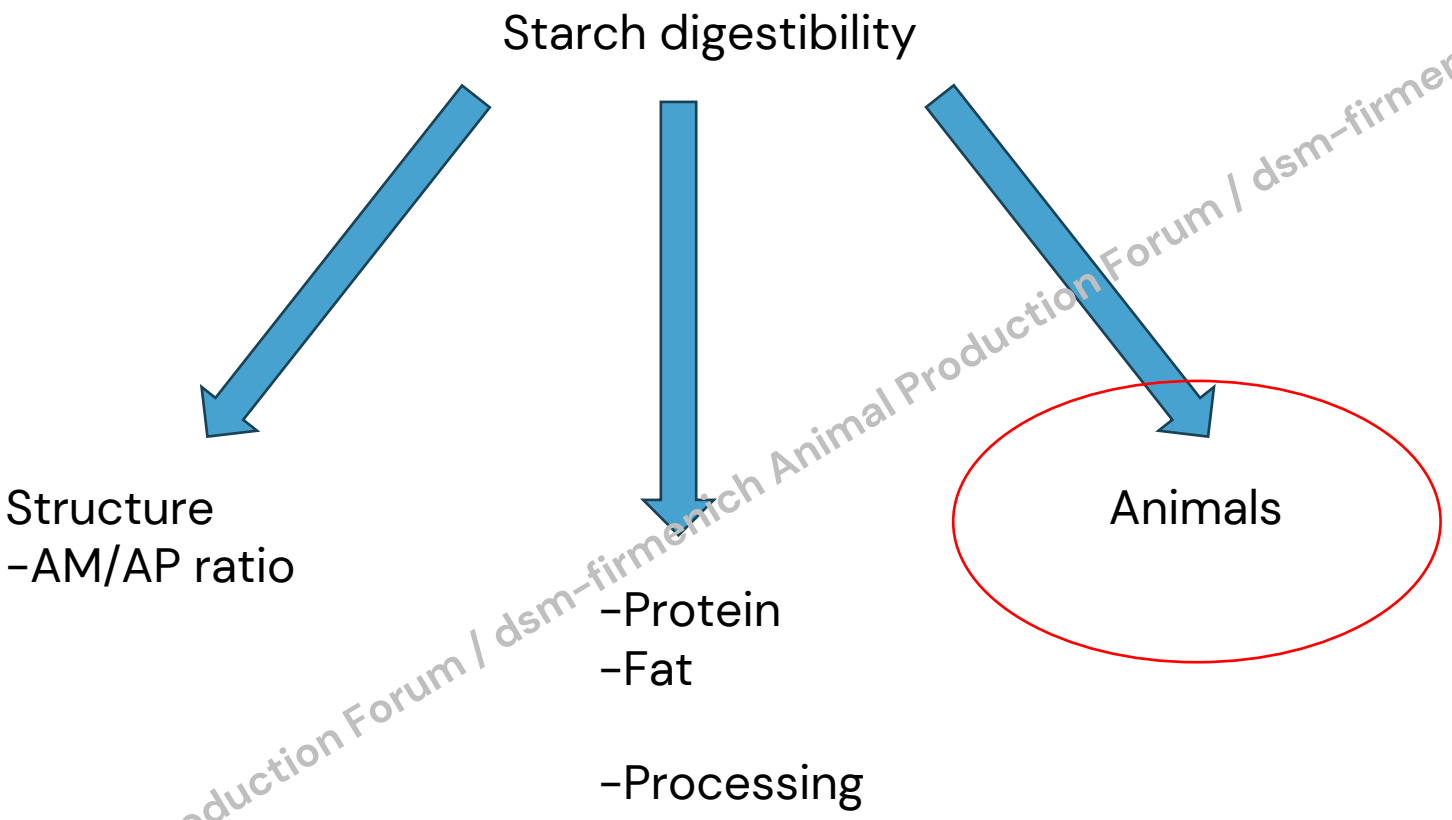
Legumes



- Positive amylase effect

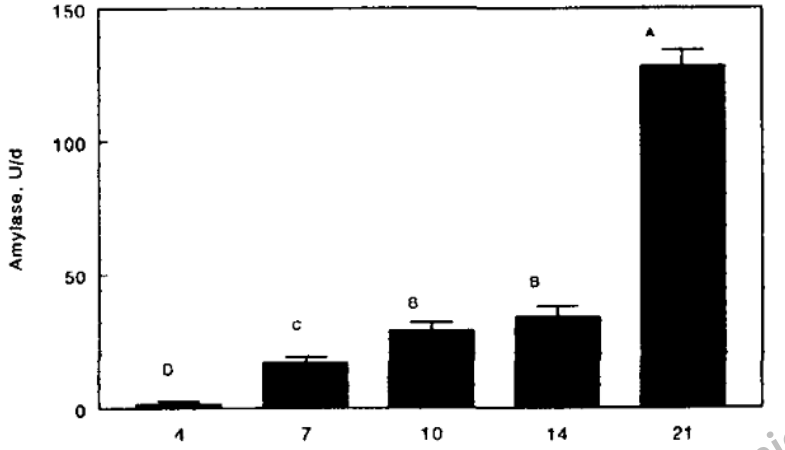


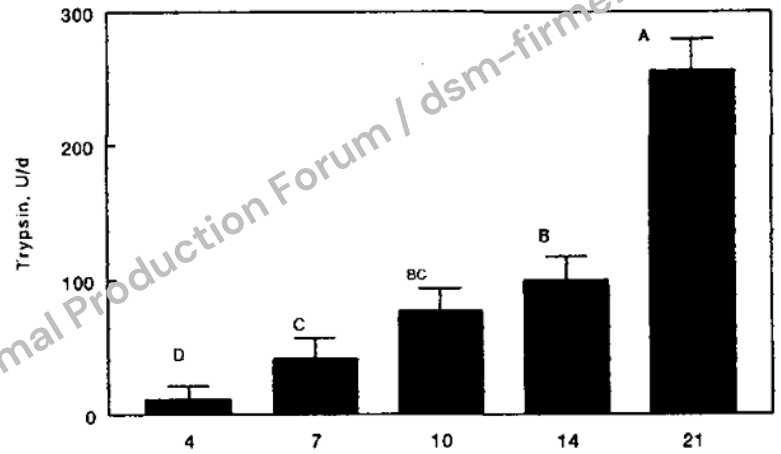


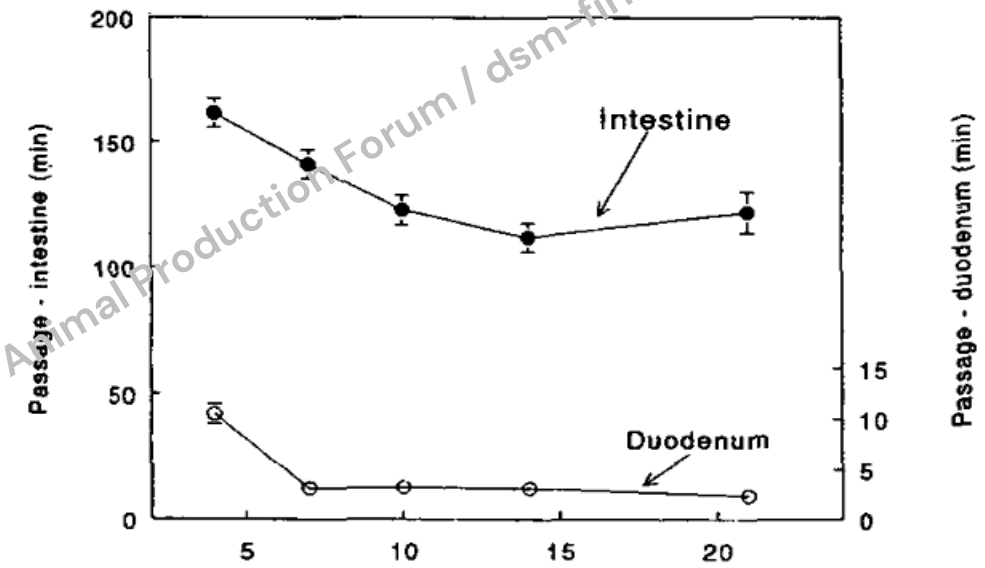


Net daily secretion and passage time:

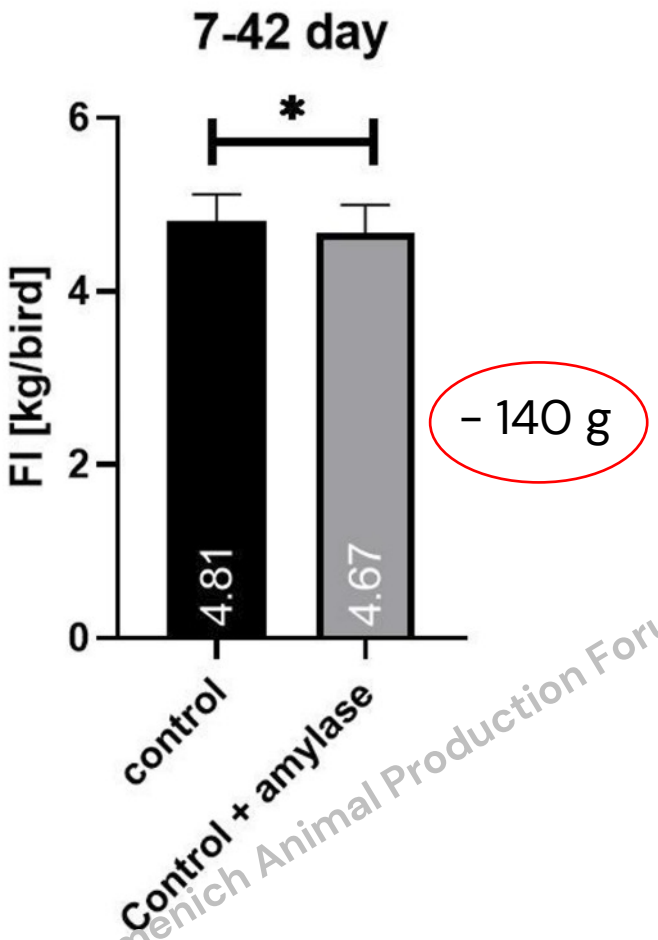
Noy Y. et al. 1995



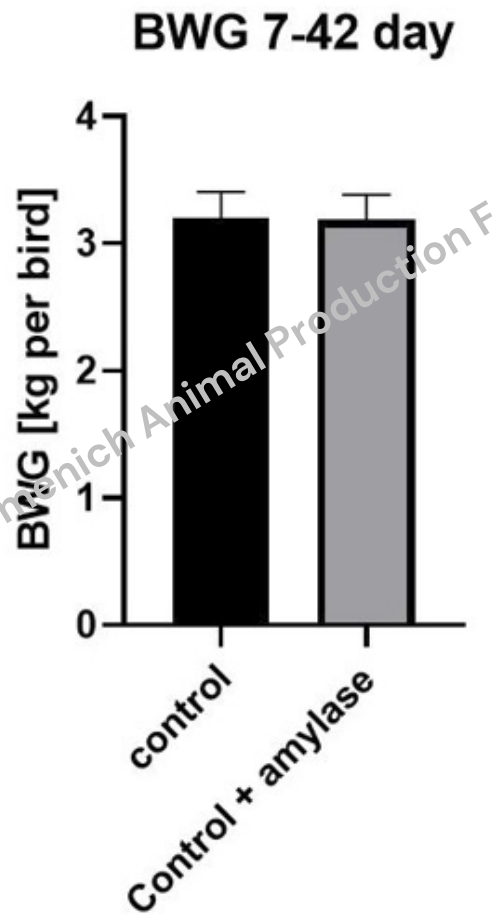


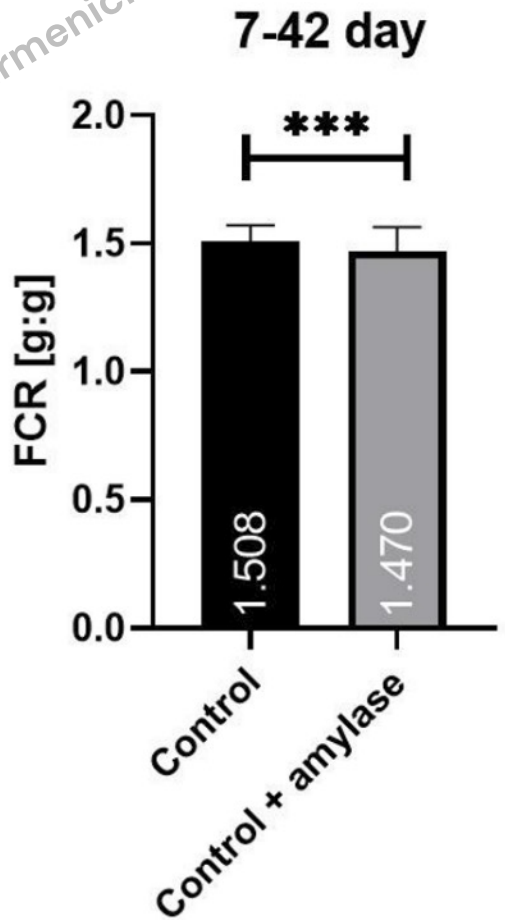


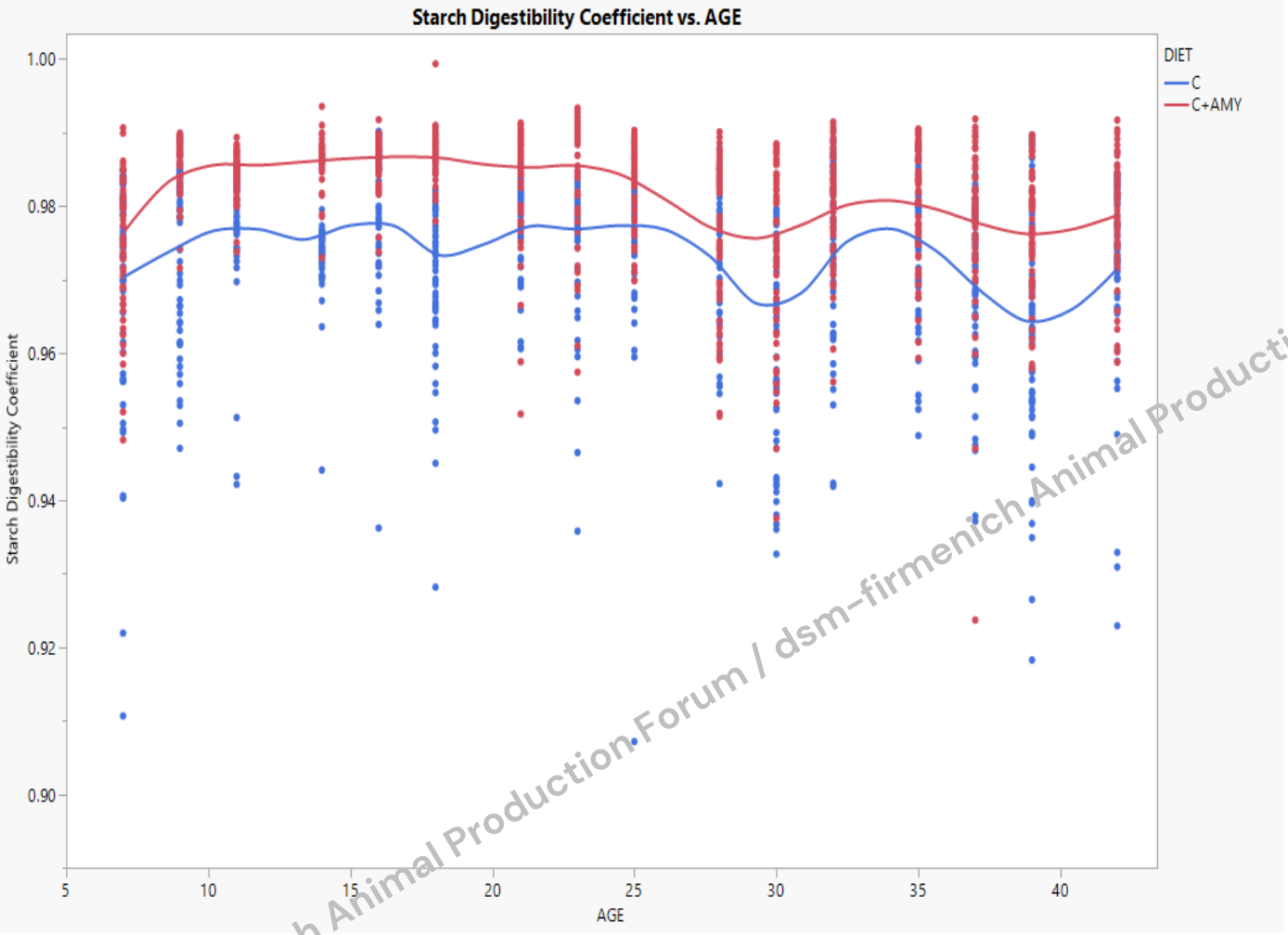
Animal effect



– 140 g





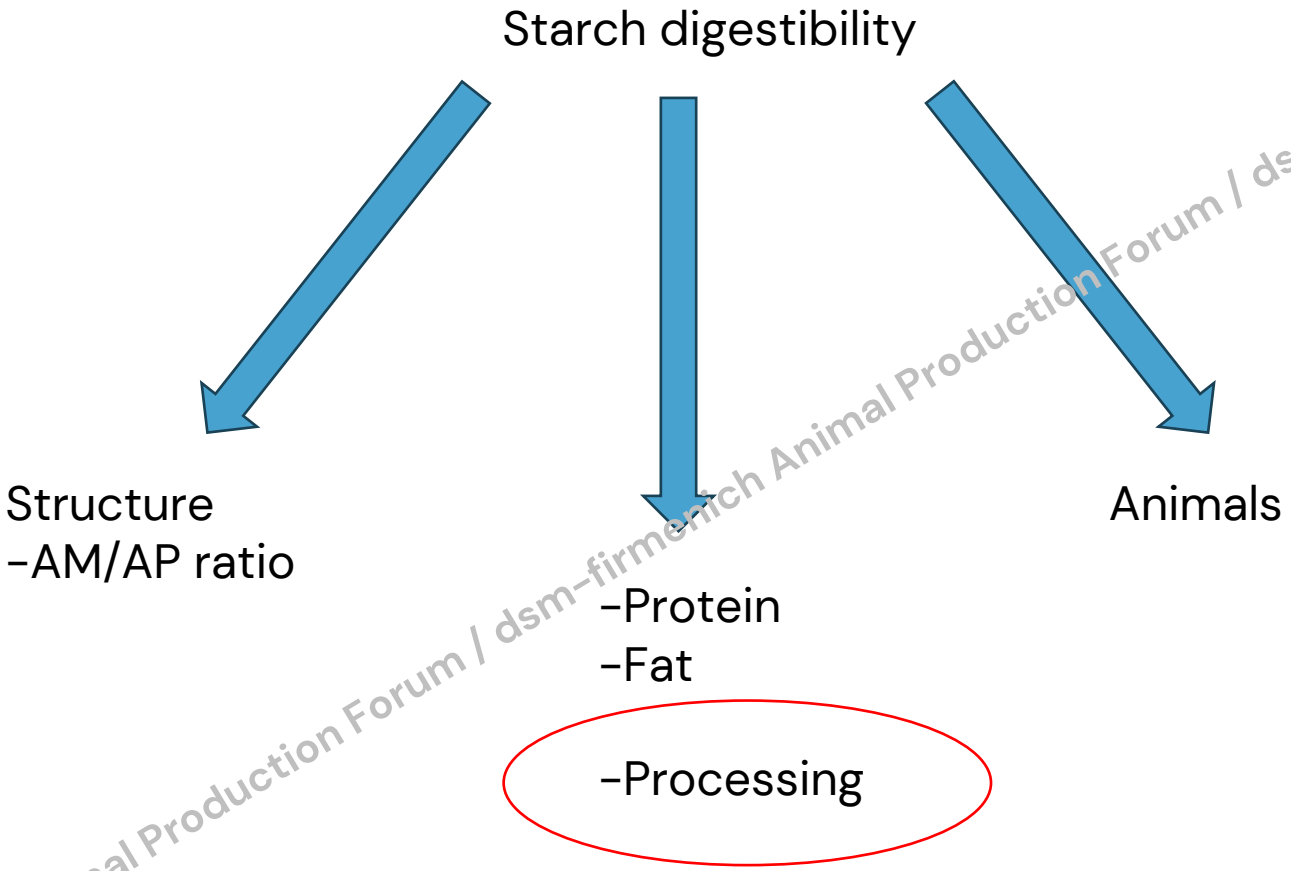


(Bassi et al., 2023)

Younger broilers had higher starch digestibility

- Endogenous amylase production reduces after 30 days
- Increasingly higher feed consumption

