ECOGEN

WEBINAR SERIES 2026

THE EFFECTS OF REDUCED DIETARY PROTEIN AND REARING PRACTICES ON GROWTH PERFORMANCE, FAT DEPOSITION, MEAT QUALITY, METABOLISM AND GENE EXPRESSION IN THE KRŠKOPOLJE PIG BREED

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Episode 9 | June3rd, 2026

HoloRuminant Understanding microbiomes of the ruminant holobiont

Re-Livestock RESILIENT FARMING SYSTEMS

GERONIMO GENOME AND EPIGENOME ENABLED BREEDING IN MONOGASTRICS

Rumigen

3D omics

Introduction

Intensive research on Krškopolje pig (2014 - 2026)

- **Growth/performance**
- **Nutritional requiremnts (proteins, AA)**
- **Tissue growth (fat, muscle)**
- **Biochemical traits (lipogenesis, FA, …)**
- **Meat quality**
- **Gene expression ← metabolism**
- Product quality/processing practices
- Selection possibilities

- ❑ **Outdoor extensive & indoor intensive (KKP vs. MP, study 1 & 2)**
- ❑ **Conventional vs. organic (KKP, study 3)**
- ❑ **Protein reduction (KKP organic vs. conventional, study 4)**

Krškopolje pig

- Local breed, only Slovenian autochthonous pig, black coat, white belt
- Reared in the extensive production systems in the past, presently in very variable conditions (intensive/extensive)
- Aimed for processing to high quality meat products

- Adapted to local environment and feed sources (?)
- Reputed for good meat quality (?)
- Performance, nitritional needs, feeding strategies, metabolic background understudied

Outdoor extensive rearing - KKP vs. modern hybrid (study 1)

- Large outdoor area + shelter, KKP vs. LwLnDu hybrid
- August to January, starting at similar weight
- Same feed (commercial mixture + hay + root vegetables)

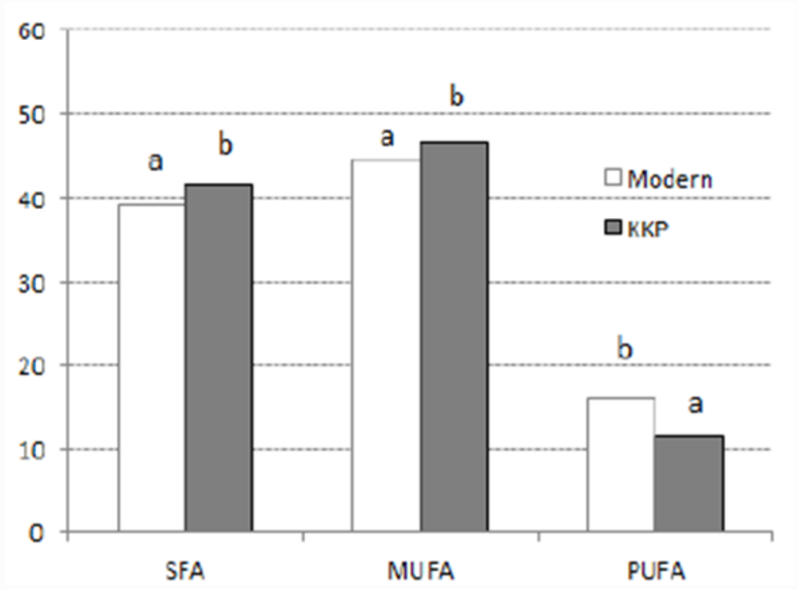
- KKP:

❑ 1.7-fold better growth - **?**better **adaptation** to (?harsh) environ.

❑ 2- to 3-fold higher **fatness** and IMF (meat **quality**)

Outdoor extensive rearing - KKP vs. modern hybrid (study 1)

- **Saturated fat** ← more SFA and (especially) more MUFA
- **Lipogenesis potential** ← higher gene expression for FA desaturase (SCD) and genes for lipo&adipogenesis (PPARγ, ACACA, FASN)
- **? faster physiological maturity** ← lower activity of lipogenic enzymes (despite being fatter)



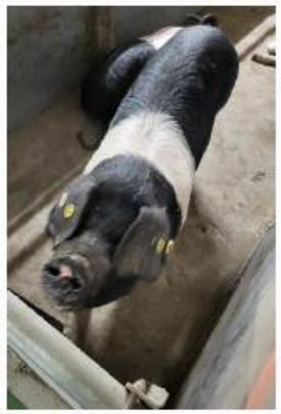
Adapted from: Poklukar et al., 2023, Livestock Science, 272, 105247.

