

Growth stage and ensiling effects on ruminal degradability of whole-crop oats

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Dairy sector



Cattle farming



Introduction

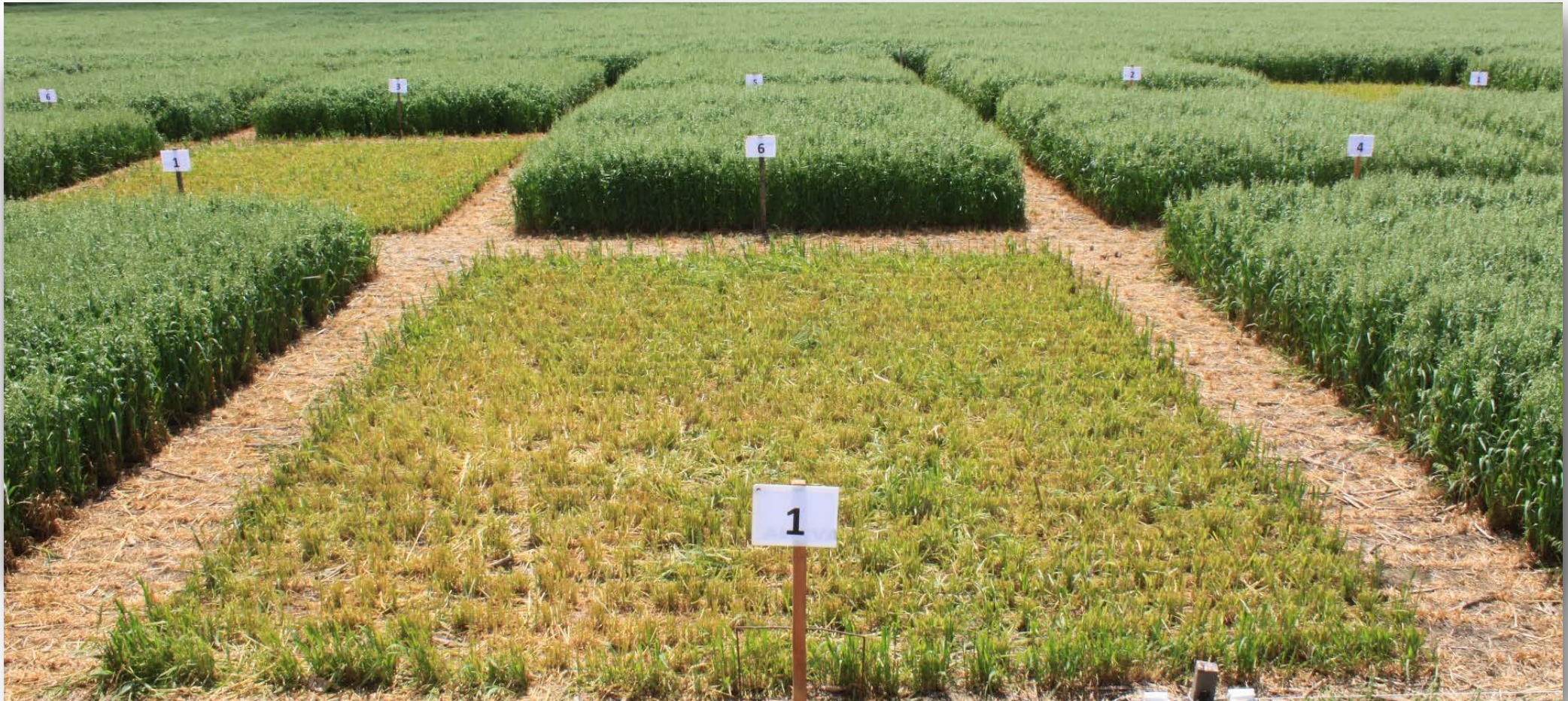
- Increasing **home-grown forage** production and utilization
- **Alternative forage crops**
- **Whole crop cereals**
- **Growth stage and silage conservation**

Objective

This study evaluated the effects of **growth stage** and **ensiling** of whole-crop oats on *in situ* ruminal dry matter degradability.

Materials and methods

- **Grain-type oats** (*Avena sativa* cv. Cantara)
- **Randomized Complete Block Design:** 3 replicates/ Treatment



Materials and methods

- Treatment = Harvest and **ensiling** at **6 stages of growth**

Boot



Heading



Water ripe



Early milk



Early dough



Grain ripe



Materials and methods

- Harvested and ensiled at **6 stages of growth**
- **Zadoks cereal growth stage key** (Zadoks et al. 1974)

GS 45



GS 59



GS 69



GS 73



GS 83



GS 91



Materials and methods

- Harvested and ensiled at **6 stages of growth**
- **Zadoks cereal growth stage key** (Zadoks et al. 1974)

125

132

139

146

161

170



- **Days post-sowing**

Materials and methods

Harvest



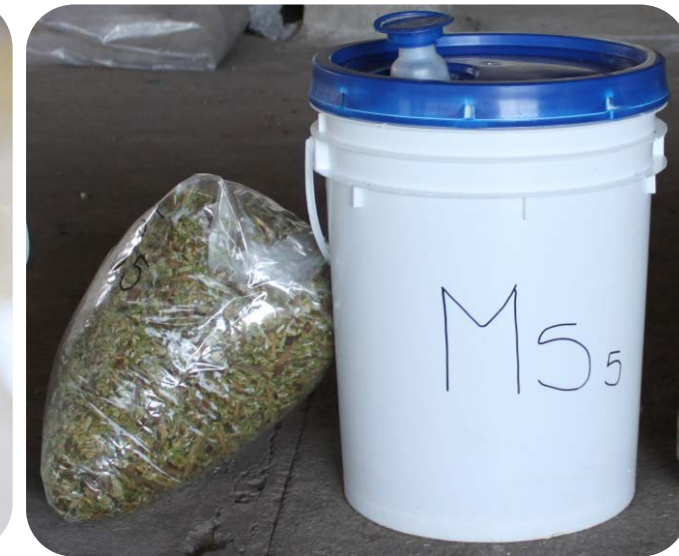
- Small scale forage harvester
- Stubble height 15 cm
- Same daytime (13.00 h)

Chop



- Particle size 2-4 cm

Ensiling



- Manual press
- 22 L drums
- Hermetically sealed
- 64 days ensiling

Materials and methods

- In situ ruminal degradation kinetics of **fresh** and **ensiled forage**
- **Pooled samples** from the same stage of growth



6 samples



6 samples

Materials and methods

- In situ ruminal degradation kinetics of **fresh and ensiled forage**
- **Pooled samples** from the same stage of growth
- **3 cows** fitted with rumen cannulas
 - ✓ Diet 2/3 Forage + 1/3 concentrate
 - ✓ Vitamin and mineral mixture
 - ✓ 20 days of adaptation period



Materials and methods

- In situ ruminal degradation kinetics of **fresh and ensiled**
- **Pooled samples** from the same stage of growth
- **3 cows** fitted with rumen cannulas
- **Incubation**
 - ✓ Dried 60°C – Ground 2 mm
 - ✓ 7 g placed in Nylon bags
 - ✓ 3, 6, 12, 24, 48, 72, 96 h
 - ✓ 2 series
 - ✓ Removal / washed/ dried



Materials and methods

- Data was fitted model proposed by Ørskov and McDonald (1979):

$$d = a + b (1 - e^{-k_d t})$$

| | |
|-----------------------|--|
| d: | material lost from the bag at time t |
| a: | soluble fraction |
| b: | insoluble degradable fraction |
| k_d: | fractional degradation rate of b (/h) |
| u: | undegradable fraction $u = 1 - (a + b)$ |

Materials and methods

- Data was fitted model proposed by Ørskov and McDonald (1979):

$$d = a + b (1 - e^{-k_d \times t})$$

- Effective degradability:

$$ED = a + (b \times k_d) / (k_d + k_p)$$

Rumen particle outflow rate (k_p):

0.03 /h low flow rate

0.06 /h high flow rate

Statistical analysis

- Effects of **growth stage**, **ensiling** and their **interaction** were analysed using the SAS MIXED procedure.

$$Y_{ijk} = \mu + GS_i + E_j + (GS * E)_{ij} + B_k + \epsilon_{ijk}$$

| | | |
|---------------|--------------|--------------------------------|
| GS_i | Growth stage | $i = 6$ growth stages |
| E_j | Ensiling | $j =$ fresh and ensiled forage |
| $GS * E_{ij}$ | Interaction | |

- **Linear** and **quadratic regressions** for growth stage.