Zelenka and Čerešňáková (2005); Cowieson et al. (2019)



- NDF and starch reduction
- Phytic –P

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The effect of different temperatures applied during extrusion on the nutritional value of faba bean and degradation of phytic P isomers

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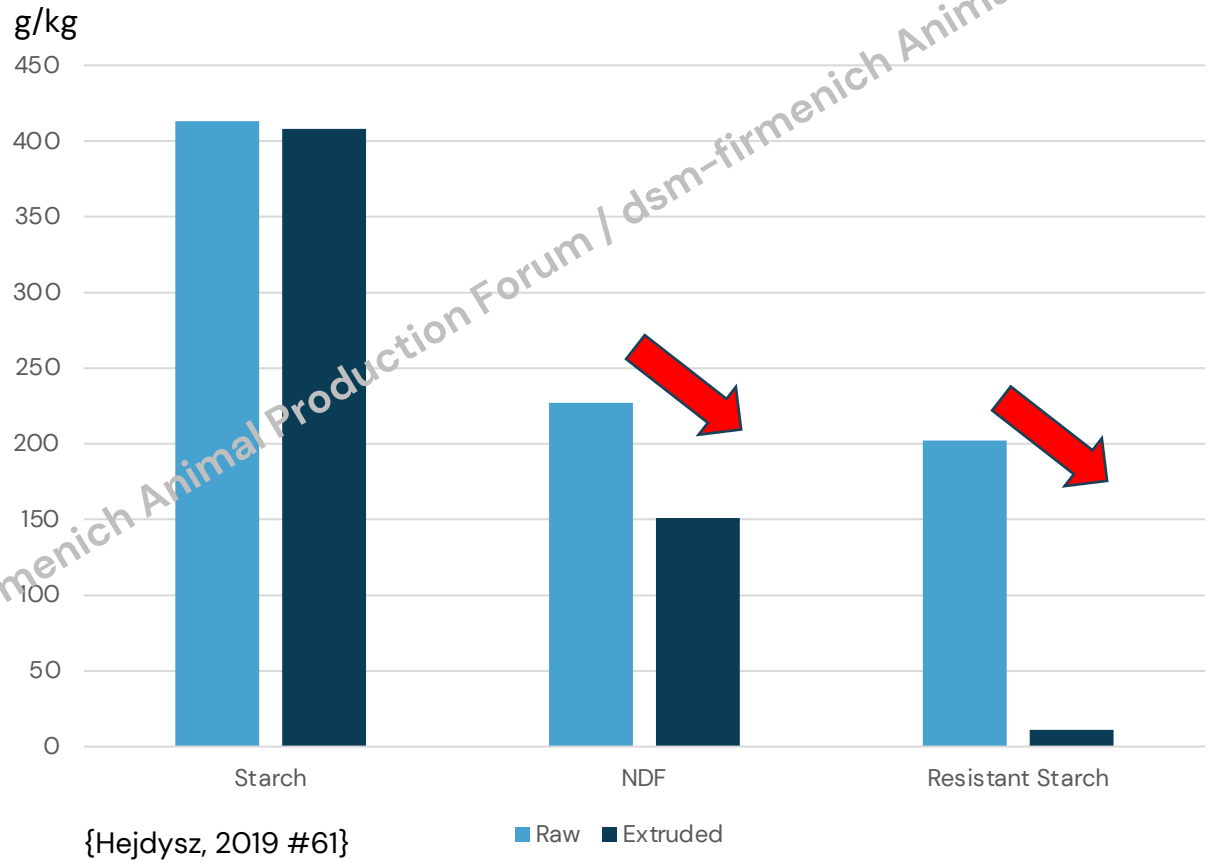
Extrusion
Nutritional value
Phytic P isomers