Indoor intensive rearing - KKP vs. modern hybrid (study 2)

- Indoor partly slatted pens, outdoor access
- KKP vs. LnLwPi hybrid
- Same starting weight (27 kg, 6 months fattening)
- Same feed, 3-phase feeding, authomatic feeder/weighing system

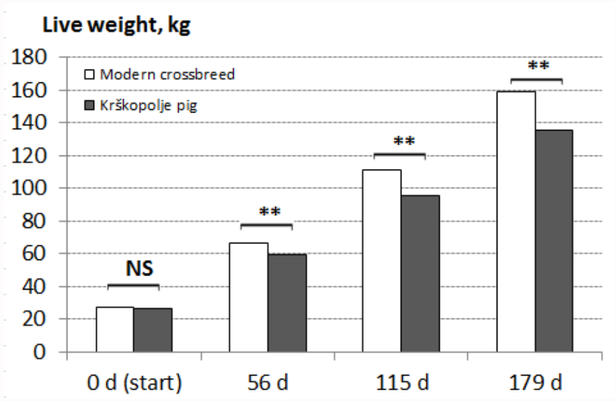
Trait	Phase 1	Phase 2	Phase 3
Duration, days	56	59	63
Feed distribution, kg/pig/day	1.64	2.42	2.81
Treatment group			
Modern, medium protein	17%	13%	11%
Krškopolje, medium protein	17%	13%	11%

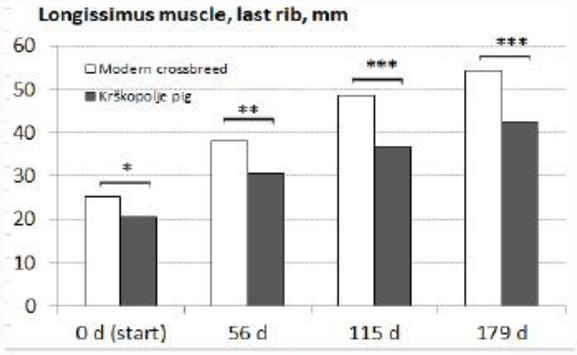


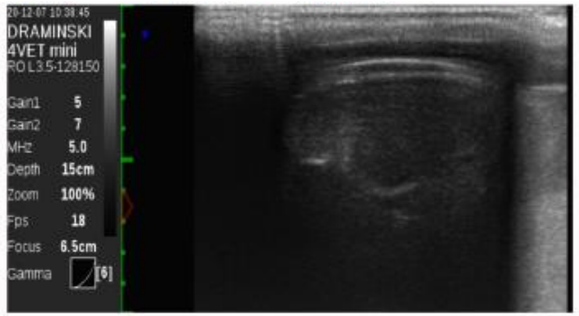

Indoor intensive rearing - KKP vs. modern hybrid (study 2)

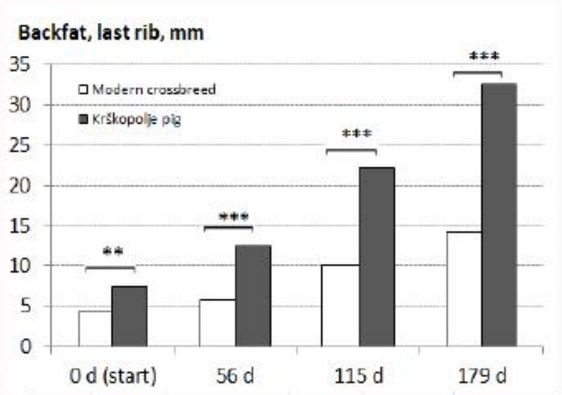
- KKP **slower growth**, constant ADG difference (≈ 130g/day)
- Rather constant difference in muscle thickness (1.3-fold for MH vs. KKP)
- KKP **increasing faster** in adiposity (1.7- to 2.3-fold thicker BFT from start to slaughter)