Results and Discussion

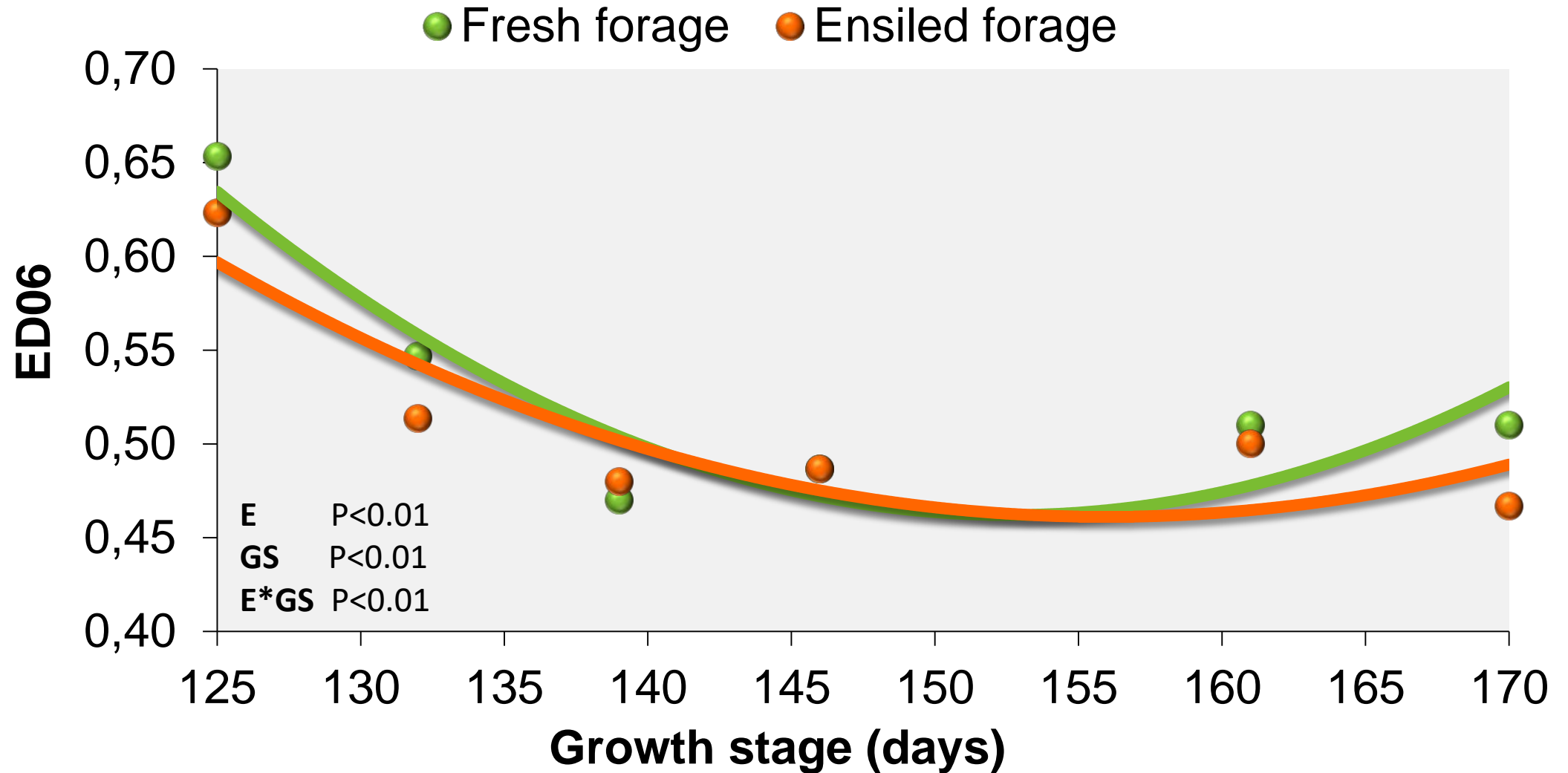


Fresh forage

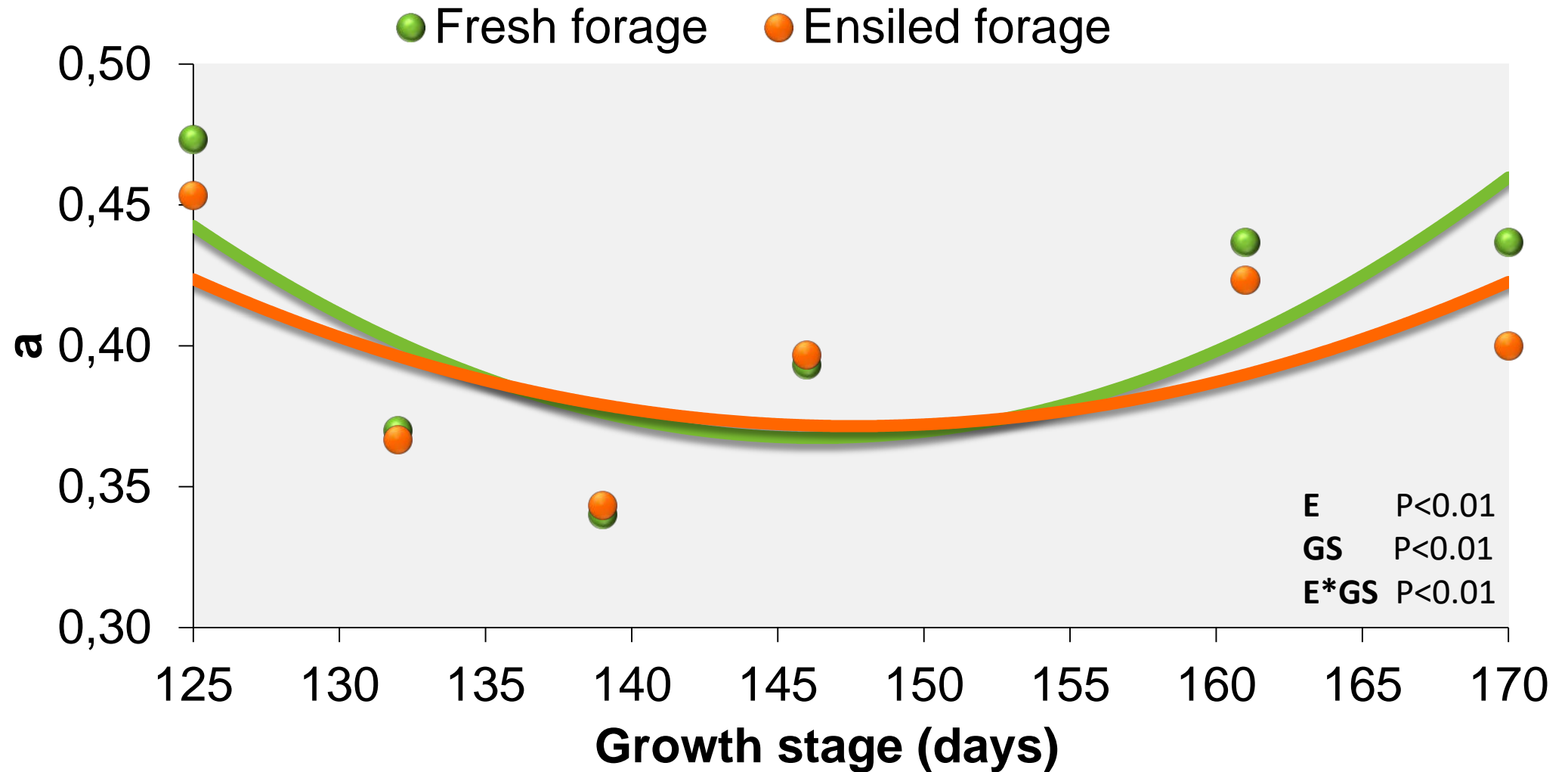


Ensiled forage