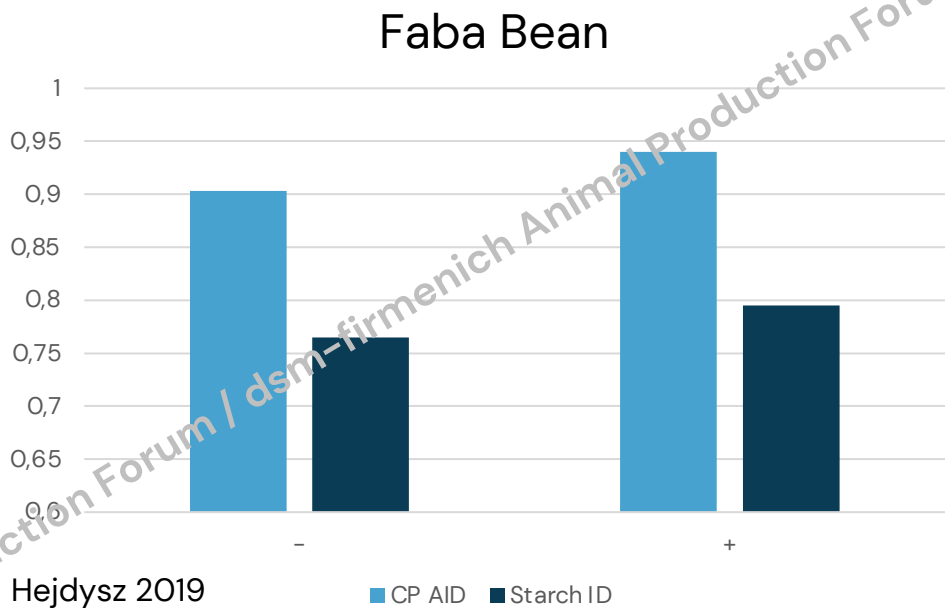
ABSTRACT

This study determined the effect of varying extrusion processing temperatures on the content of phytic P isomers (InsP6–InsP3), myo-inositol, nutrients, and antinutritional factors in faba beans and went on to estimate the nutritional value of these extrudates and the effect they had on InP6-Insp3 contents in the gastrointestinal tract of birds. The study was performed on 240 male Ross 308 strain broiler chicks (1-day old) which were divided into six experimental groups (20 replications/group; two birds/replication). A maize/soybean meal basal diet was mixed (60:40 ratio) with faba beans that were fed either raw or extruded at 110, 115, 120, or 125 °C. The extrusion process decreased the level of trypsin inhibitors, phytic P and resistant starch and reduced the content of InsP6 and increased InsP5, InsP4, and InsP3 and myo-inositol. Digestibility of dry matter, crude protein, starch and apparent metabolisable energy (AME) and nitrogen-corrected (AME_N) of the beans were optimized when they were extruded between 110 and 115 °C. Increasing the temperature of extrusion had a linear and quadratic negative effect on nutrient (except starch) digestibility and AME_N value. Increasing extrusion temperatures also resulted in the reduction in InsP6, InsP4 and InsP3 and an increase in myo-inositol concentrations. Thus, it can be concluded that extrusion can enhance the nutritional value of faba bean by improving the digestibility of several nutrients while at the same time degrading some antinutritional factors including InsP isomers. However, higher temperatures can compromise nutrient digestibility. In the current study, we concluded that the optimal temperature of extrusion is 110–115 °C.

