# Increasing the utilisation of forage protein in ruminant diets

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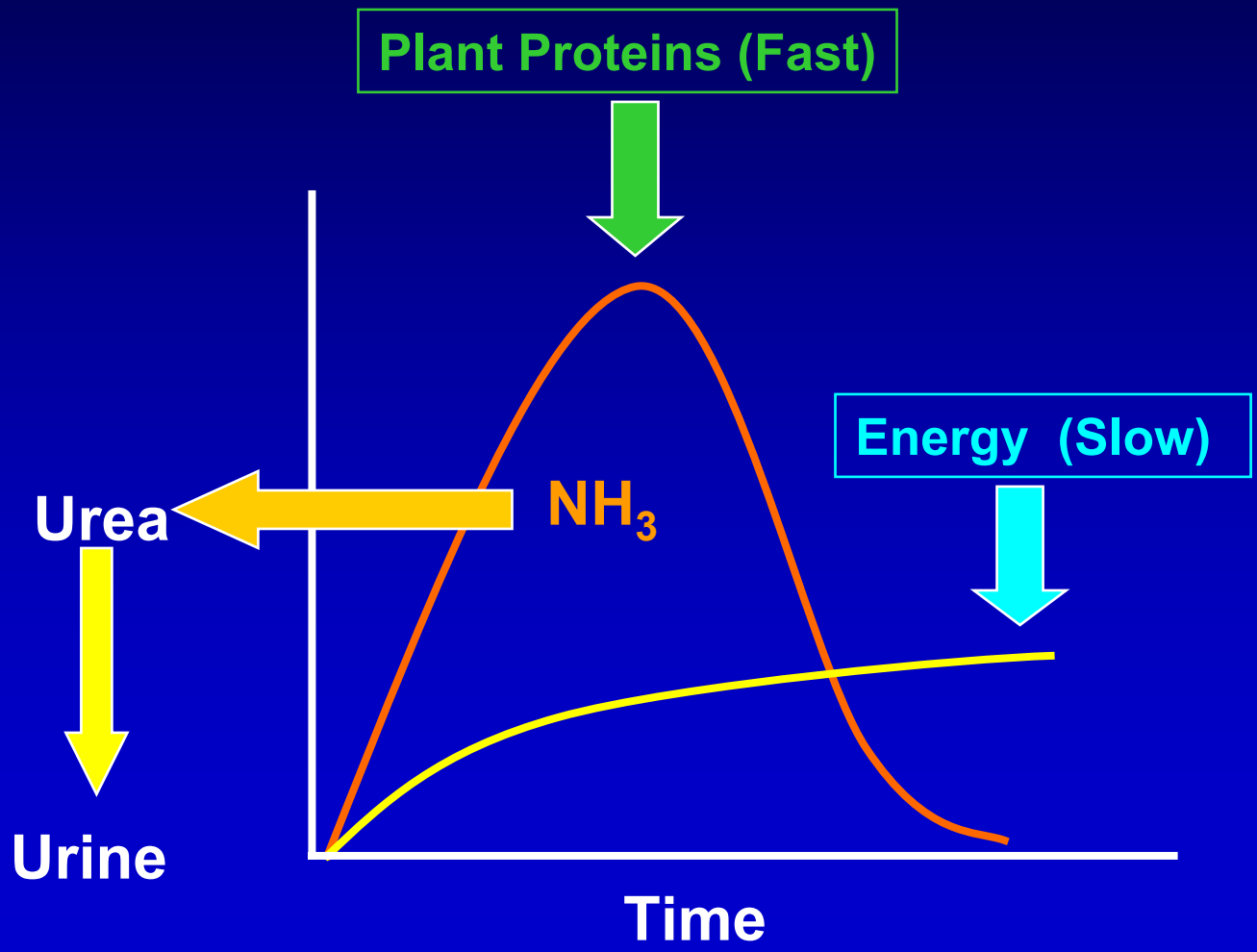
# N-use efficiency

- Milk N as a % of Feed-N (n=51 expts)
  - Mean: 27.6
  - Range: 14.5 to 40.0
  - Particular problem with forages

# Synchrony of nitrogen and energy supply in the rumen



# Evidence for synchrony effect?

- Difficult to separate synchrony and specific raw material effects?
- Contradictory results: one study showed higher microbial efficiency with an asynchronous diet
- Better to consider the balance of substrates

# Two Basic Approaches

- Increase fermentable energy supply
  - High-sugar grasses
  - Forage mixtures (maize silage)
- Reduce rate of protein degradation
  - Polyphenol oxidase (red clover)
  - Plant proteolysis

# Complementary science

- High-sugar grasses
  - cold tolerance
- Polyphenol oxidase
  - plant defence (pathogen/pest)
- Plant proteolysis
  - senescence