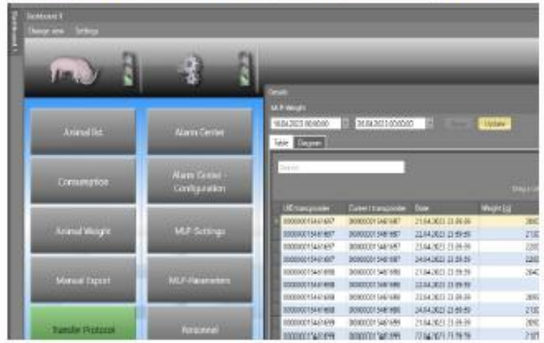


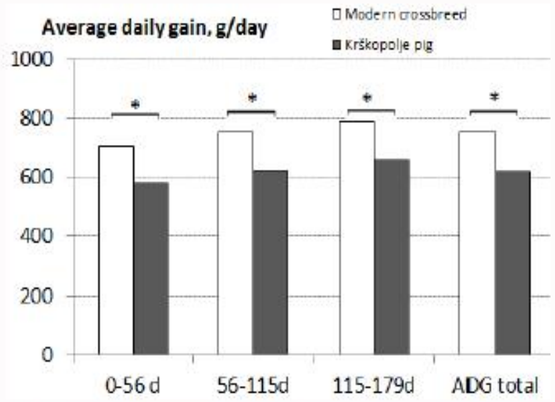


Adapted from: Škrlep et al., 2024, Animals, 14, 3331



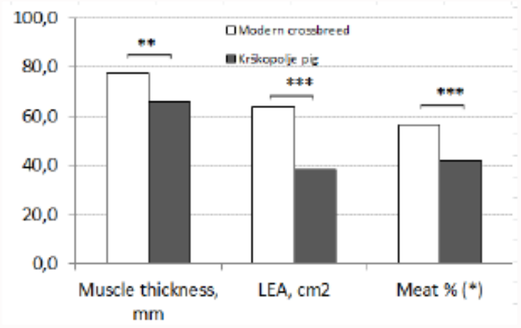


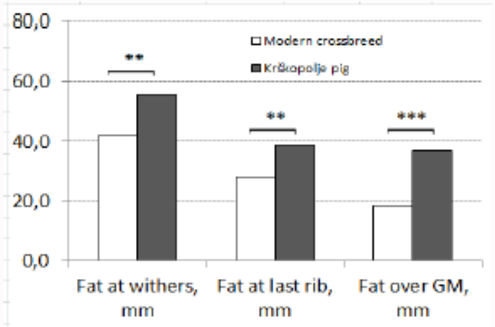


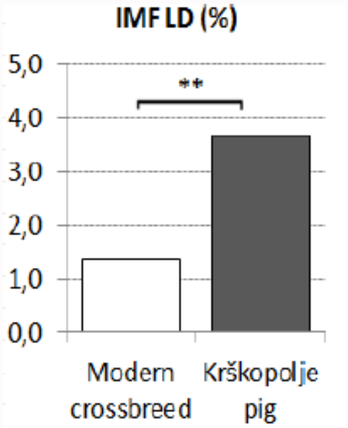


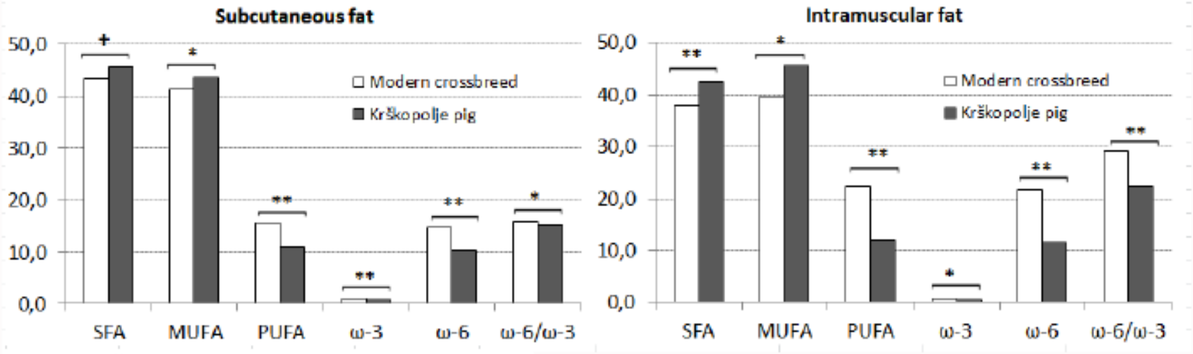
Indoor intensive rearing - KKP vs. modern hybrid (study 2)

- KKP much **lower leanness** and muscularity, fattier carcass, more than 2-fold **higher IMF**
- KKP more **saturated fat** (MUFA, SFA, less PUFA)
- KKP better n-6/n-3 PUFA ratio (but still very high values)