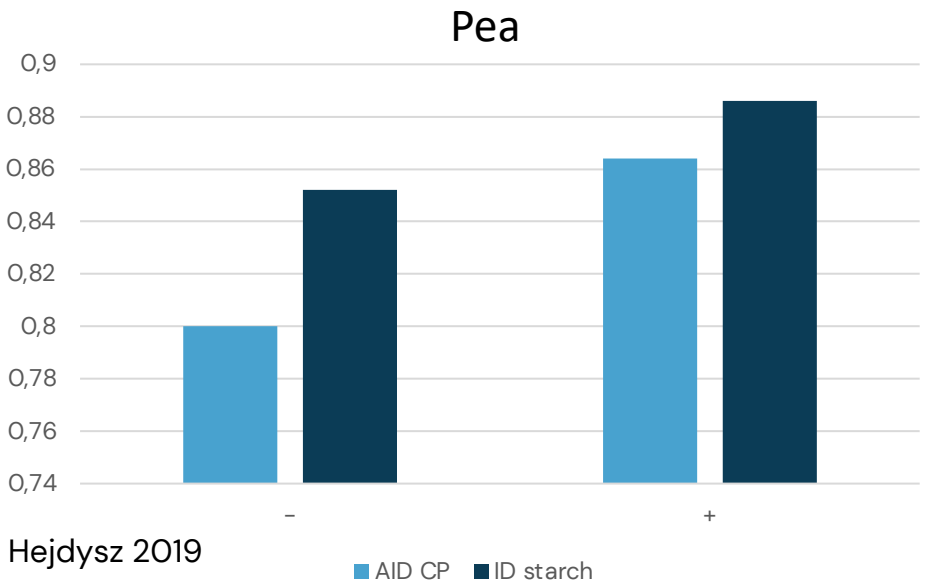


{Hejdysz, 2019 #61}

- Improvement in starch digestibility and CP

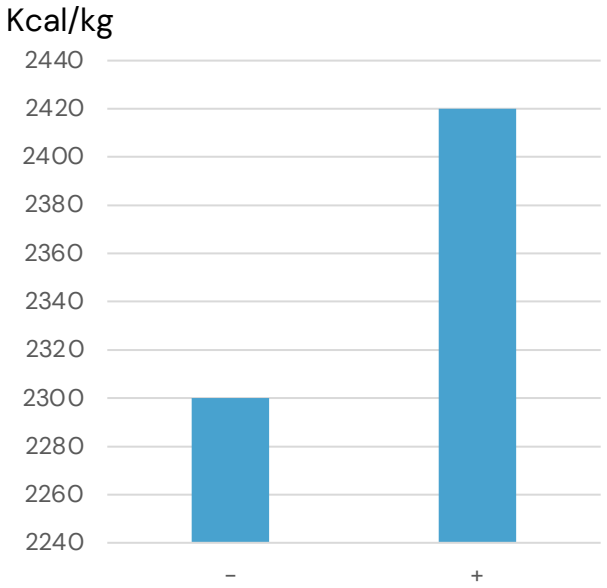


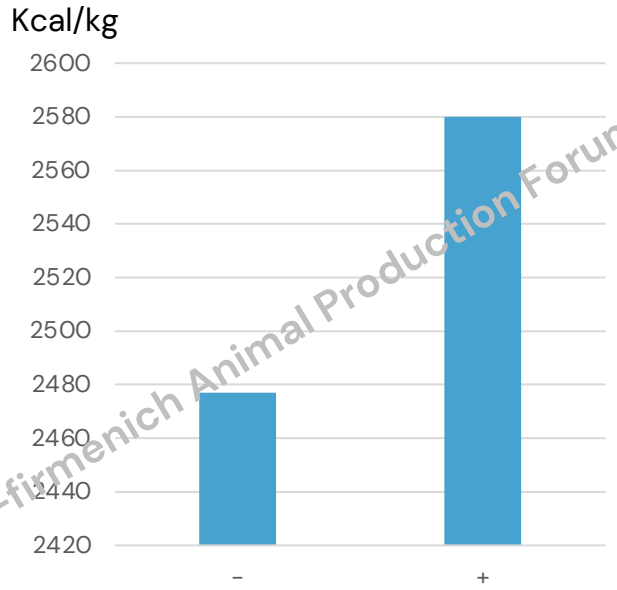
Hejdysz 2019