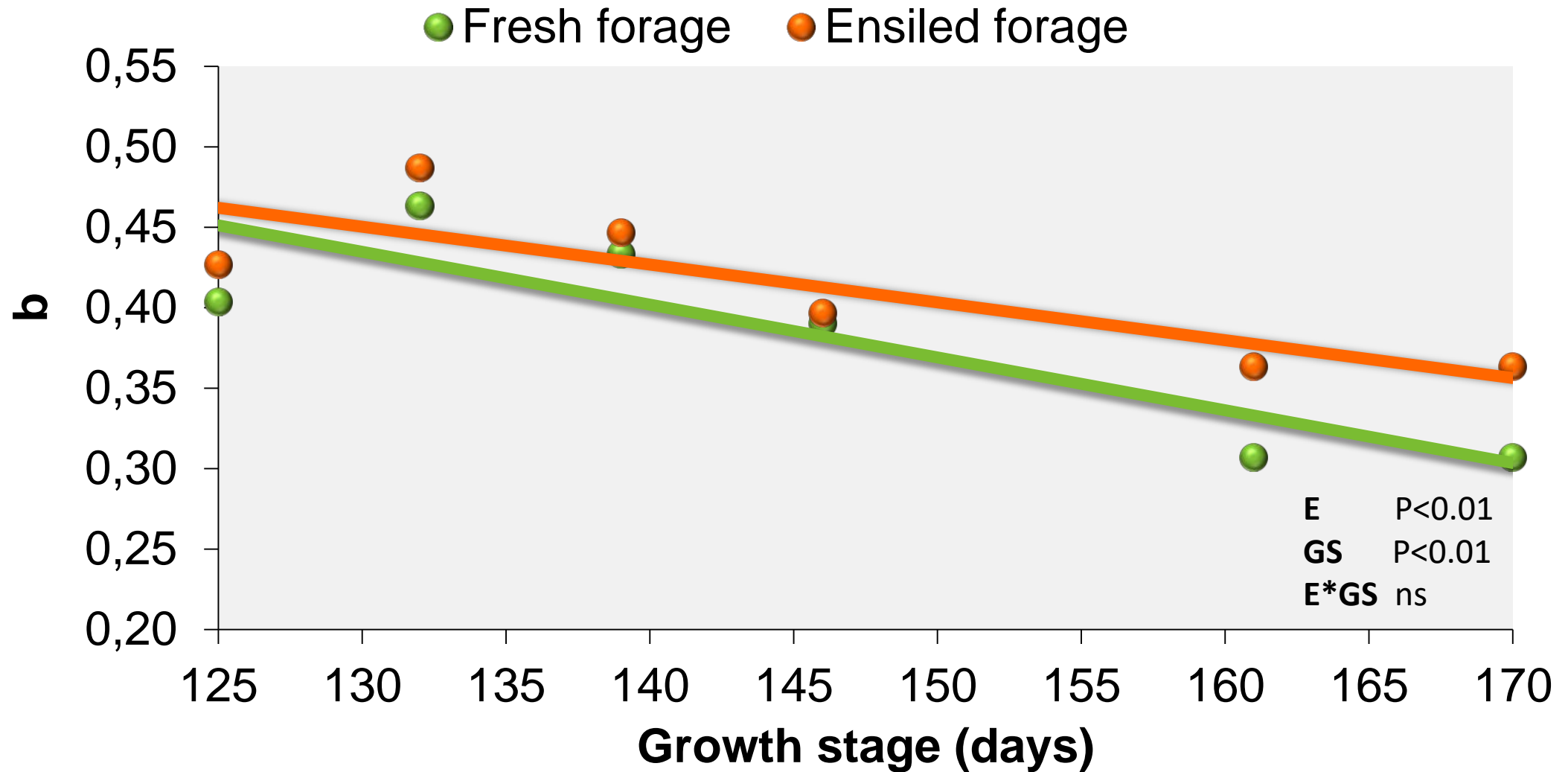
Effective degradability



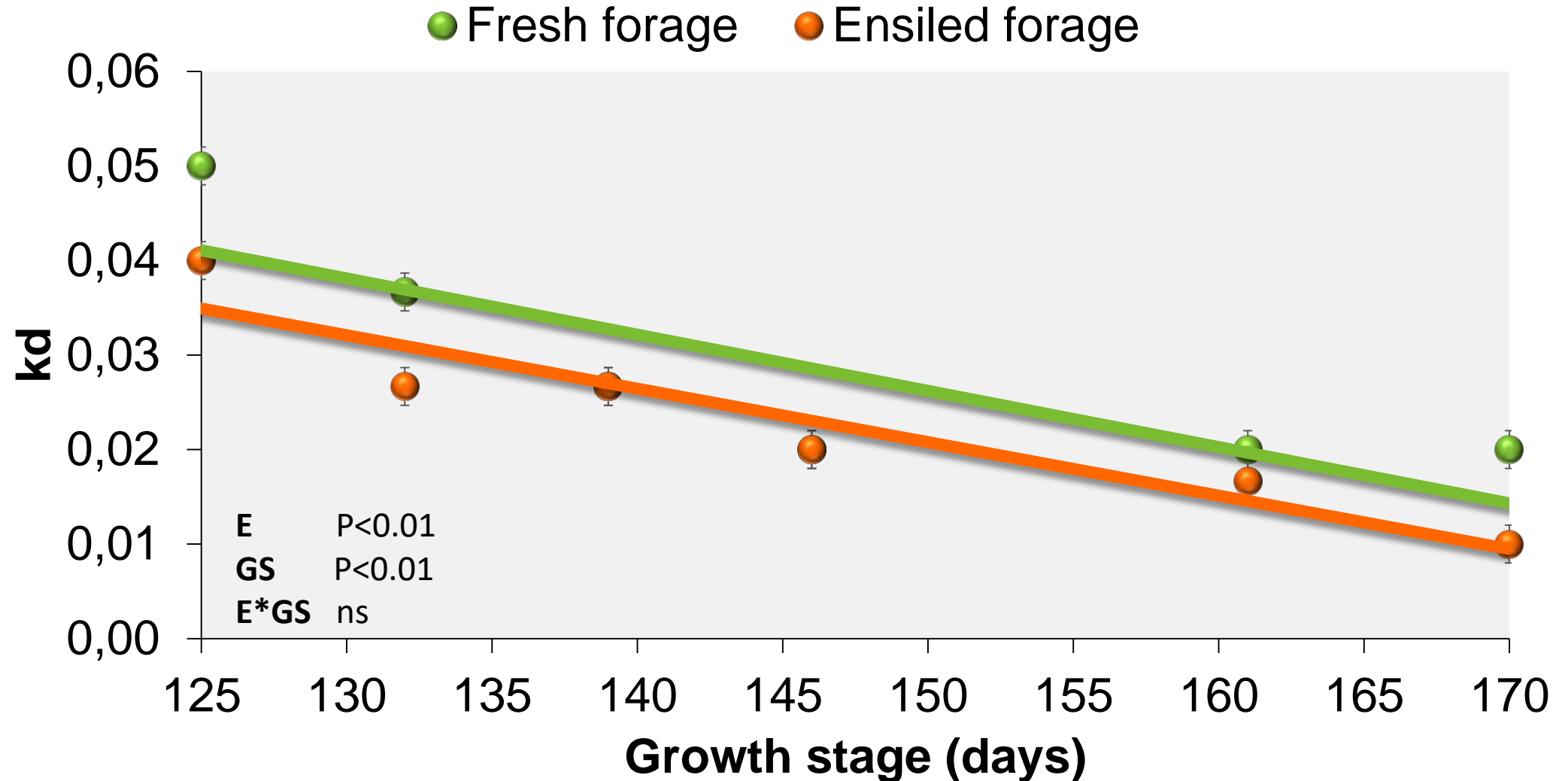
Soluble fraction (a)