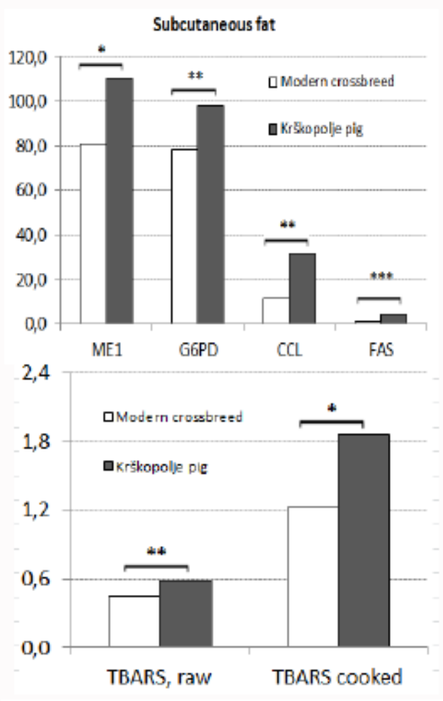


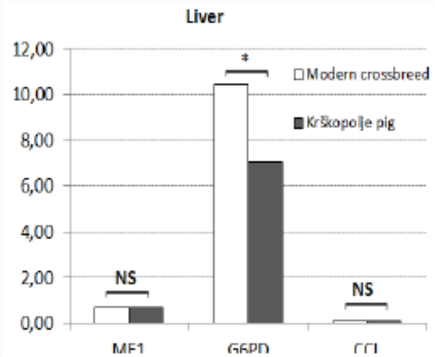


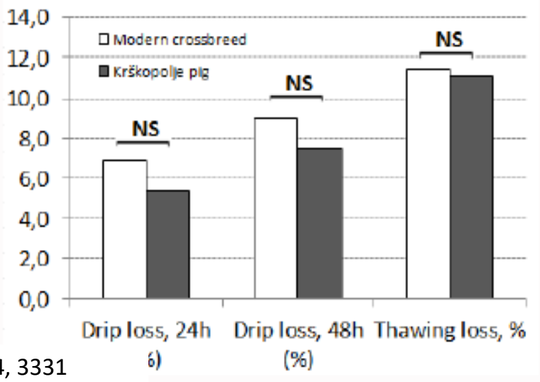
Adapted from: Škrlep et al., 2024, Animals, 14, 3331

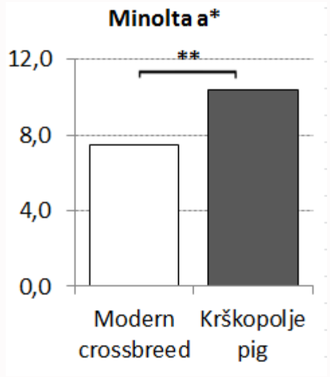
Indoor intensive rearing - KKP vs. modern hybrid (study 2)

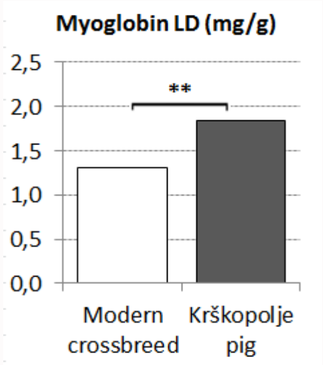
- KKP overall **higher** lipogenic enzyme activity (**tissue specific** – BFT vs. liver)
- KKP **darker** muscle colour ← more Mb, muscle oxidation (TBARS ≠ FA saturation, higher IMF)
- **Comparable** meat quality (WBSF, WHC)

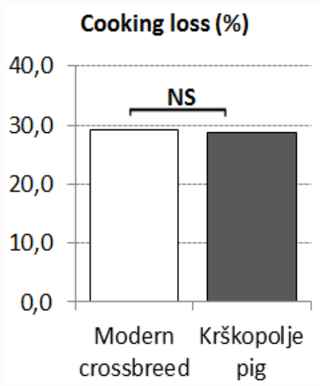


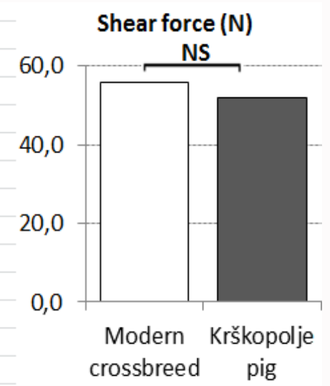












Adapted from: Škrlep et al., 2024, Animals, 14, 3331

Indoor intensive rearing - KKP vs. modern hybrid (study 2)

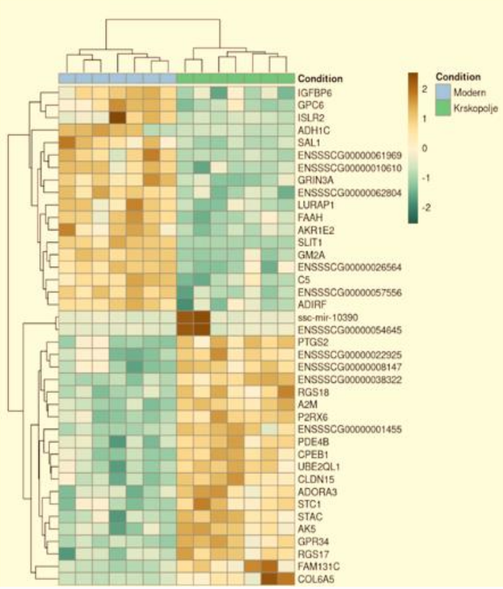
- Study of **adipose tissue transcriptome** (363 DEGs) elucidated key processes associated to higher fat accumulation in KKP.
- Upregulated in KKP:

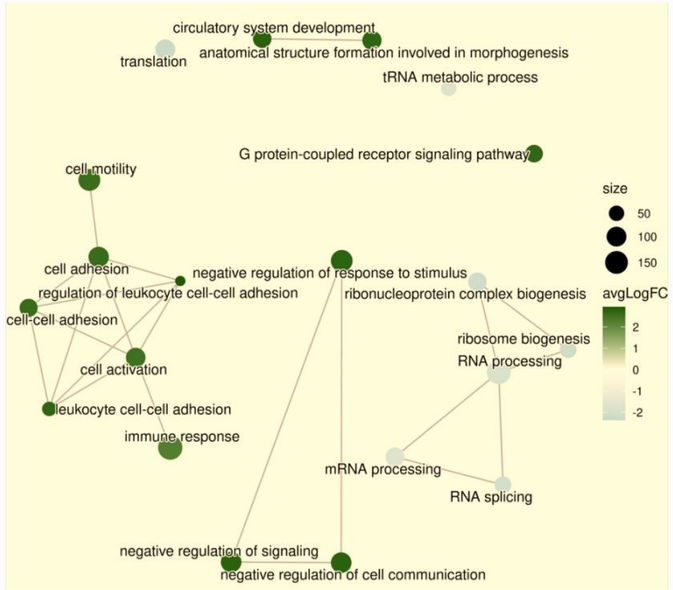
❑ **Energy metabolism** (NR4A3, ACBD7, PTSG, CES1)

❑ Adipocyte **proliferation and differentiation** (IL-1A, PAPPA2)

❑ **Extracellular matrix** composition (COL6A5), **inflamation** (CXCL8, CCL4)

- Gene set enrichment analysis pointed out genes invilved in **immune response**





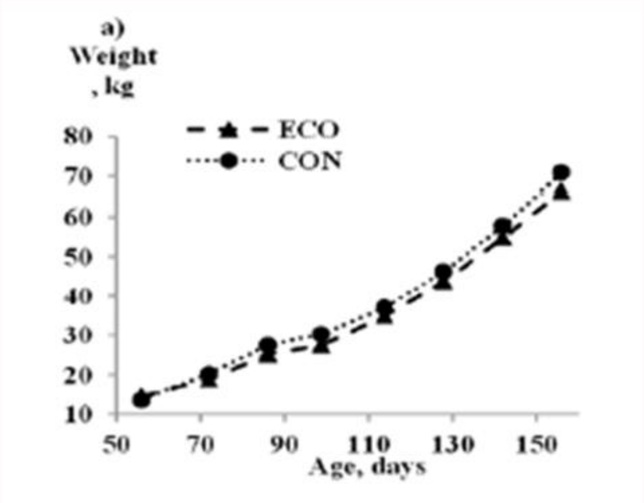
Source (adapted from):
- Poklukar et al., 2025, EAAP meeting, Krakow
- Poklukar et al., 2026, Animal, 101864

Conventional vs. organic KKP (study 3)

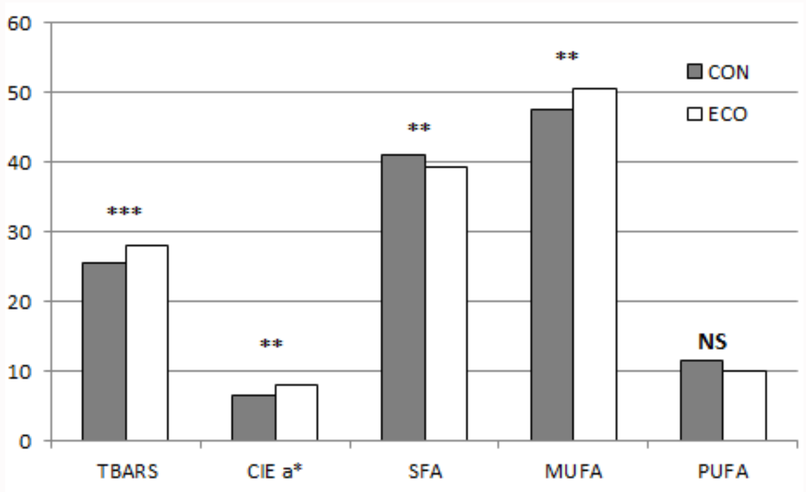
- **Conventional**: indoor, commercial feed, 13.6% CP.
- **Organic**: 100 m^2 outdoor area + shelter, organic feed 12.9% CP + alfalfa hay.
- Organic KKP pigs:

❑ Slightly lower ADG (13%), similar carcass traits.