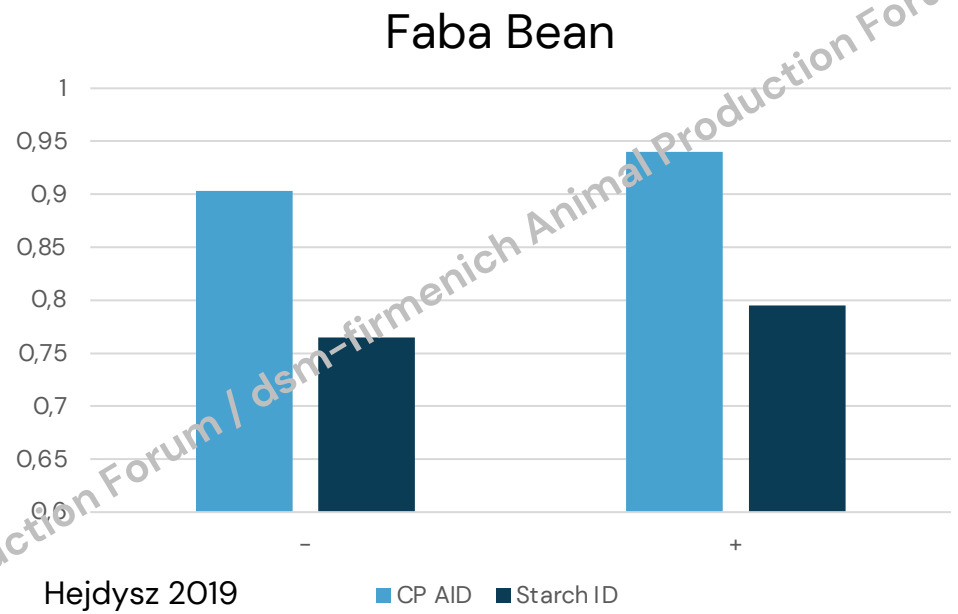


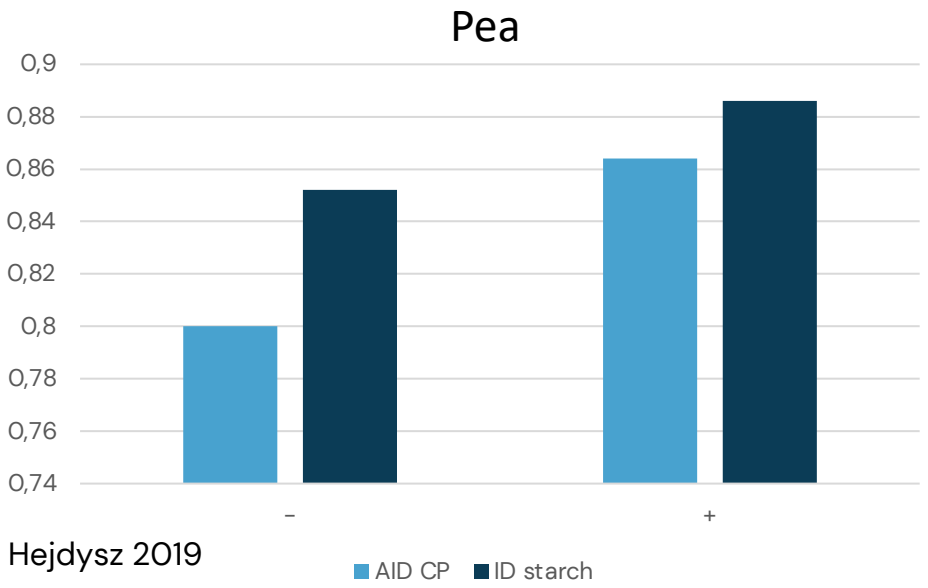
Hejdysz 2019

Starch procesing

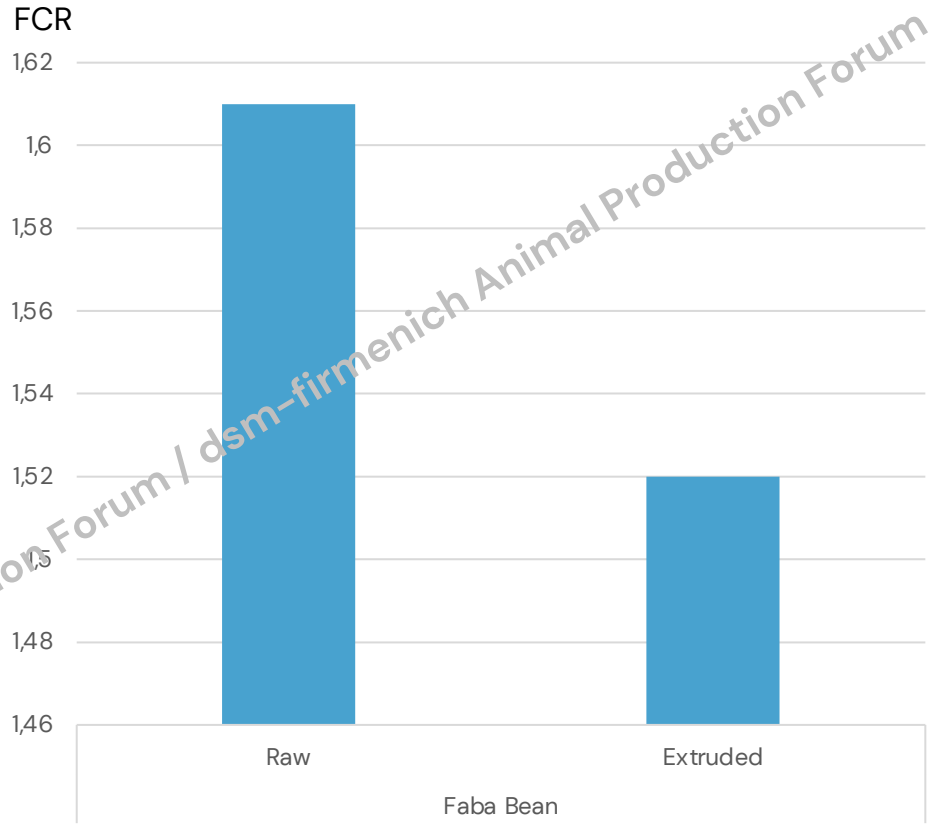






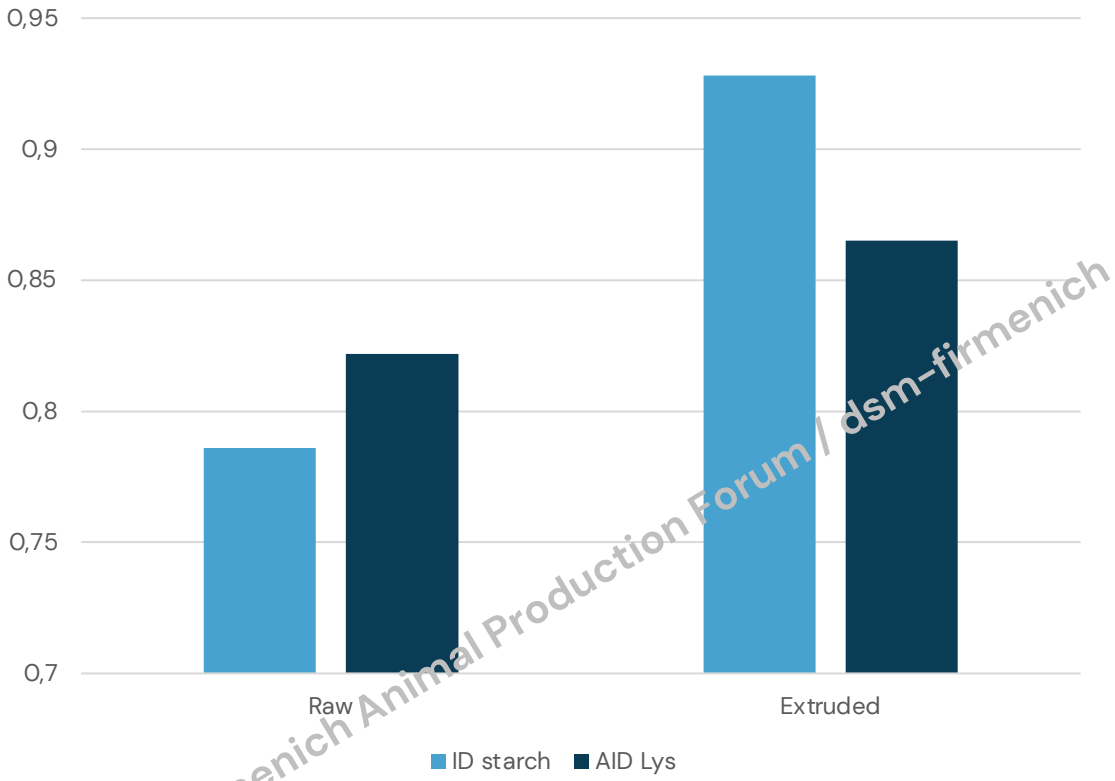