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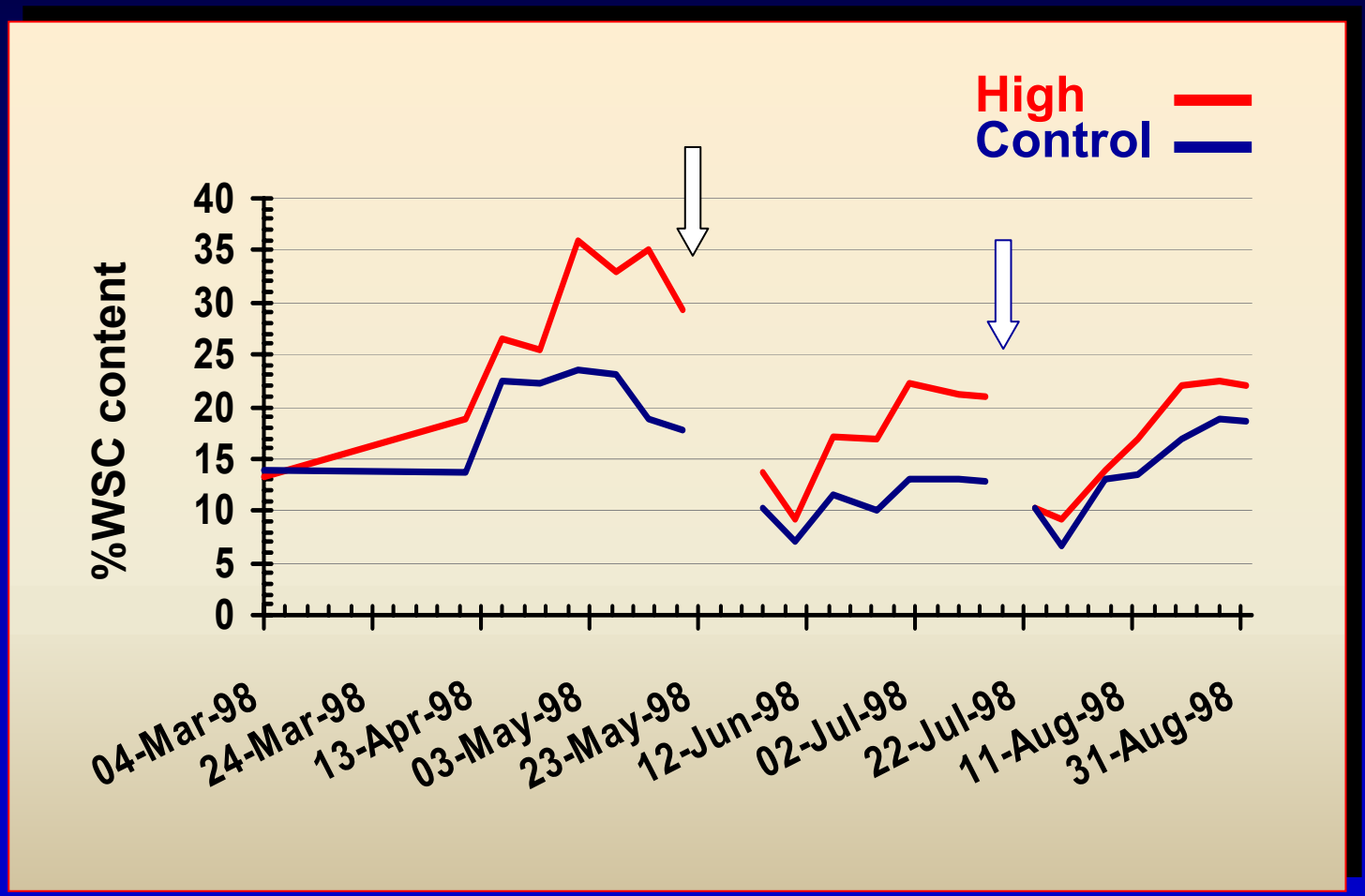
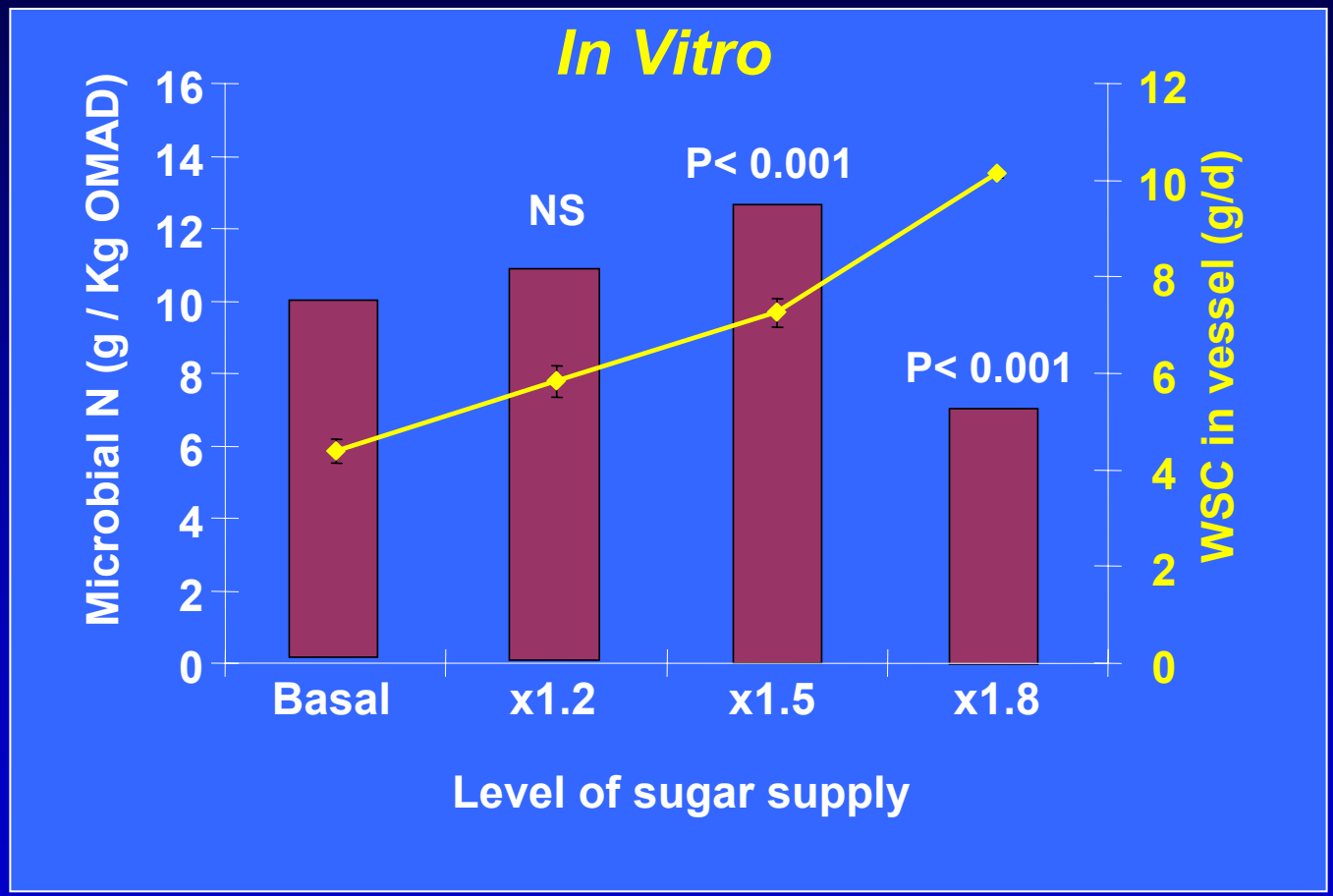
# Seasonal Change in WSC Content