❑ Darker meat, lower WHC, more unsaturated fats (← alfalfa, exercise), lower oxidative stability (TBARS) → products (↓Q, caution)



Source: Čandek-Potokar et al., proc. 11th Intern. Symp. Modern trends in Livestock Production, Belgrade, 2017

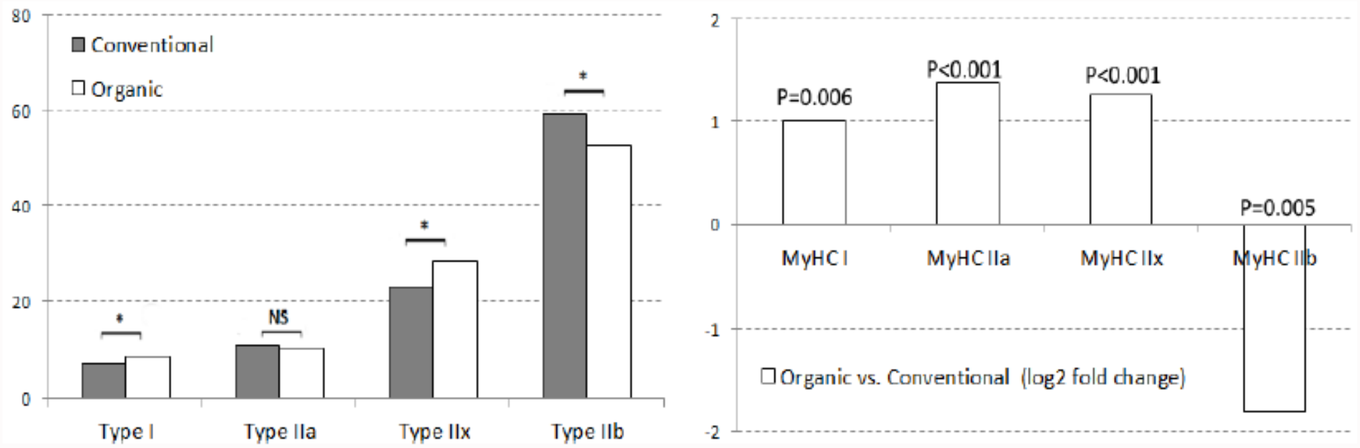


Adapted from: Tomažin et al., 2019, Animal, 13, 1103-1110.

Conventional vs. organic KKP (study 3)

Analysis of muscle **fibre type** and **metabolic** features :

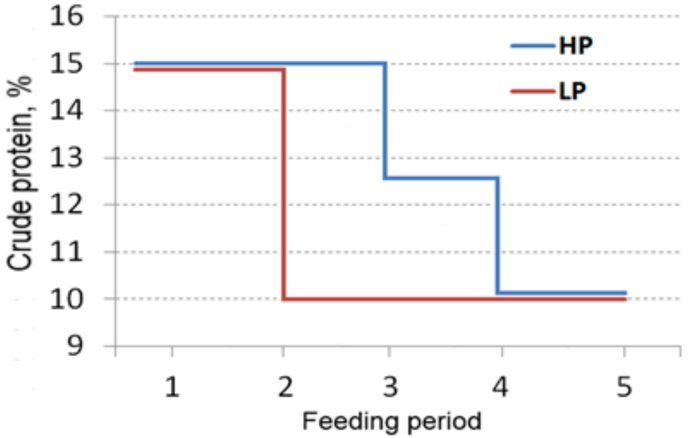
- Organic → shift towards **more oxitative** fibers (SDH positive myofibres)
- Higher expression of I, IIa and IIx, lower expression of IIb MyHC isoforms
- No effect on muscle metabolic phenotype (energy & fat metabolism-related genes (i.e. PGC1α, PPARγ, LPL, FASN, GYS1, HK2)
- **??** effect on meat quality traits **through fibre traits**



Adapted from: Fazarinc et al., 2020, Frontiers in Veterinary Science, 7, 533936

Dietary protein reduction in KKP (study 4)

- **High** vs. **low protein** group, tested in **two production** systems
- Organic (outdoor): fenced area with shelter, *ad lib.* feeding, organic origin of feed
- Conventional rearing: indoor pens, same amount of food than organic, same but conventional ingredients
- Similar starting weight (25 kg), fattening to higher weight (≈160-170 kg)