- FCR and FI response



Hejdysz 2019

- FCR and FI response



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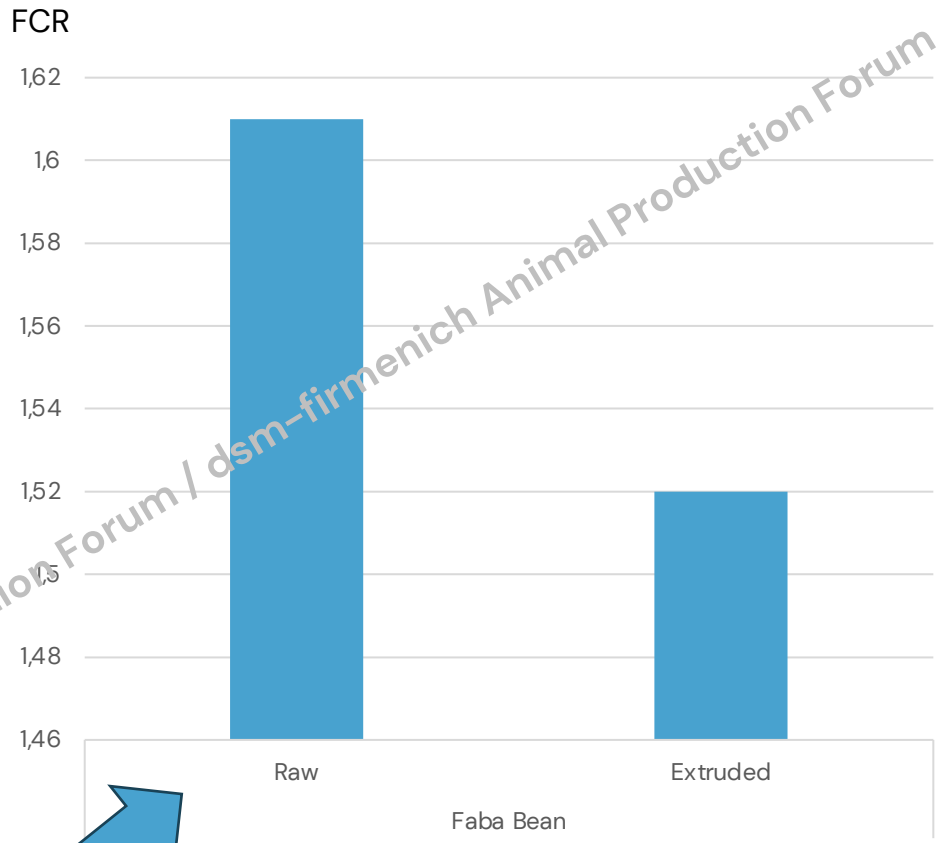
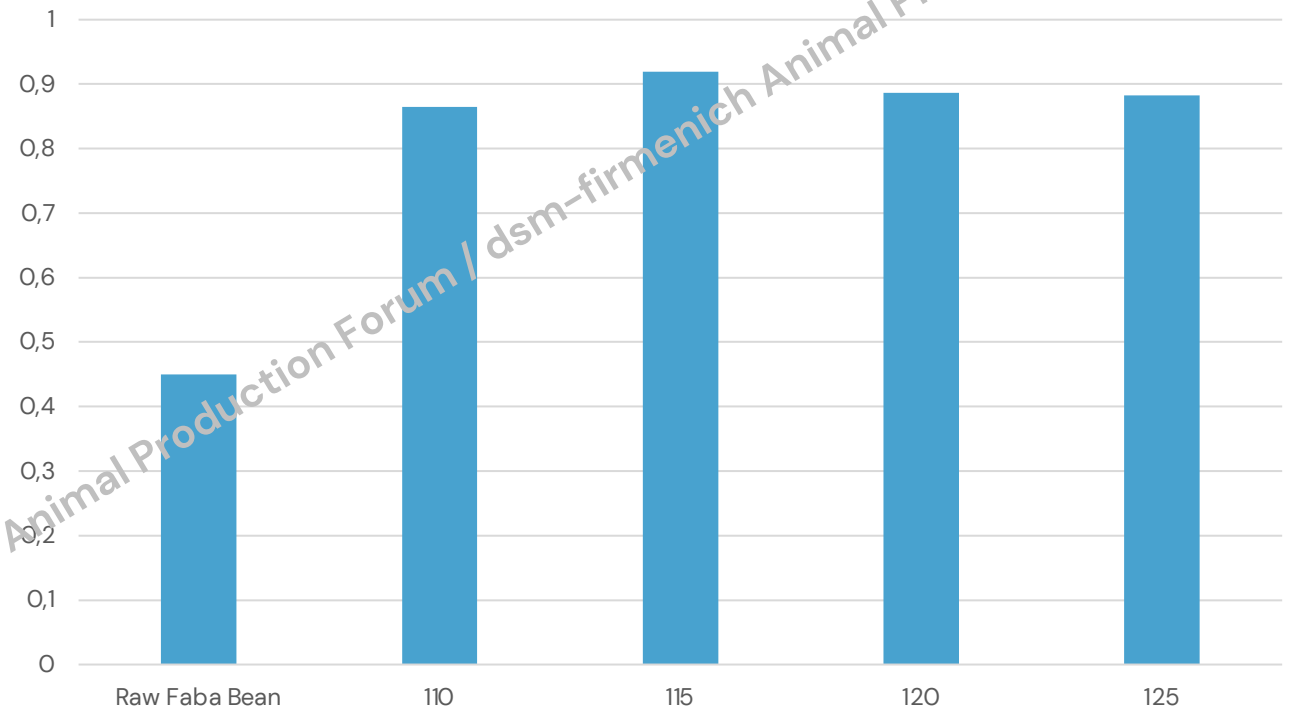