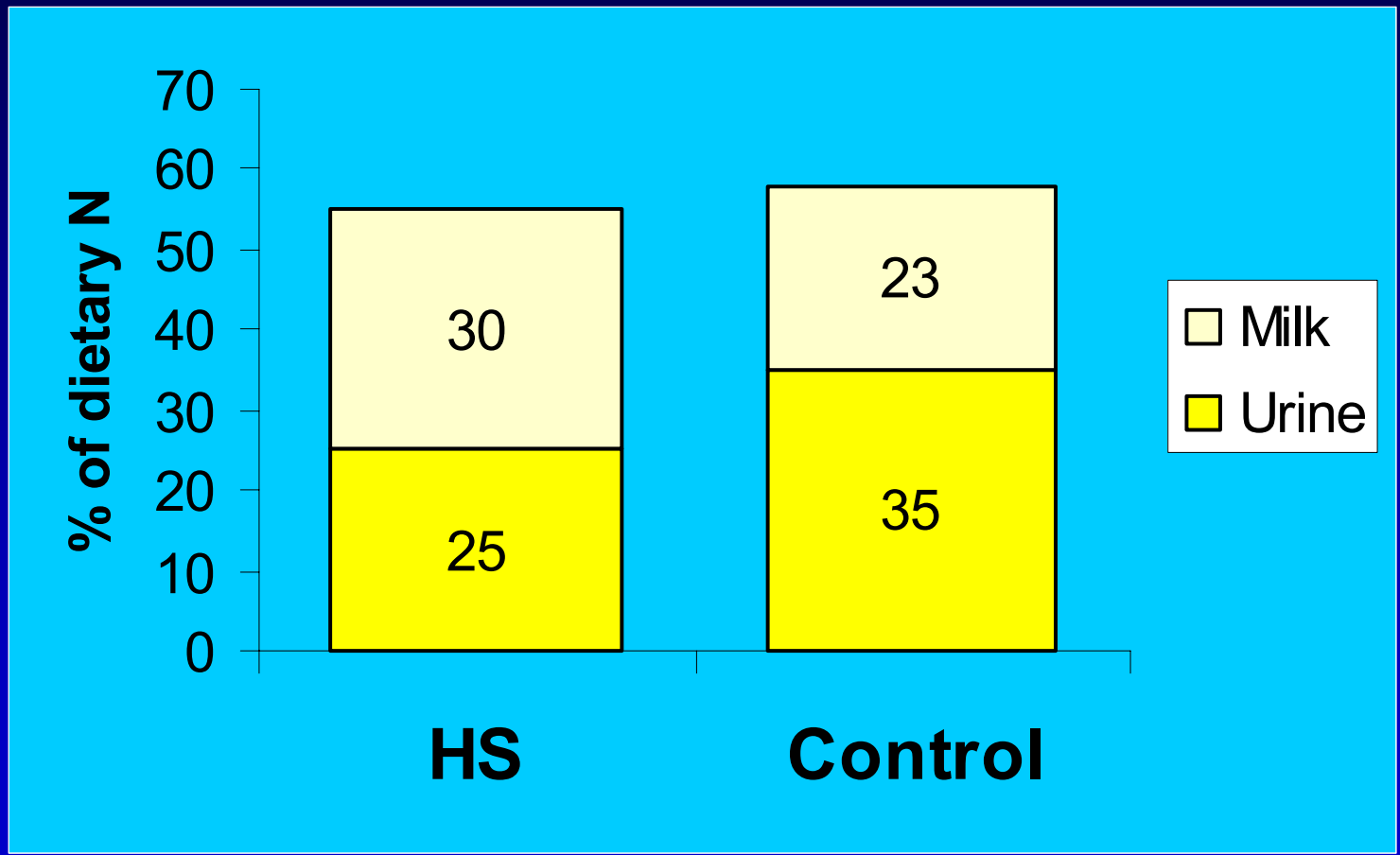


# High sugar grasses

## Efficiency of microbial protein synthesis




# N partitioning in dairy cows grazing control and high sugar grass (HS)




Miller *et al.* 2002

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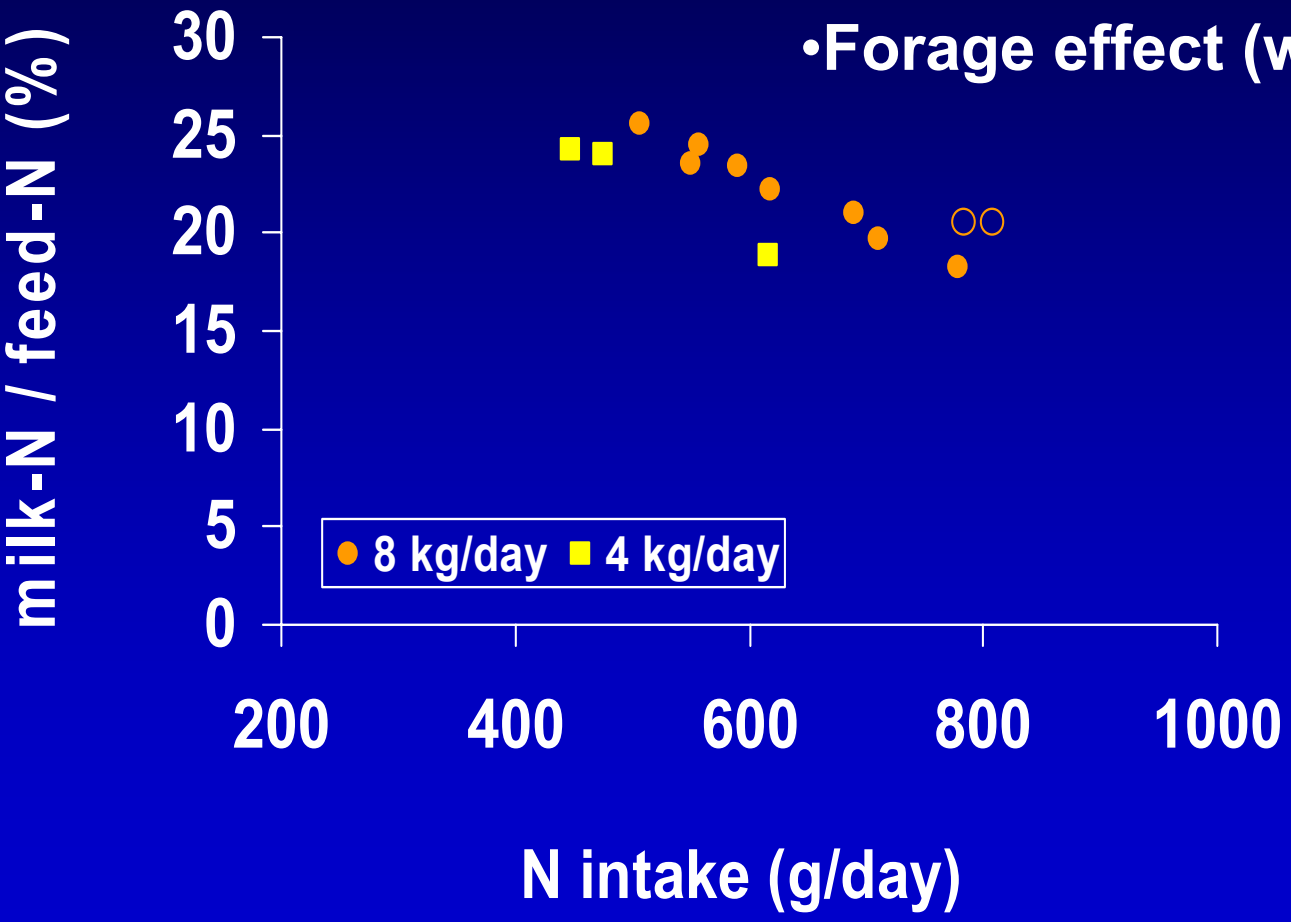
# Previous work on forage legumes

+ Yield 10-12 tonnes of DM per ha with no N fertiliser (sustainable systems)
+ Higher voluntary intakes
+ Higher milk production
+ Increased PUFA in milk

– Low N-utilisation

# N-use efficiency

- N intake effect
- Concentrate effect
- Forage effect (white clover)




Dewhurst *et al.* 2003

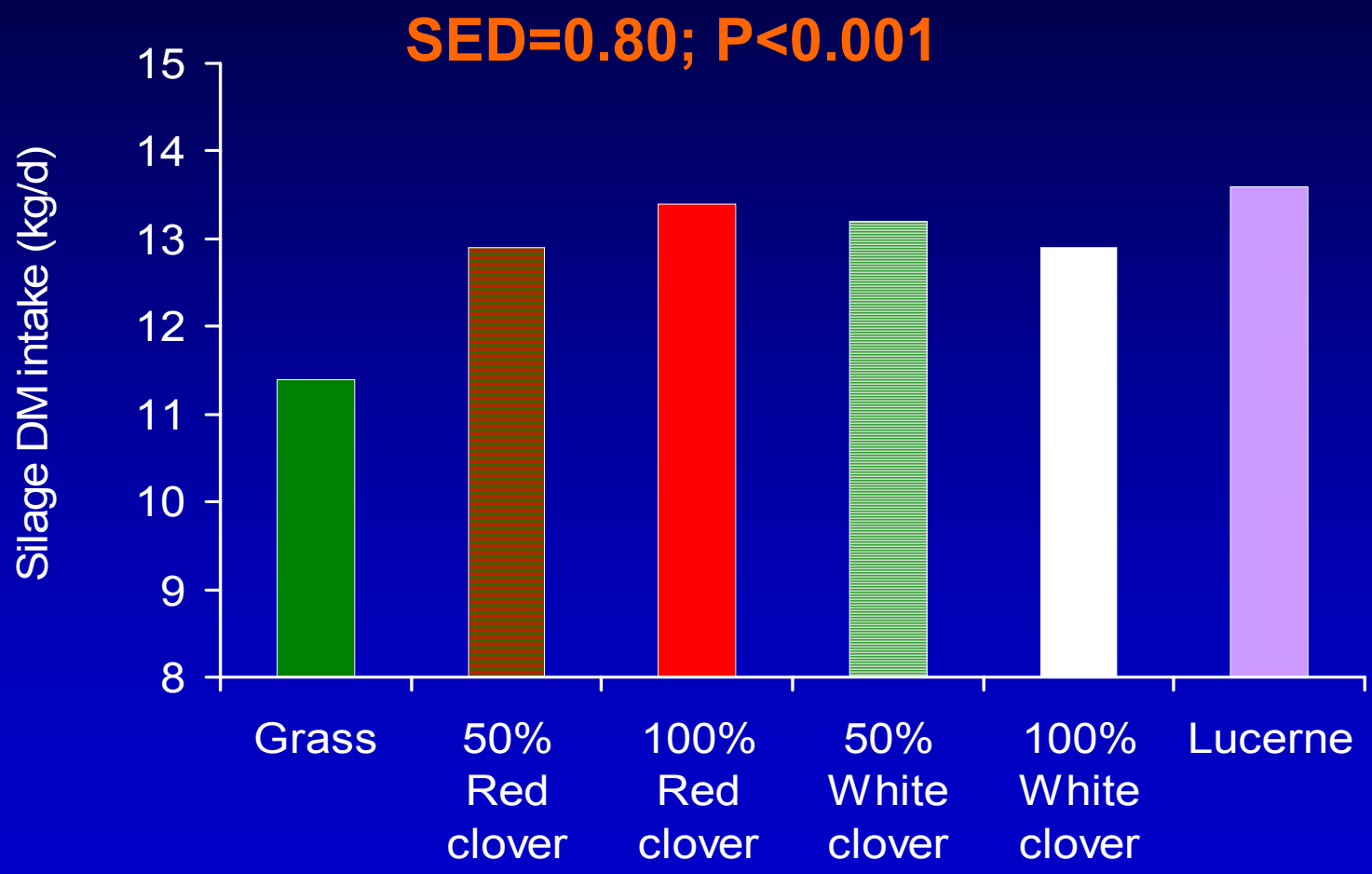
# White clover silage

- Higher rumen fermentation rate than grass silage
- Higher rumen passage rate than grass silage