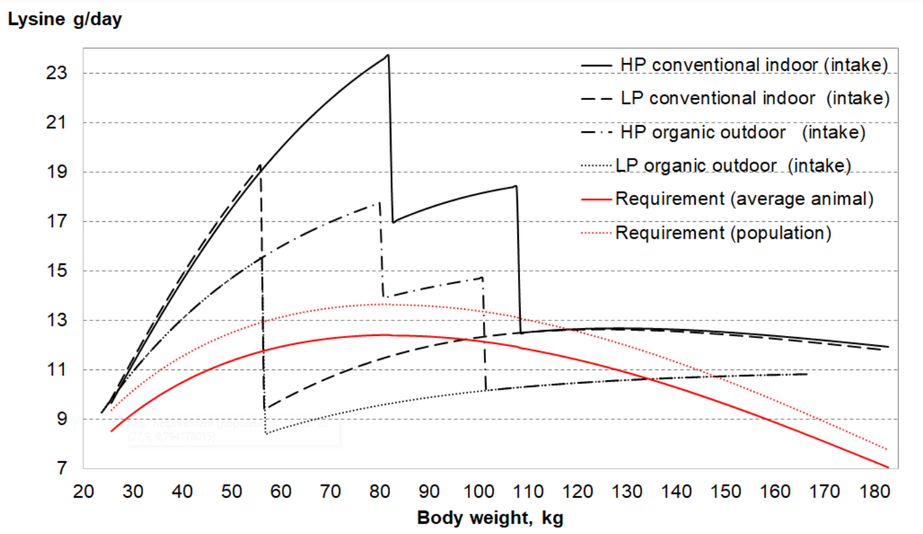


Adapted from: Škrlep et al., 2025, Animal Science Journal., 96, e70077

Dietary protein reduction in KKP (study 4)

Modeling of nutritional needs (InraPorc®):

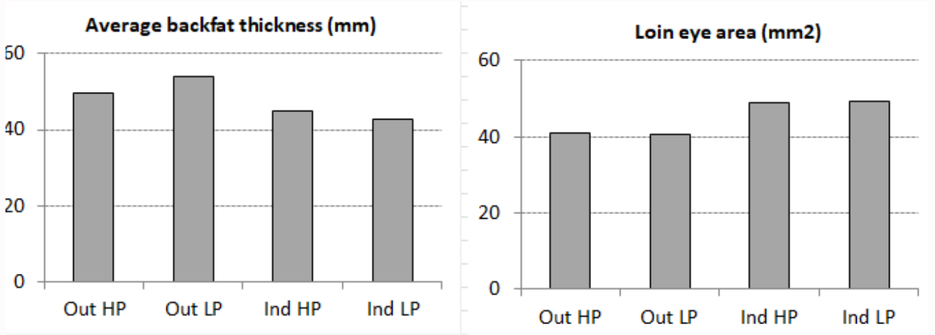
- Only some lysine deficit observed (depending on the rearing system)
- **Conventional:** HP – over requirements; LP – ↓ deficit (switch to 10% CP), no effect on protein deposition.
- **Organic:** HP – ↓ deficit (25-30 kg, 100-120 kg) but overall still balanced; LP – ↑↑ deficit (after switch to 10% CP, lover PD and higher LD compared to HP)



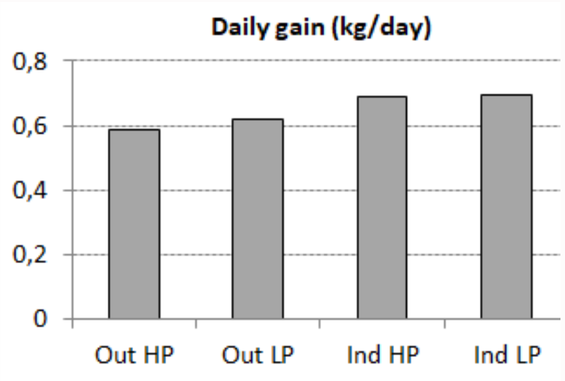
Adapted from: Škrlep et al., 2025, Animal Science Journal., 96, e70077

Dietary protein reduction in KKP (study 4)

- Conventional – **no large differences** in growth and carcass between LP and HP
- Organic – **slower growth** in LP group (phase 2, 3)
- Both systems – **similar final weight** in HP and LP
- **Small/no clear** differences in meat and carcass quality



Earlier protein restriction had only limited effects on perfirmance and quality in KKP (compensatory growth in the subsequent period, when nutritional needs were covered)