Insoluble degradable fraction (b)



Fractional degradation rate (kd)



In summary...

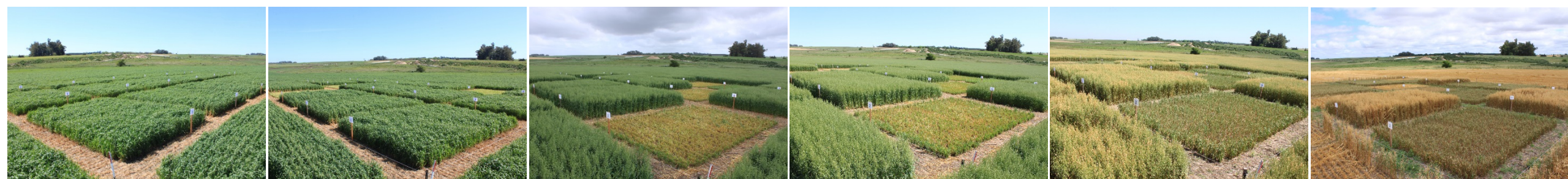
- **Effect of GROWTH STAGE**

- Changes in the plant chemical composition
- Plant maturation

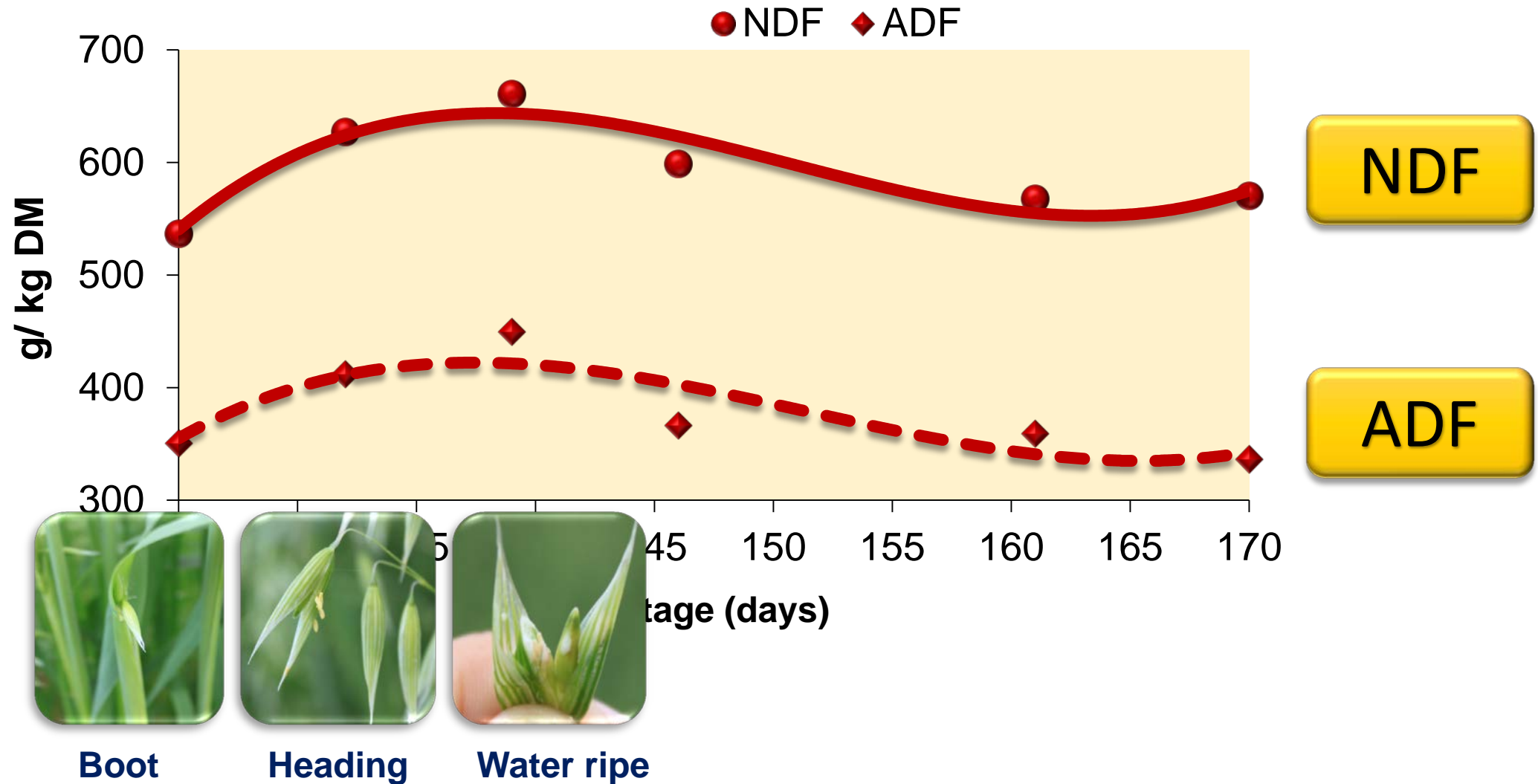
- **Effect of ENSILING**

- Changes in the chemical composition of ensiled forage
- Silage fermentation

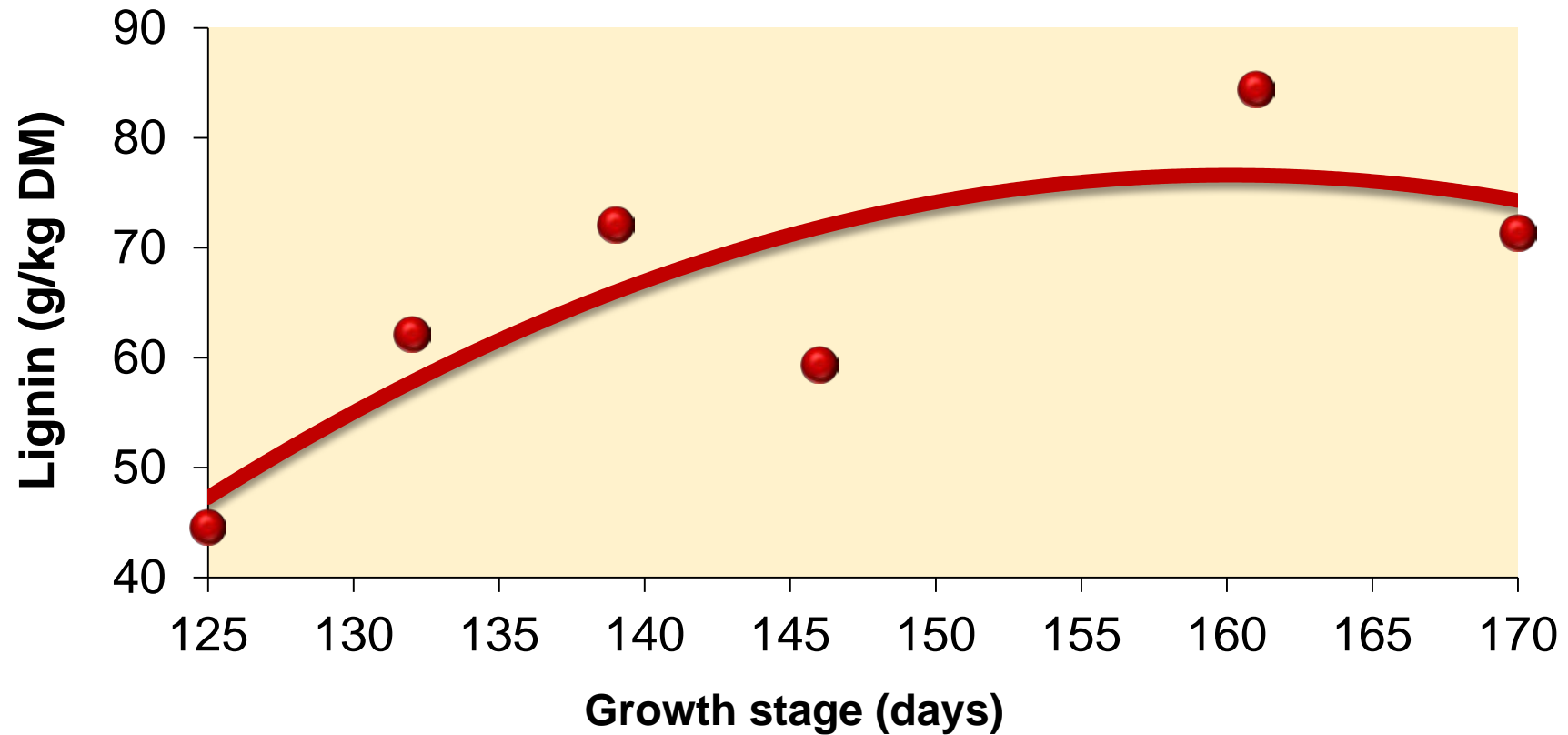
What changes in **chemical composition** occurred with increasing crop maturity?