**HOWEVER, little evidence of increased N-use efficiency in the rumen**

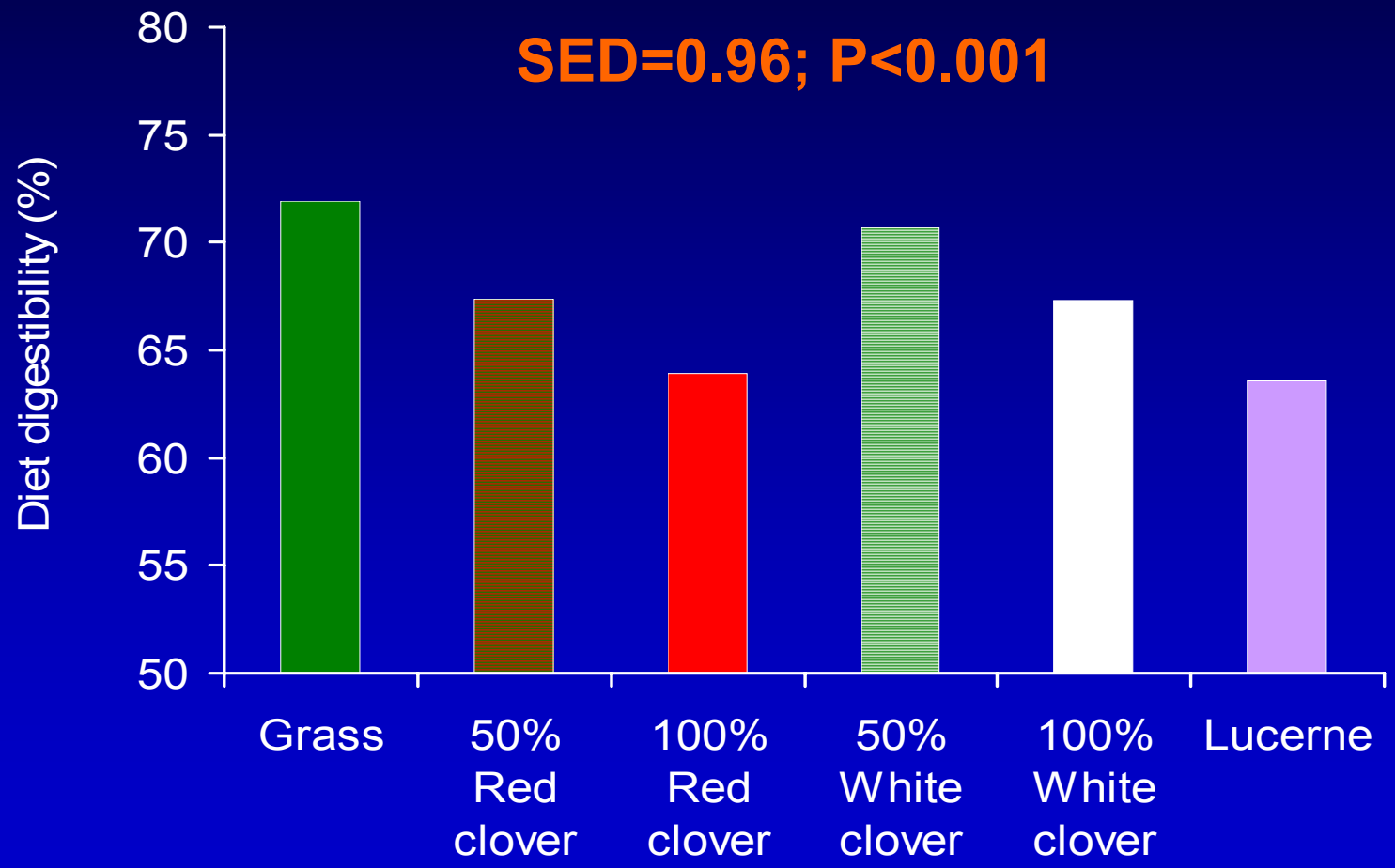
- Effect appears related to increased energy supply to animal tissues (high DM intake and digestibility)

# DM intake of legume silages




Dewhurst *et al.* 2003

# Digestibility of legume silage-based diets



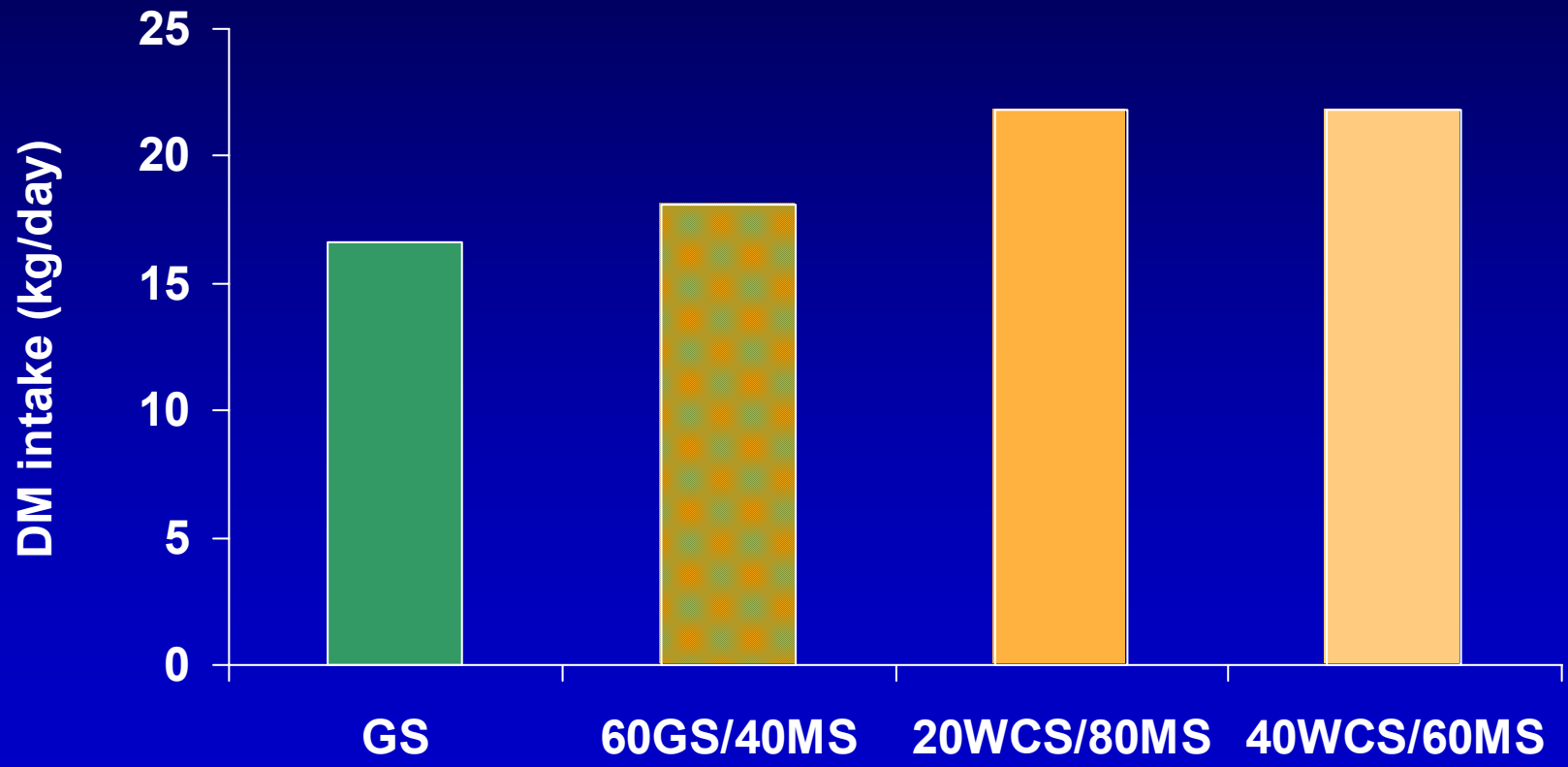

Dewhurst *et al.* 2003

# Maize silage to complement white clover silage

- Grass silage (GS)
- 0.6 grass silage + 0.4 maize silage (60GS/40MS)
- 0.2 white clover silage + 0.8 maize silage (20WCS/80MS)
- 0.4 white clover silage + 0.6 maize silage (40WCS/60MS)