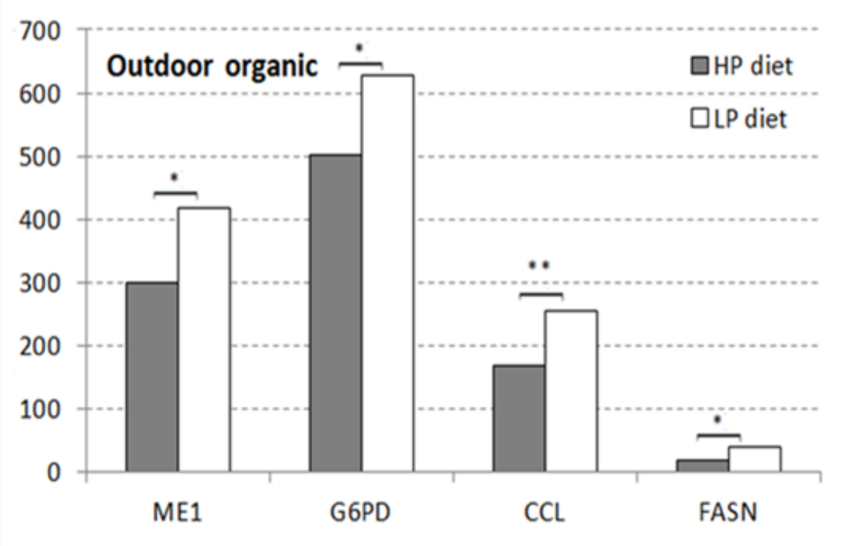
Adapted from: Škrlep et al., 2025, Animal Science Journal., 96, e70077

Dietary protein reduction in KKP (study 4) - transcriptome, biochemical traits

Organic system, pigs receiving **LP diet**:

- ↑ lipogenic enzyme activities
- ↑ MUFA, and ↓ PUFA content

- ↑ lipid metabolism (ACLY, FASN, ACACA, MOGAT2)
- ↑ oxidative stress (PON1, XDH),
- ↑ mitochondrial function (MPV17L, ECHDC1, ACSM5).



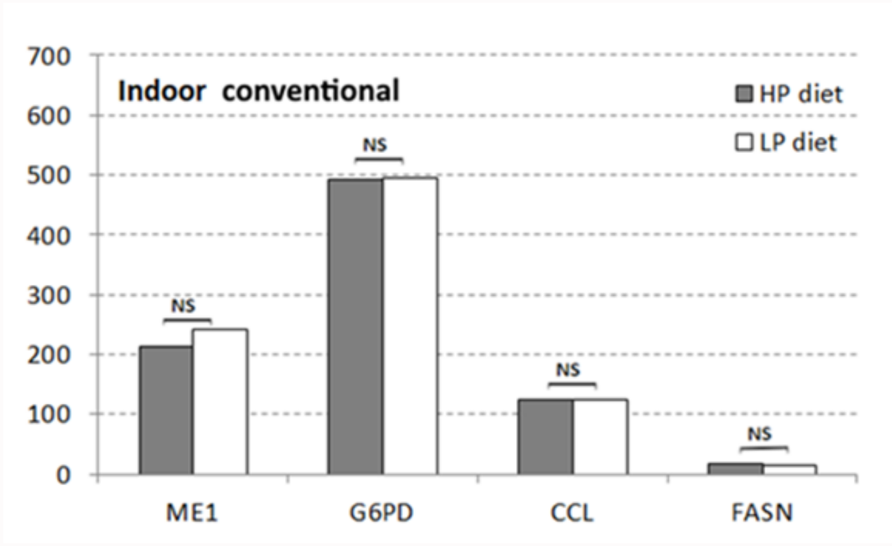
Adapted from: Poklukar et al., 2025, International Journal of Molecular Sciences, 26, 4440

Dietary protein reduction in KKP (study 4) - transcriptome, biochemical traits

Conventional system, pigs receiving **LP diet**:

- no effect on lipogenic enzymes and FA composition

- ↑ **heat shock** protein genes (HSP70, HSPA6)
- ↓ innate immune system (MSR1, TREM2, CSF3R) regulation of addipose tissue **homeostasis**
- no significant involvement of lipogenic genes



Adapted from: Poklukar et al., 2025, International Journal of Molecular Sciences, 26, 4440

CONCLUSIONS

- **Krškopolje pigs demonstrated distinct adaptability and fat deposition characteristics compared to modern breeds.**

- **Subjecting KKP to different rearing/feeding practices offers additional possibilities to moderate performance or quality and composition.**

- **The findings observed for growth, fat deposition and composition may be utilized to improve the breed‘s potential for specialized and sustainable production.**

Thank you for your attention!

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