1. Increase of Cell Wall Components

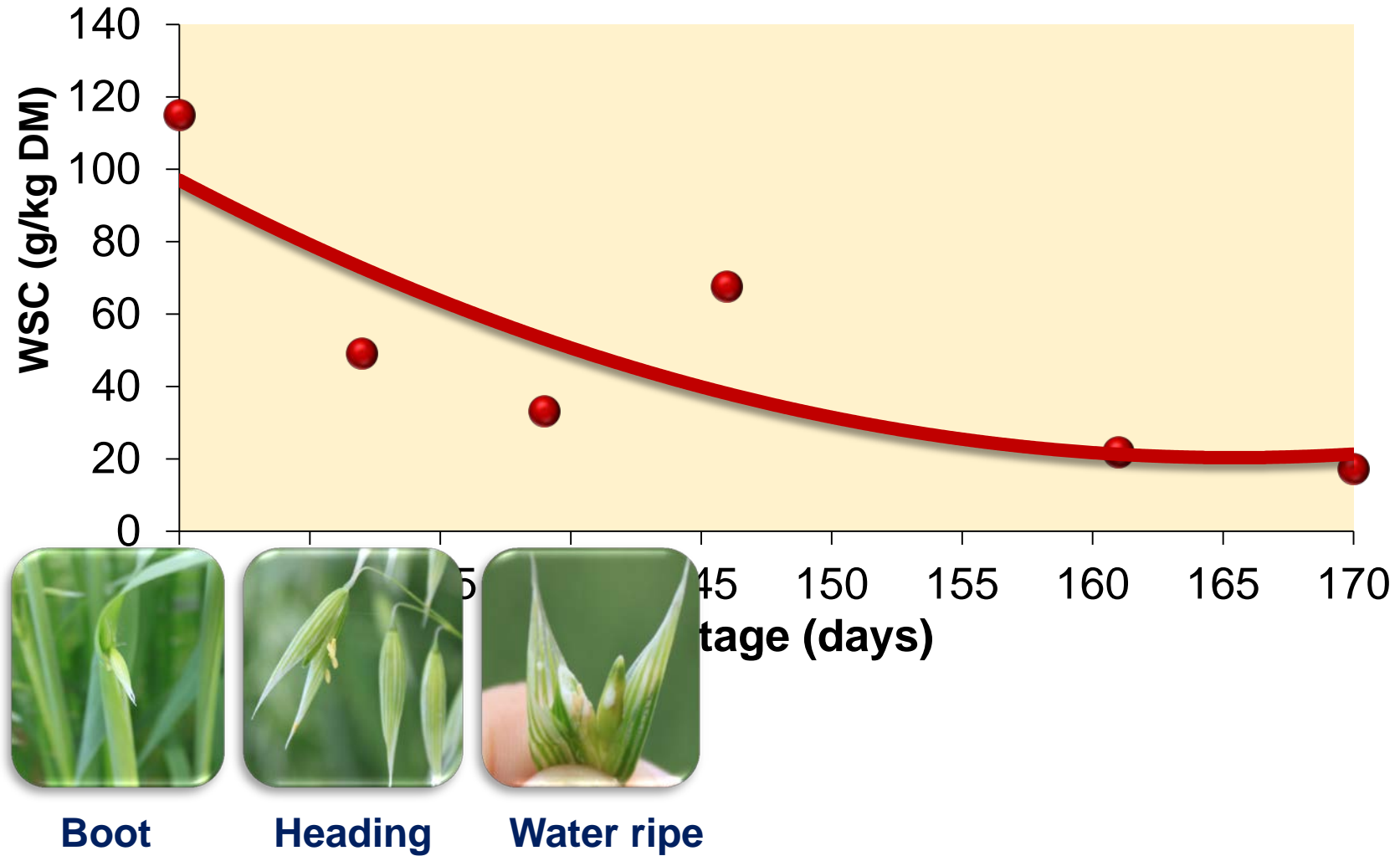


1. Increase of Cell Wall Components



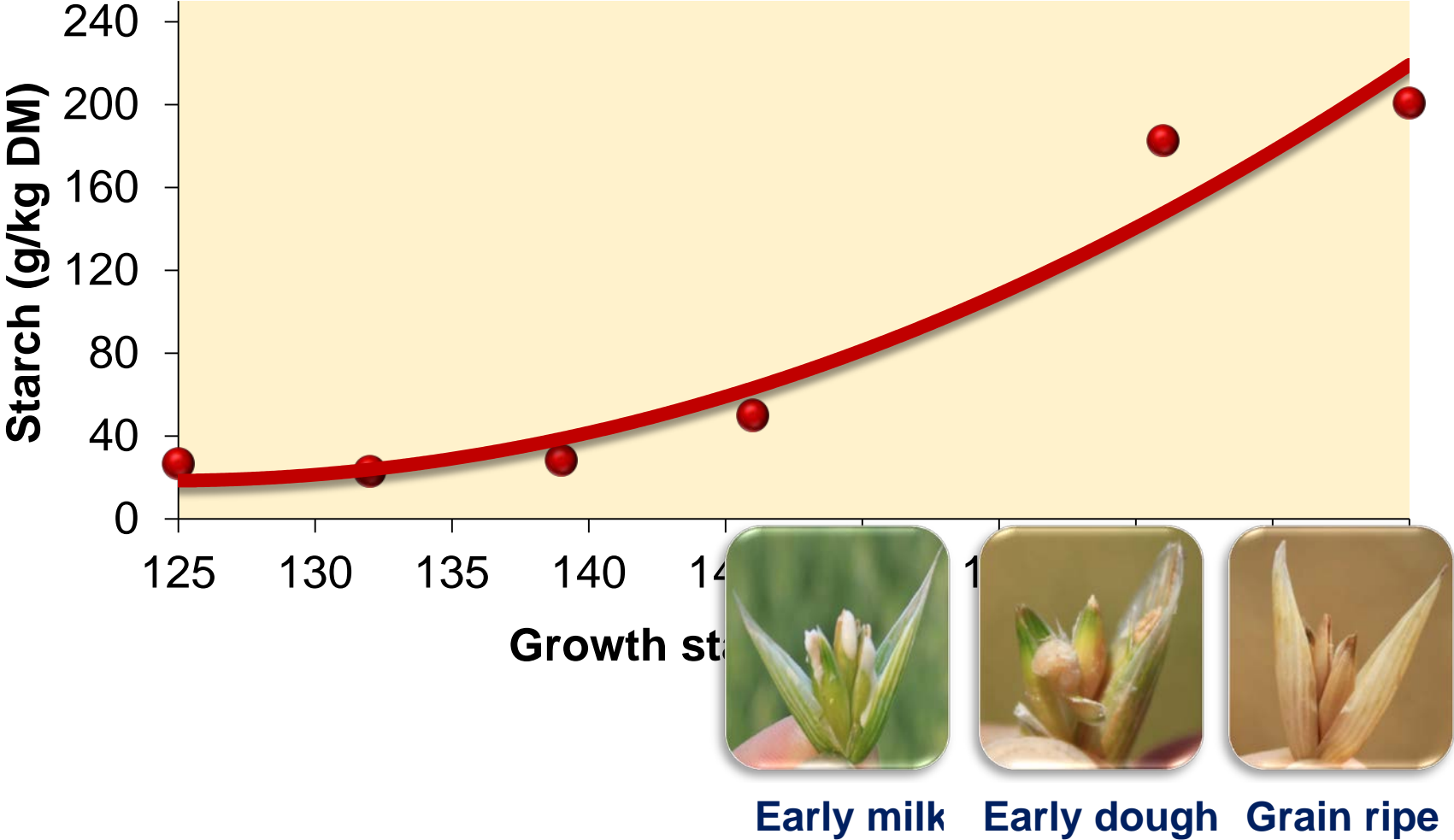
Lignin

2. Decrease of WSC