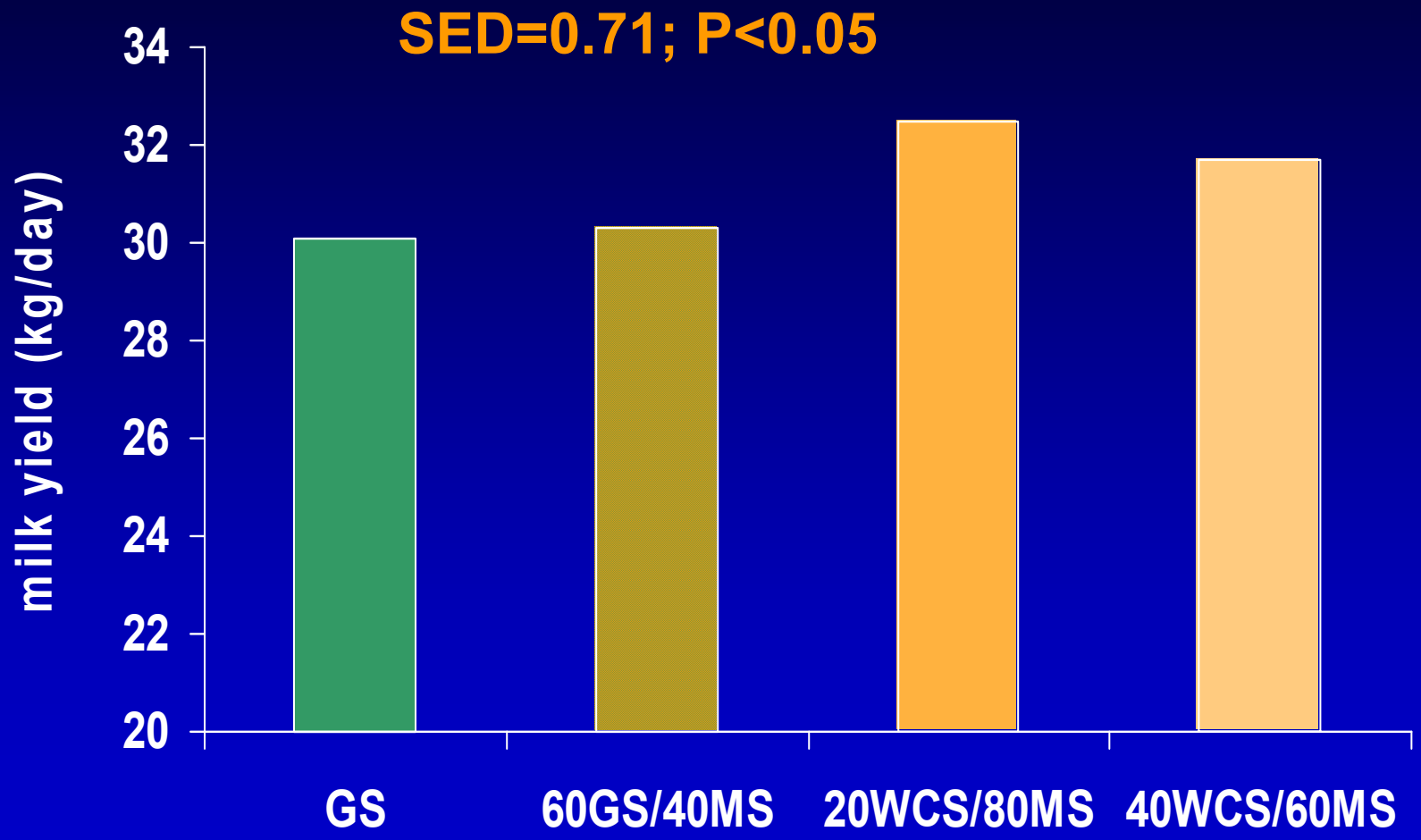
# DM intake (kg/day)

SED=0.54; P<0.001




Dewhurst *et al.*, 2004

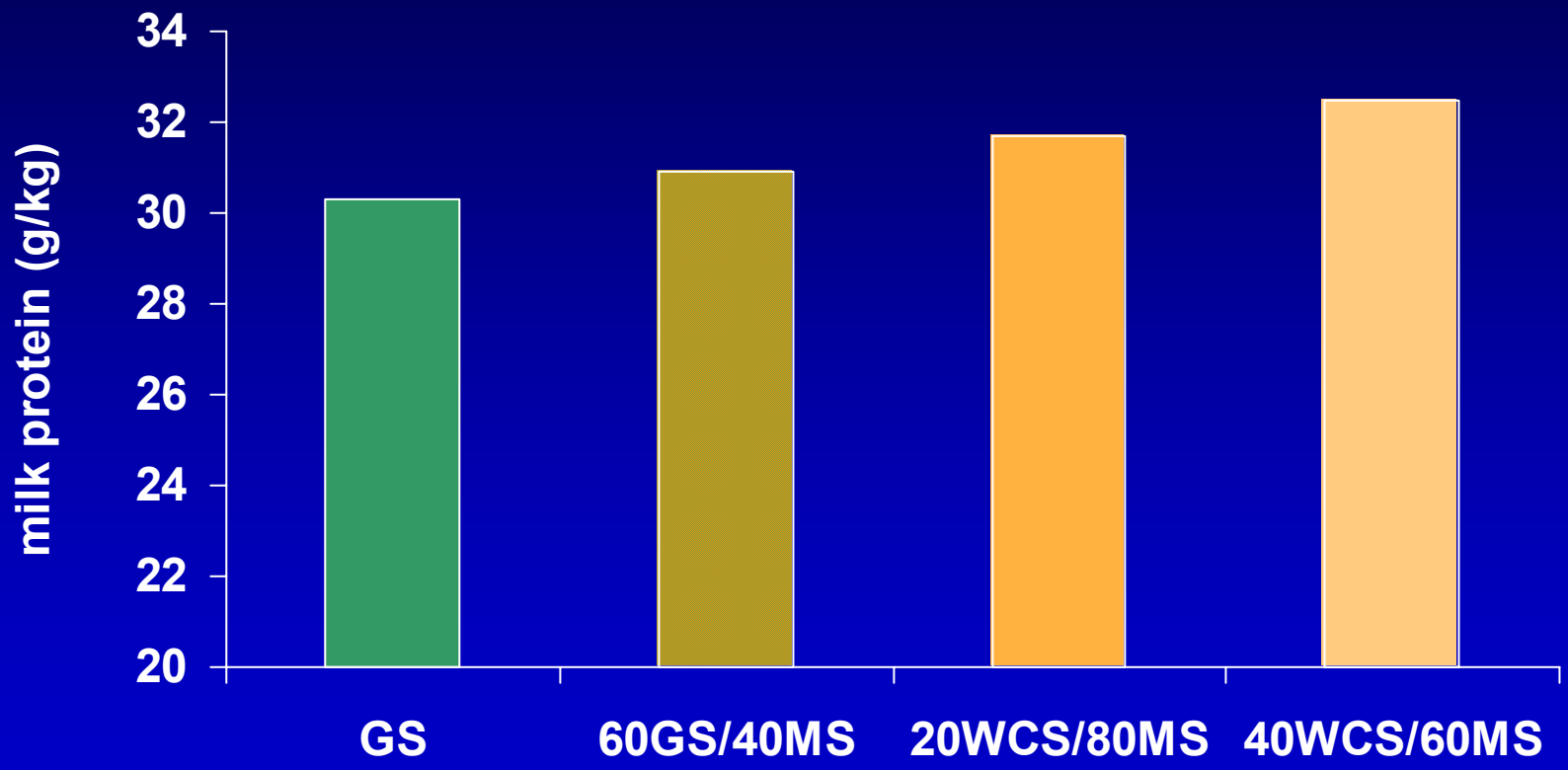
# Milk yield (kg/day)