Hejdysz 2019

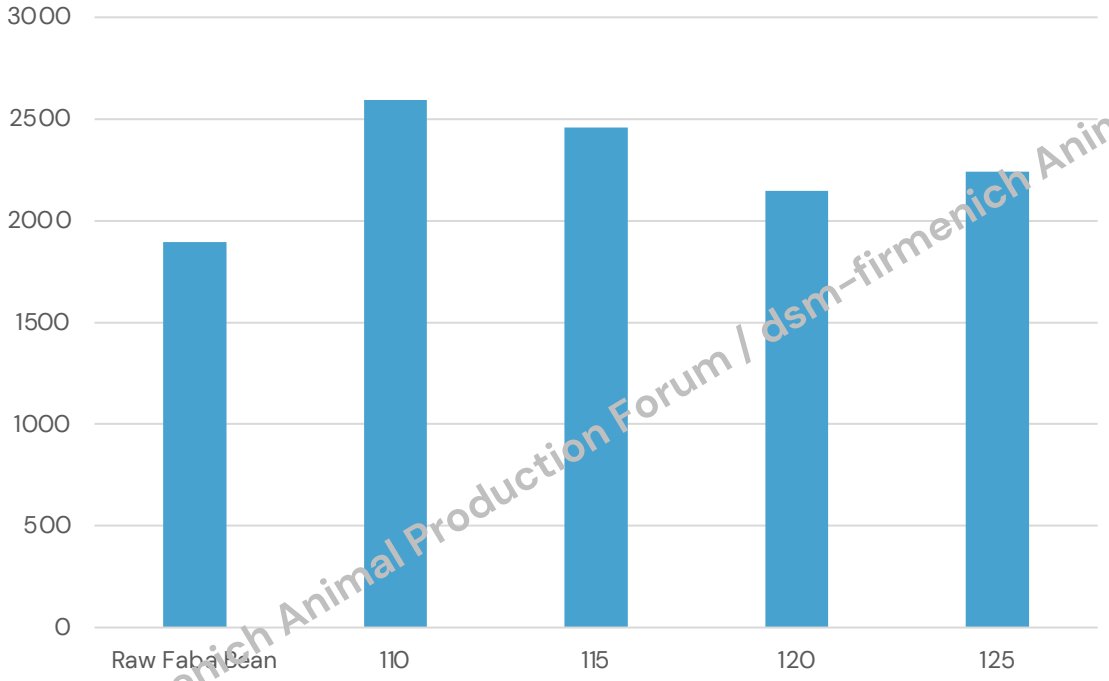
- Quadratic effect - starch AID

Fig. 3. Scanning electron microscope images of diets containing barley in ground (a) and extruded forms (b), maize in ground (c) and extruded forms (d), and high-amylose maize in ground (e) and extruded forms (f). 1000× magnified.

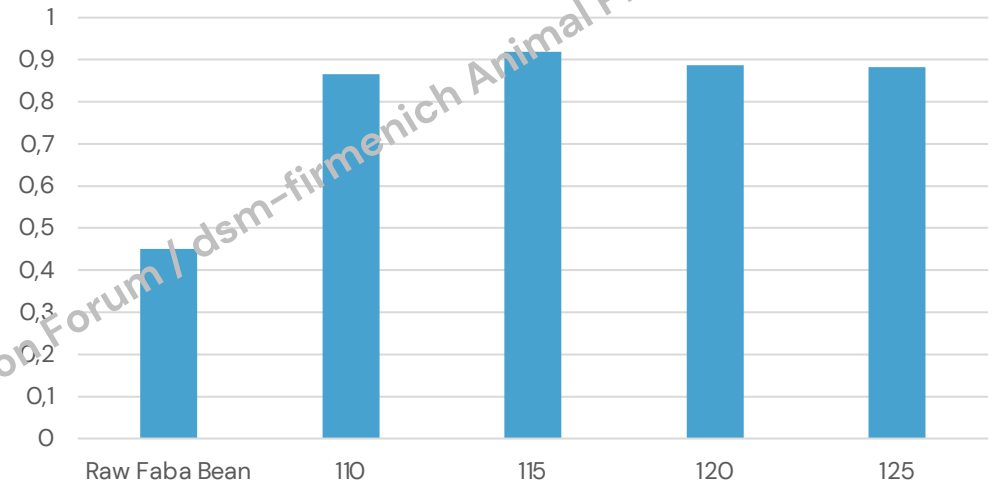


Hejdysz 2022

- Quadratic effect - starch AID



Hejdysz 2022



Hejdysz 2022

pelleting

- Conditioning temperature
  - BW
  - Starch digestibility
    - ME?

Temp C		BW	F/G	Pellet Durab. [%]	AID starch
60		1030	1.27	79	95
75		942	1.3	82	94.8
90		961	1.32	82	93.7

Edwin F. 2019

- 1.3 pp

45.5 kcal ?

- Starch digestibility is high but…
  - 10 g of starch is over 30 kcal
    - We will see higher FI

Obrigado | Gracias | Thank you