WSC

3. Increase of Starch

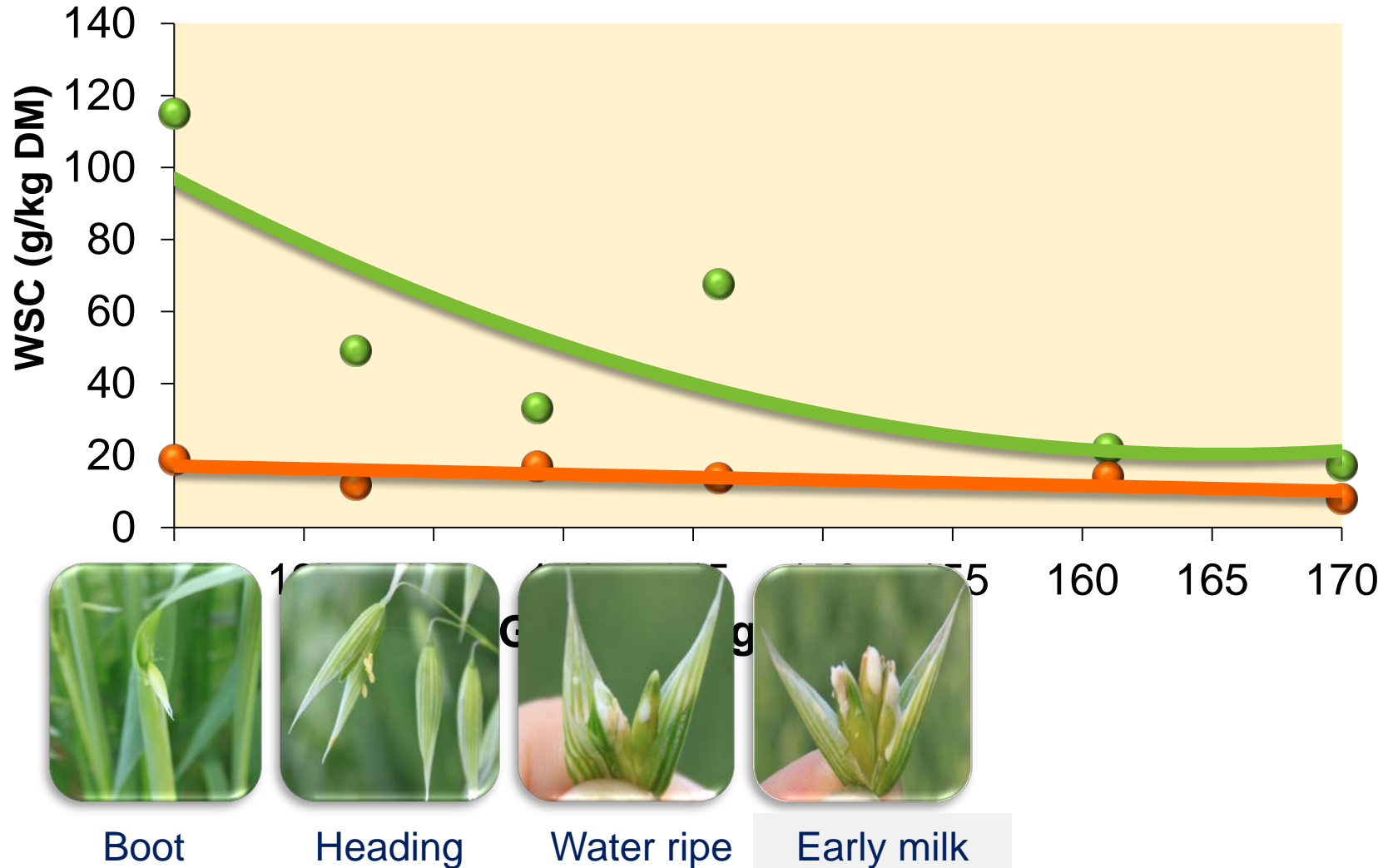


Starch

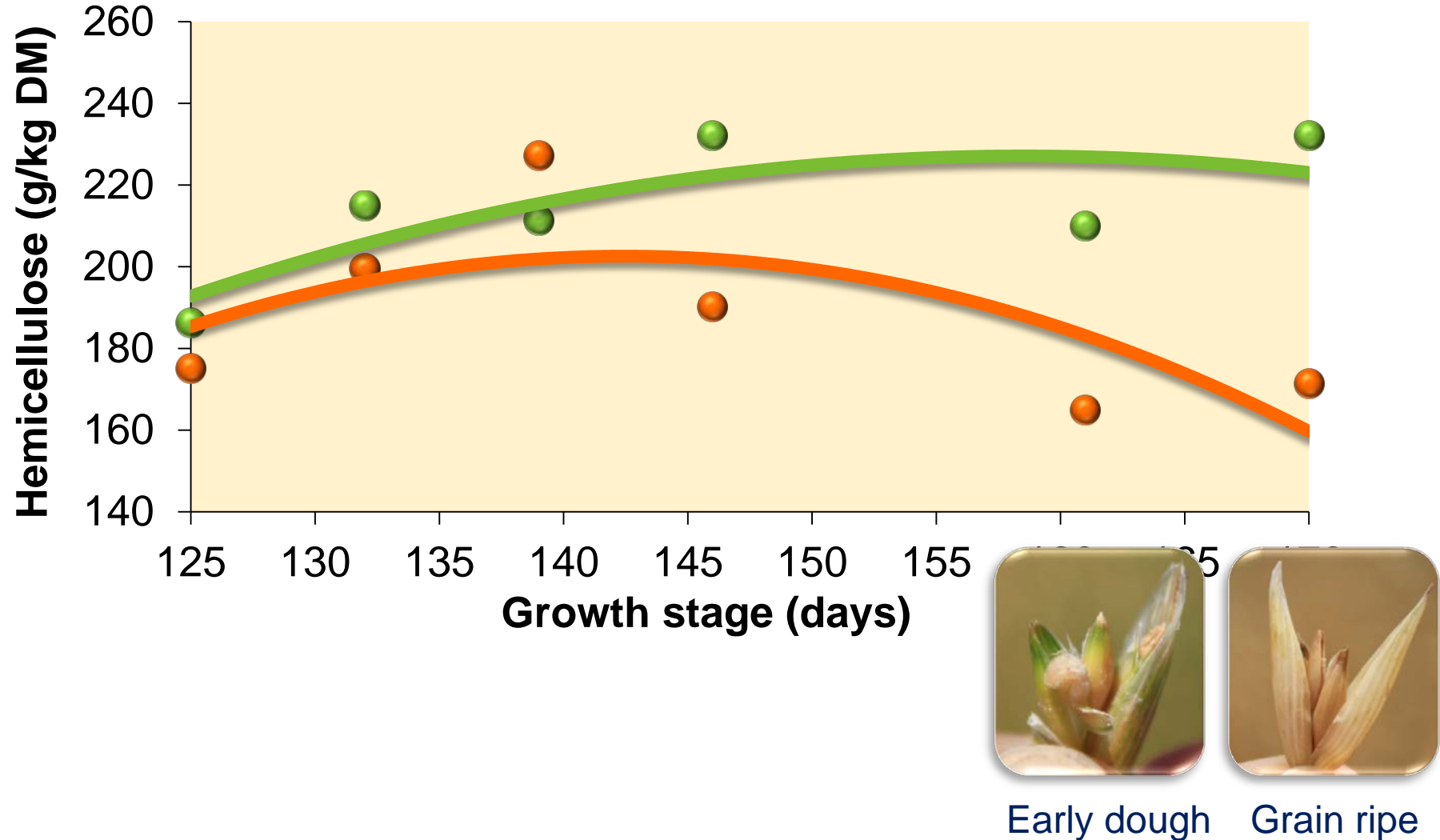
What changes in **chemical composition** occurred **after ensiling?**