Dewhurst *et al.*, 2004

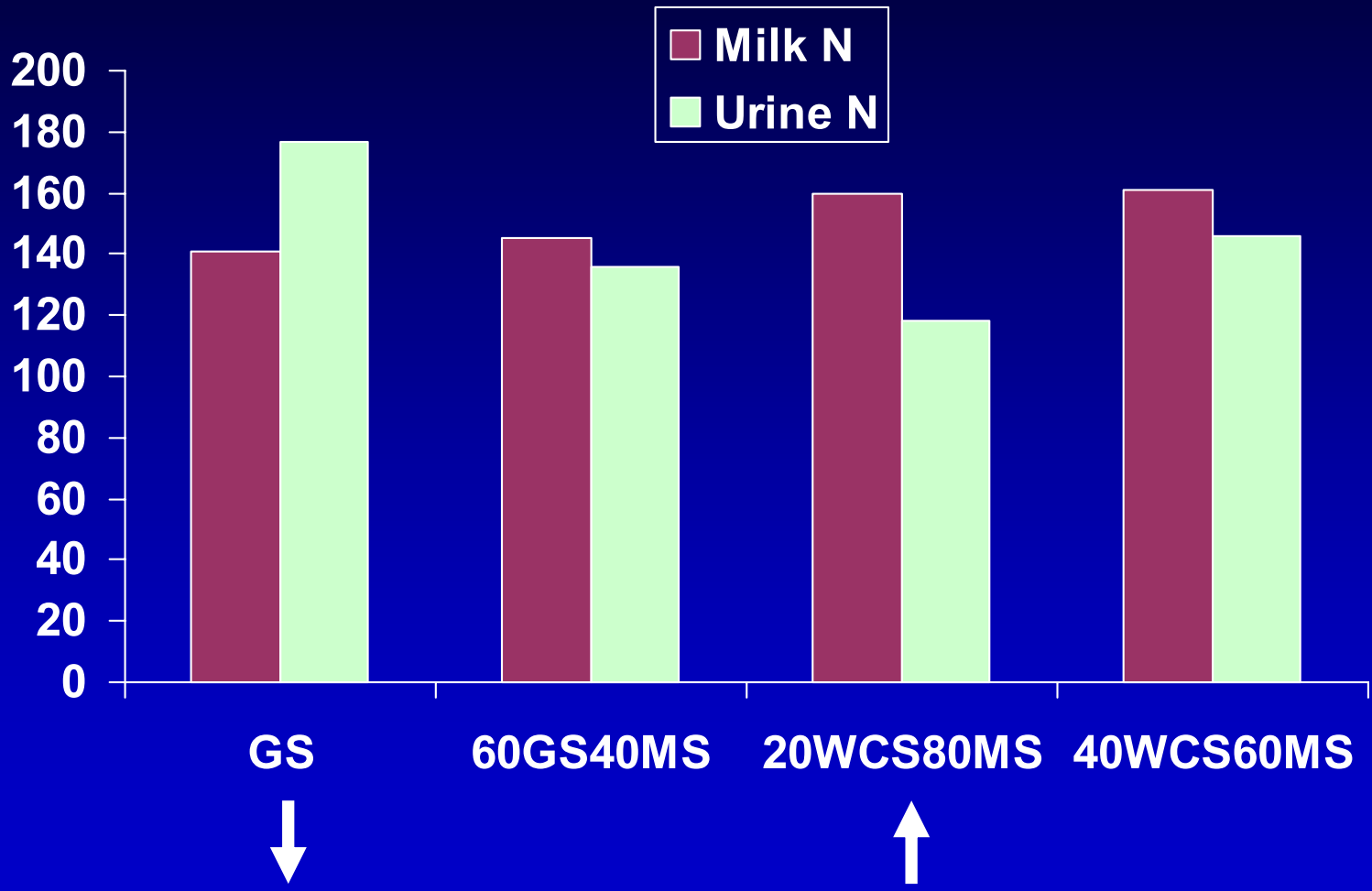
# Milk protein (g/kg)

SED=0.52; P<0.01




Dewhurst *et al.*, 2004

# Milk and Urine N output (g/day)




41% less urine N per unit milk N

Dewhurst *et al.*, 2004

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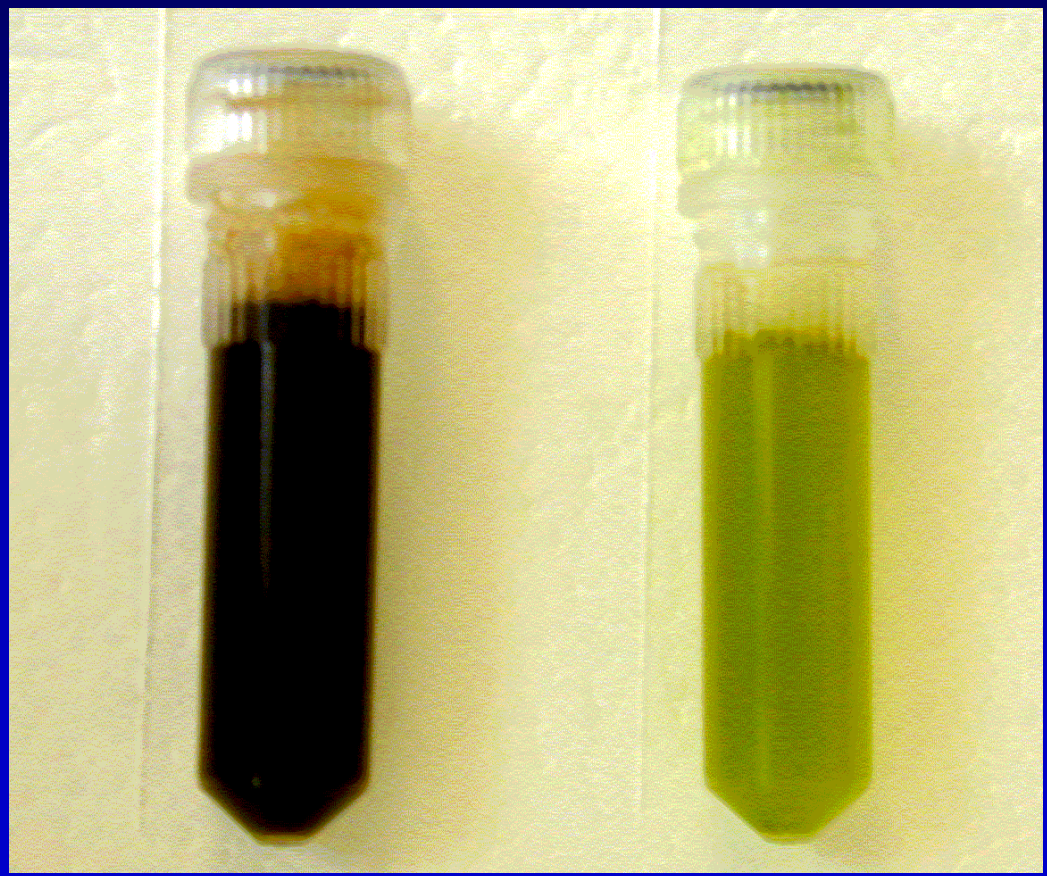
  - Plant proteolysis

# What is Polyphenol oxidase ?

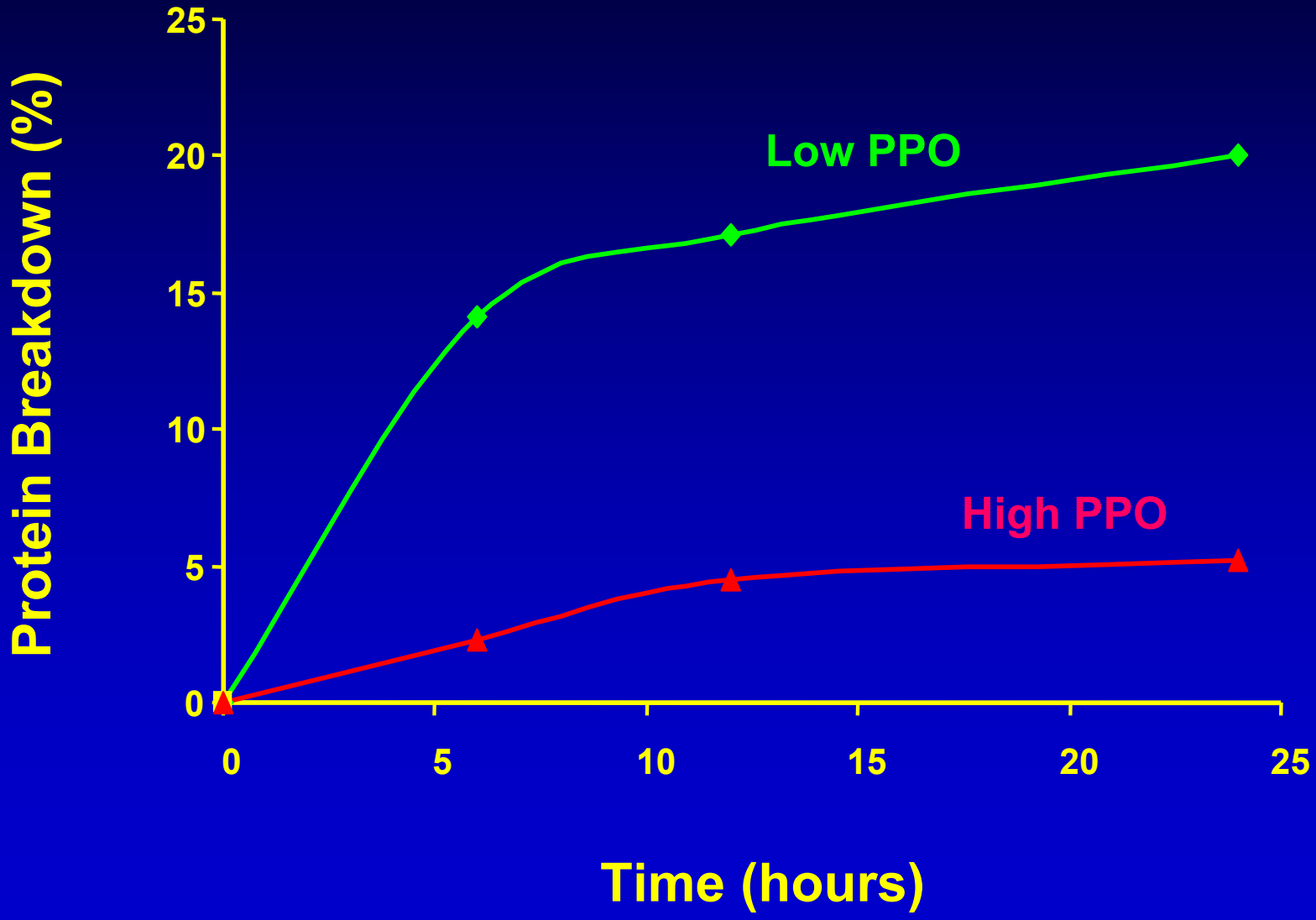
- Enzyme
- Oxidises phenols to quinones
- Quinones are very reactive and “sticky”
- Cause complexing of proteins
- Protein complexes are difficult to break down

# Polyphenol oxidase in red clover

**Normal Red Clover** **Low PPO Red Clover**



# Protein Breakdown in Red Clover Leaf Extracts



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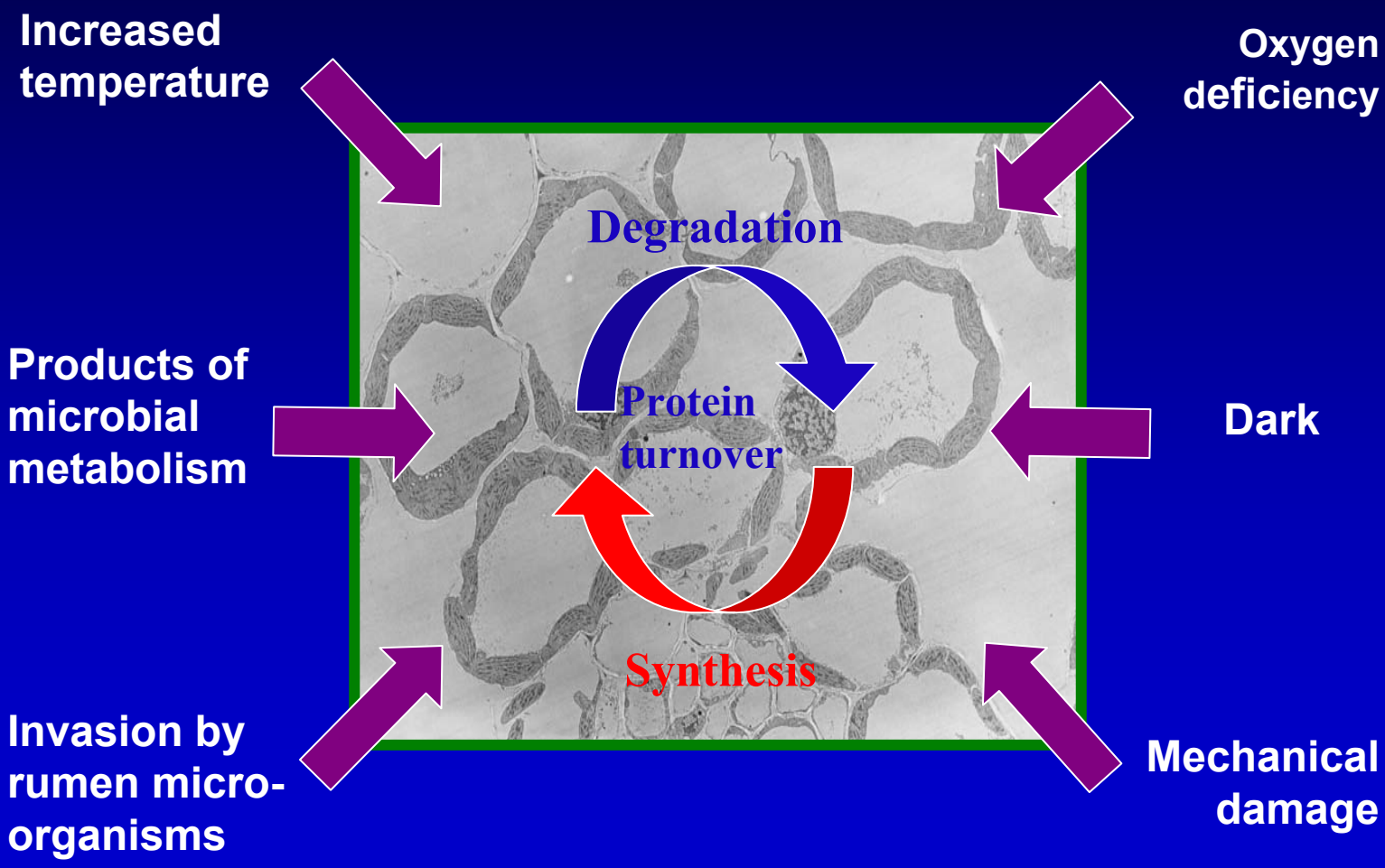
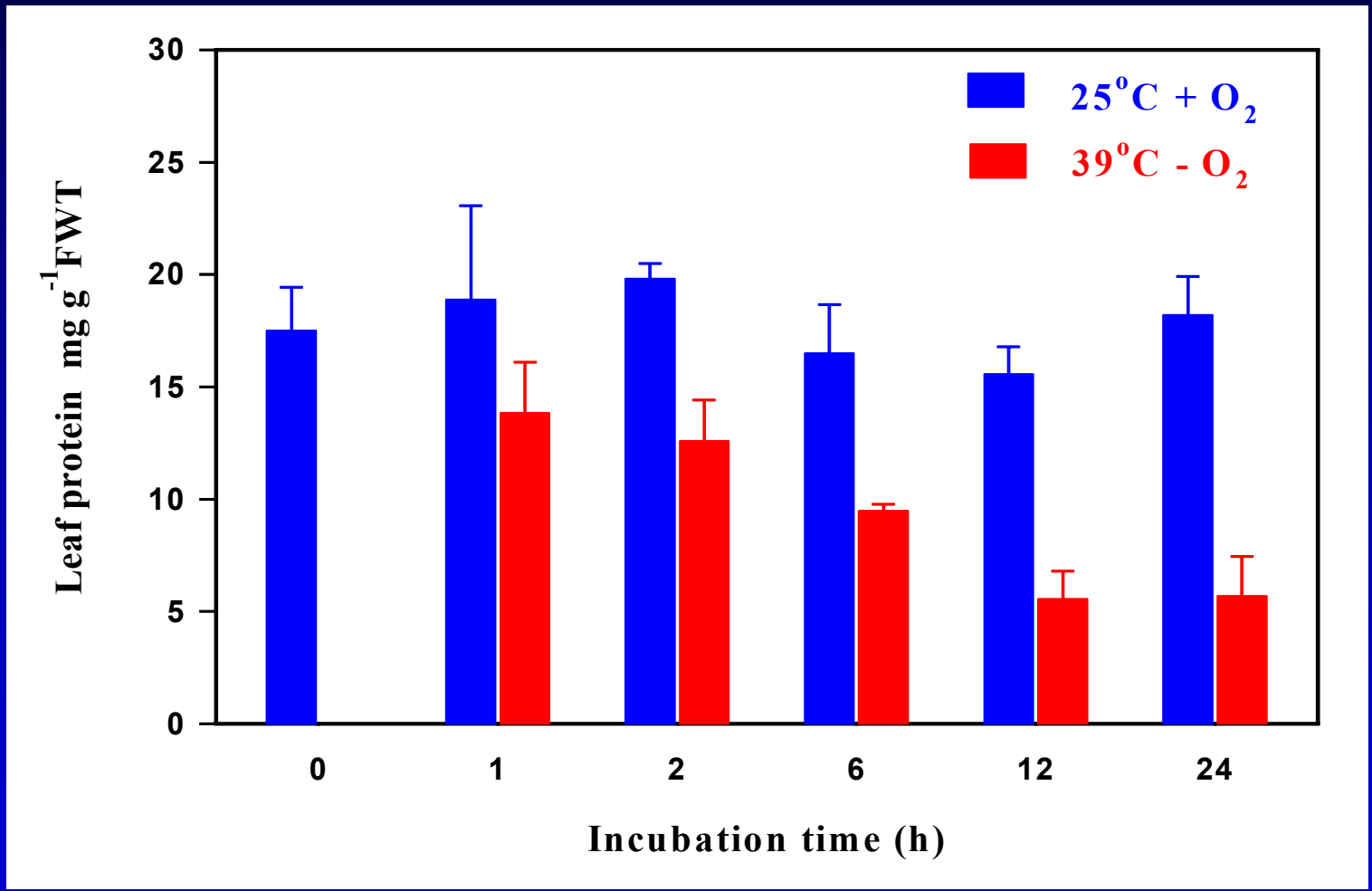
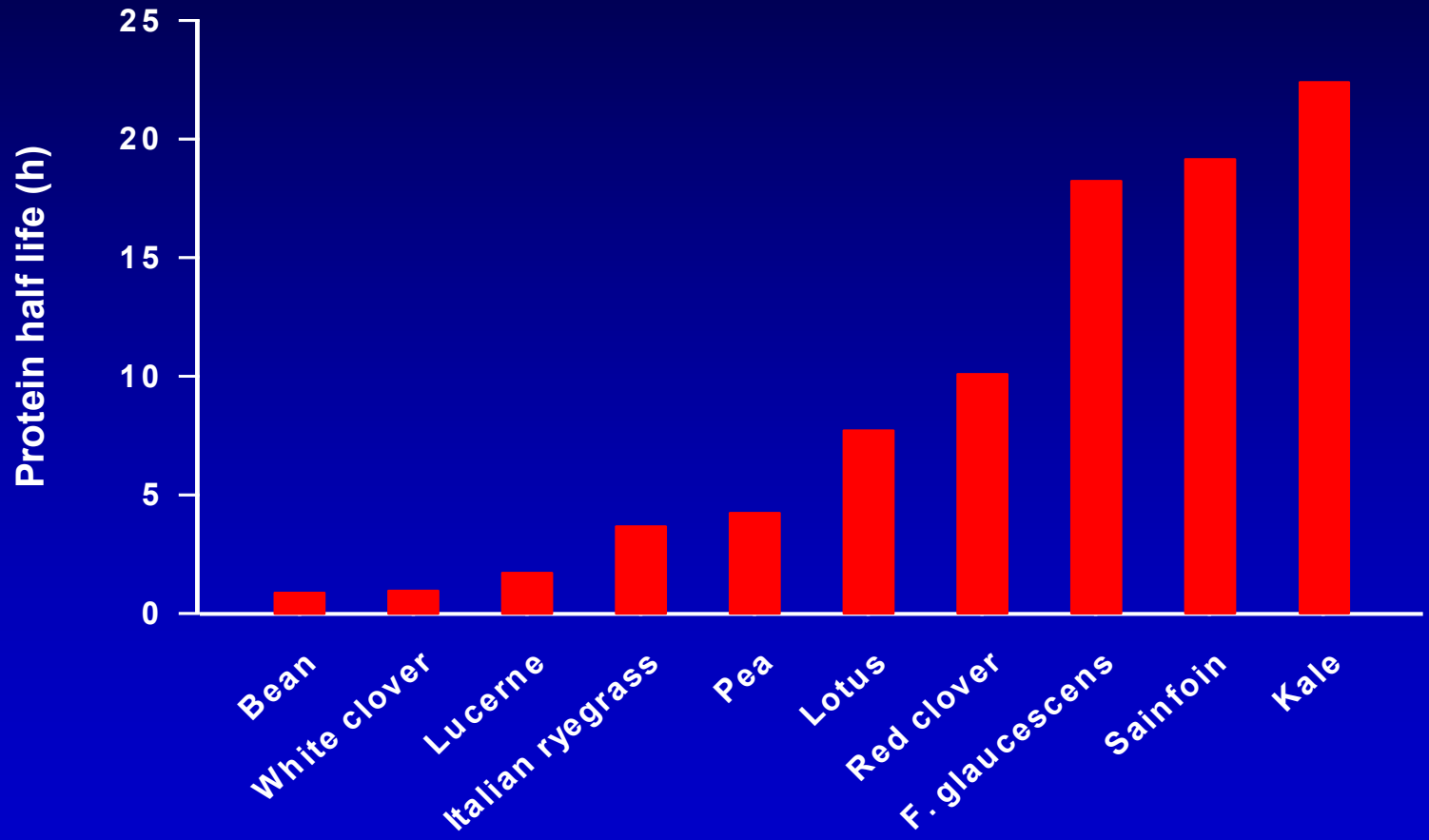