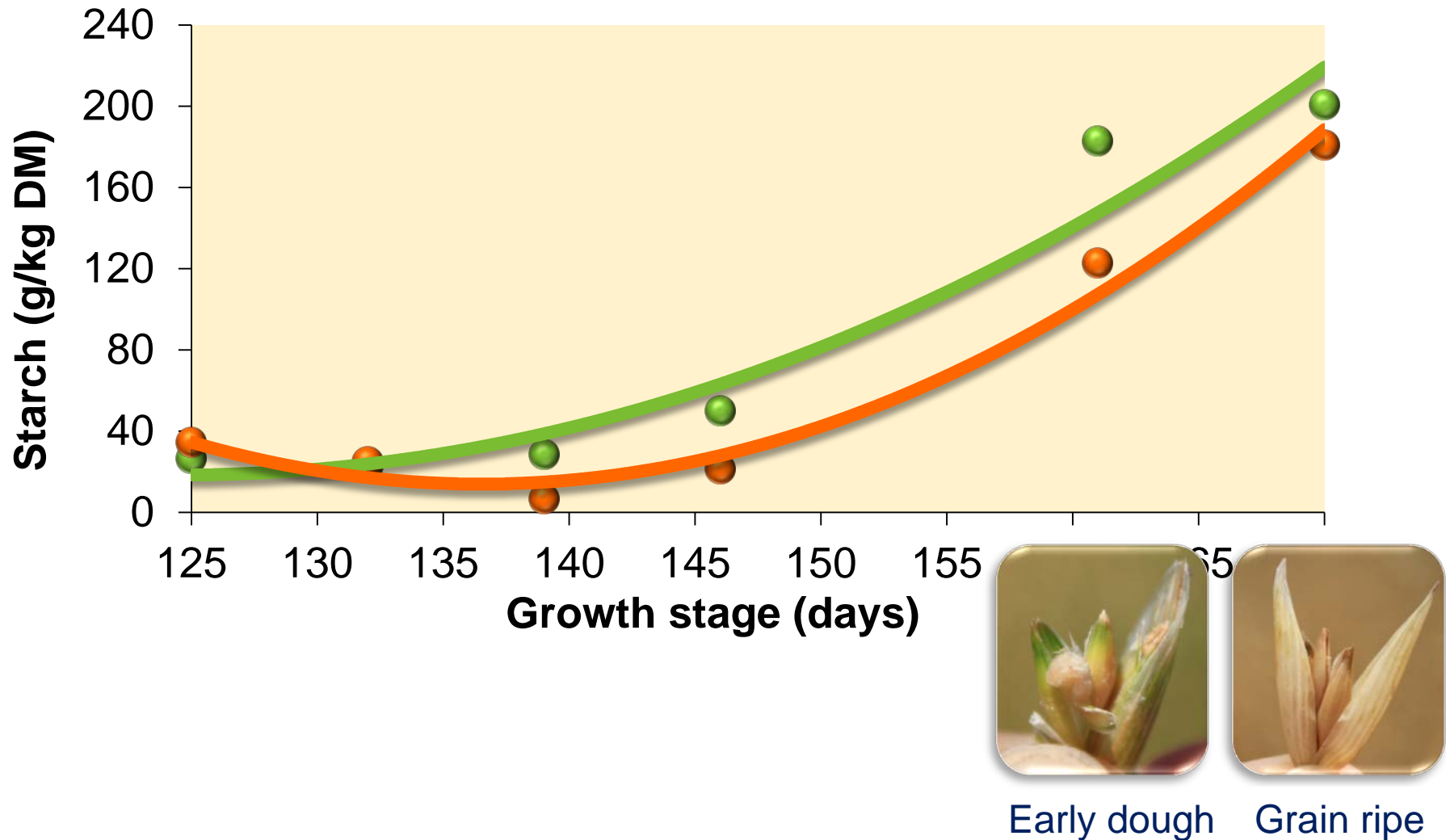
1. WSC fermentation



2. Hydrolysis of Hemicellulose



2. Hydrolysis of Starch

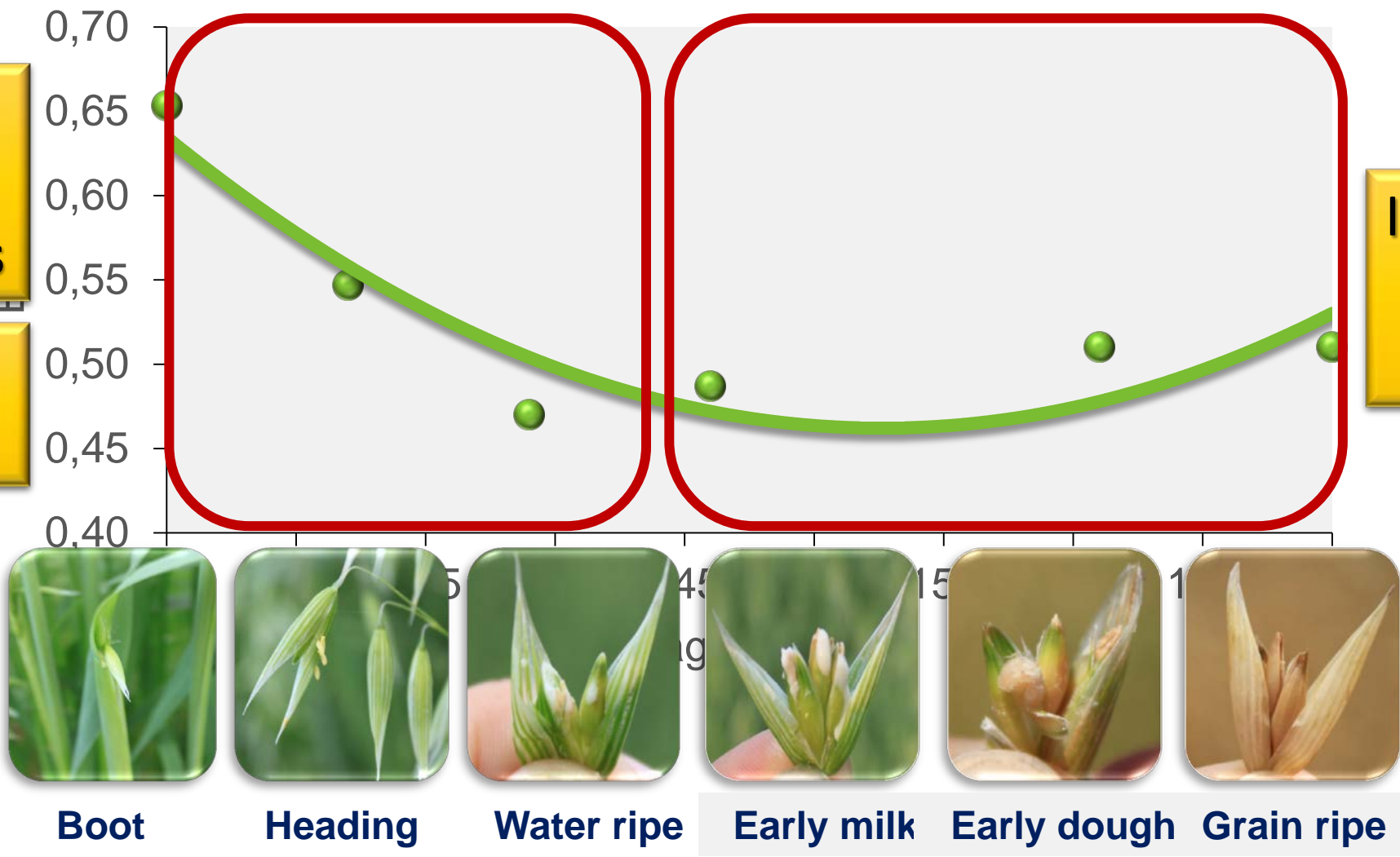


Effect of growth stage

Increase of
**Cell wall
components**

Decrease of
WSC

Increase
of
Starch



Boot



Heading



Water ripe



Early milk

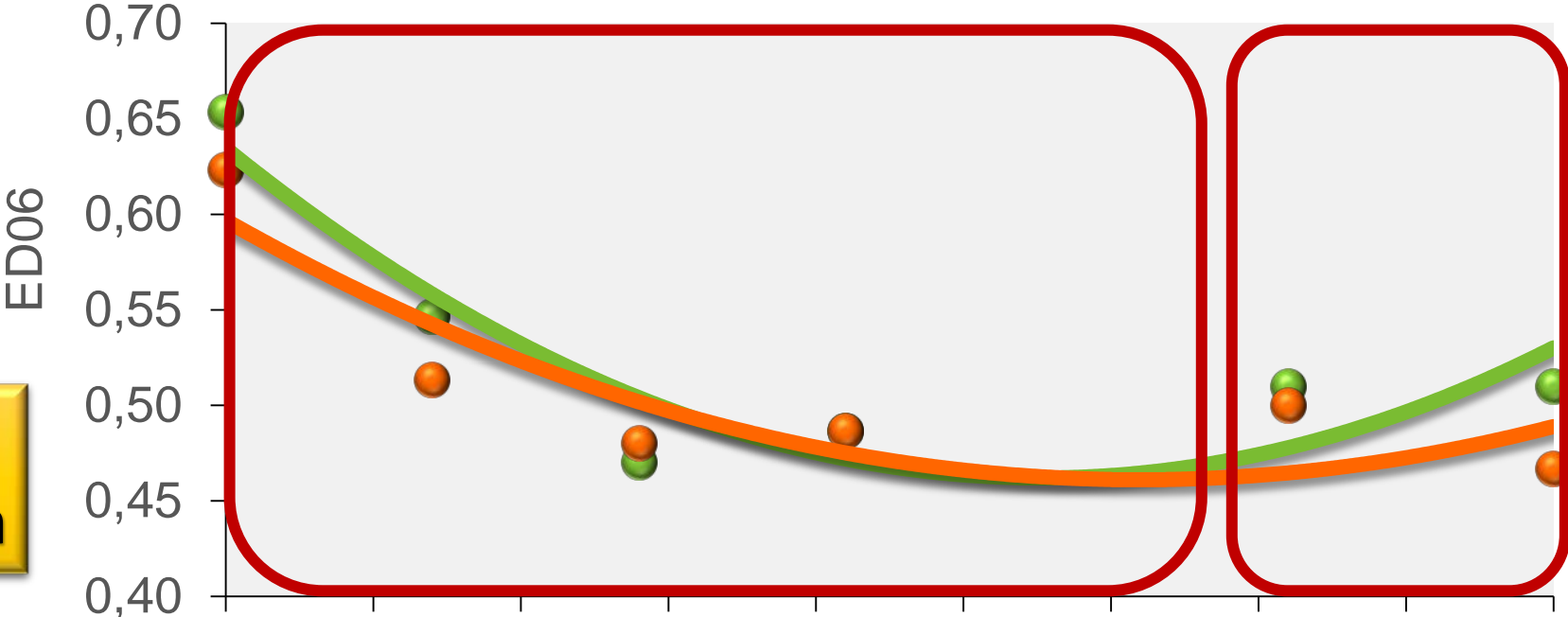


Early dough



Grain ripe

Effect of ensiling



WSC
fermentation

Hydrolysis
Hemicellulose
Starch



Boot



Heading



Water ripe



Early milk



Early dough



Grain ripe

Growth stage:

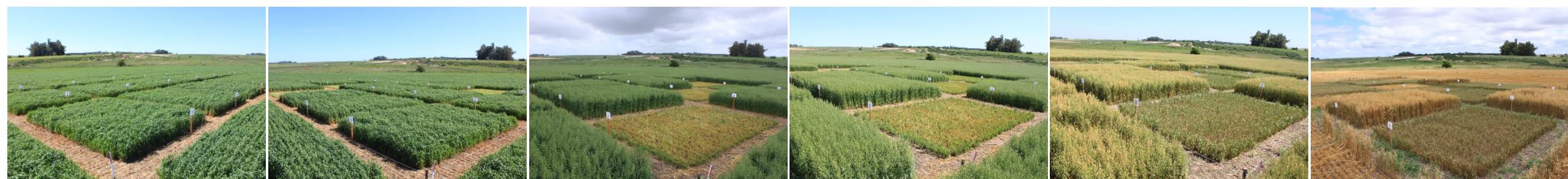
- ✓ Strongly influenced chemical composition.
- ✓ Negative effect on DM degradability of whole crop oats.
- ✓ Starch compensated the high levels of lignin.

Ensiling:

- ✓ Reduced forage nutritive value and ruminal fermentation at some stages of growth.
- ✓ This reduction had less impact in comparison with the effect of growth stage.

Implications

Understanding the changes that occur across *Avena sativa cv. Cantara* stages of growth will allow to harvest the crop at the desired moment and to achieve a good quality silage.



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