# *In vitro* proteolysis

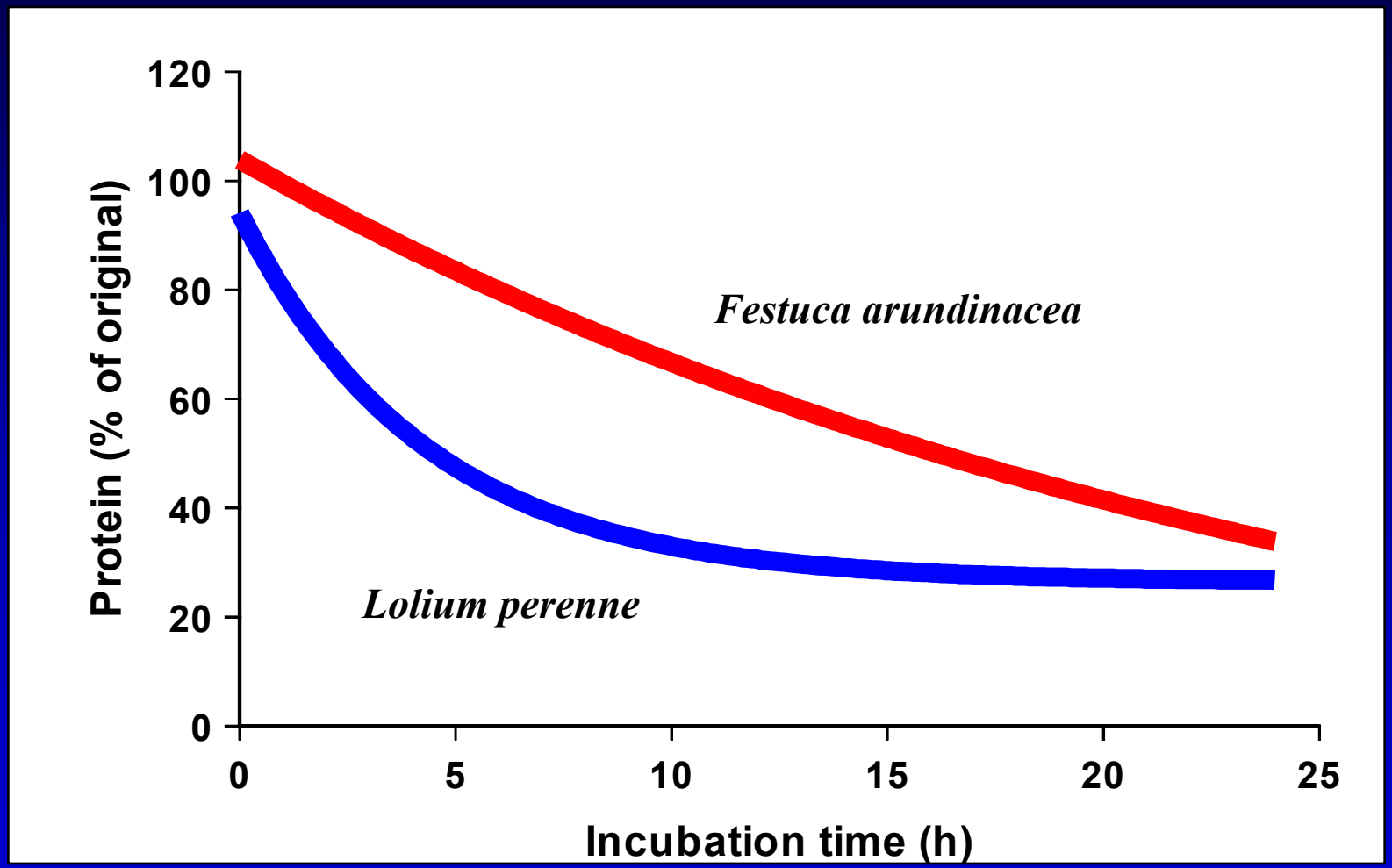
# Protein degradation *in vitro*



# Half-life of leaf protein



# *Lolium* vs *Festuca*



# Conclusions

- Potential to increase utilisation of forage N by:
  - increasing levels of sugar and starch (e.g. high-sugar grasses; maize silage)
  - using high-intake forages and forage mixtures
  - selecting species and traits with lower rates of protein degradation