

# MITIGATION OF ACRYLAMIDE FORMATION DURING MALT PROCESSING

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# OUTLINE

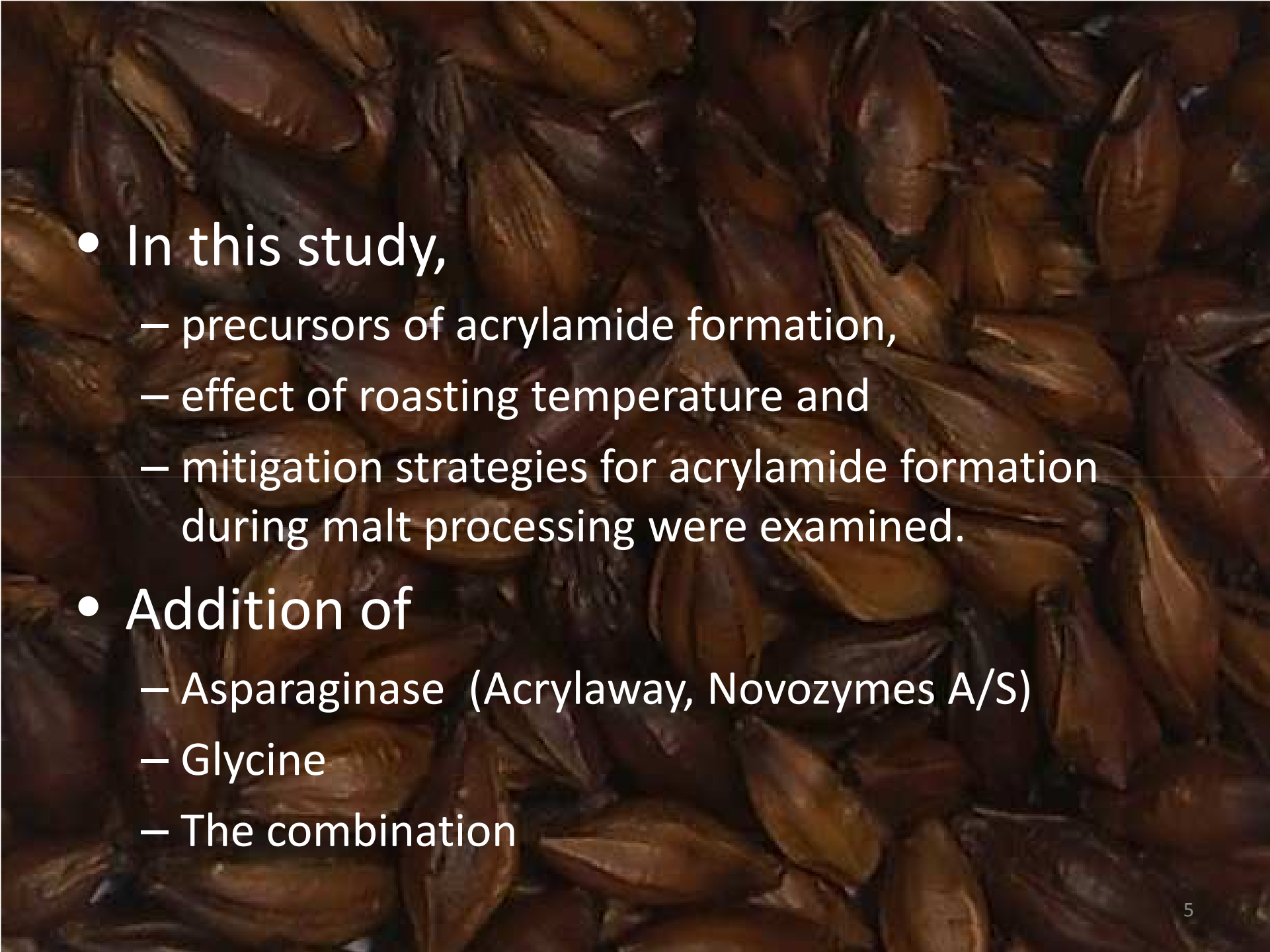
- Acrylamide formation during malt processing
- Mitigation strategies
- Experimental design
- Results
- Conclusion

# INTRODUCTION

- Why to mitigate?
  - acrylamide is carcinogenic
  - dark roasted malt is used for aroma and color
    - Dark beer production
    - Bakery products and contain acrylamide.

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- Malt is germinated, dried and roasted barley kernels.
  - During production there is a risk for acrylamide formation due to
    - increasing asparagine content
    - increasing reducing sugar content
    - following high temperature roasting

} High levels of acrylamide

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- In this study,
    - precursors of acrylamide formation,
    - effect of roasting temperature and
    - mitigation strategies for acrylamide formation during malt processing were examined.
  - Addition of
    - Asparaginase (Acrylaway, Novozymes A/S)
    - Glycine
    - The combination

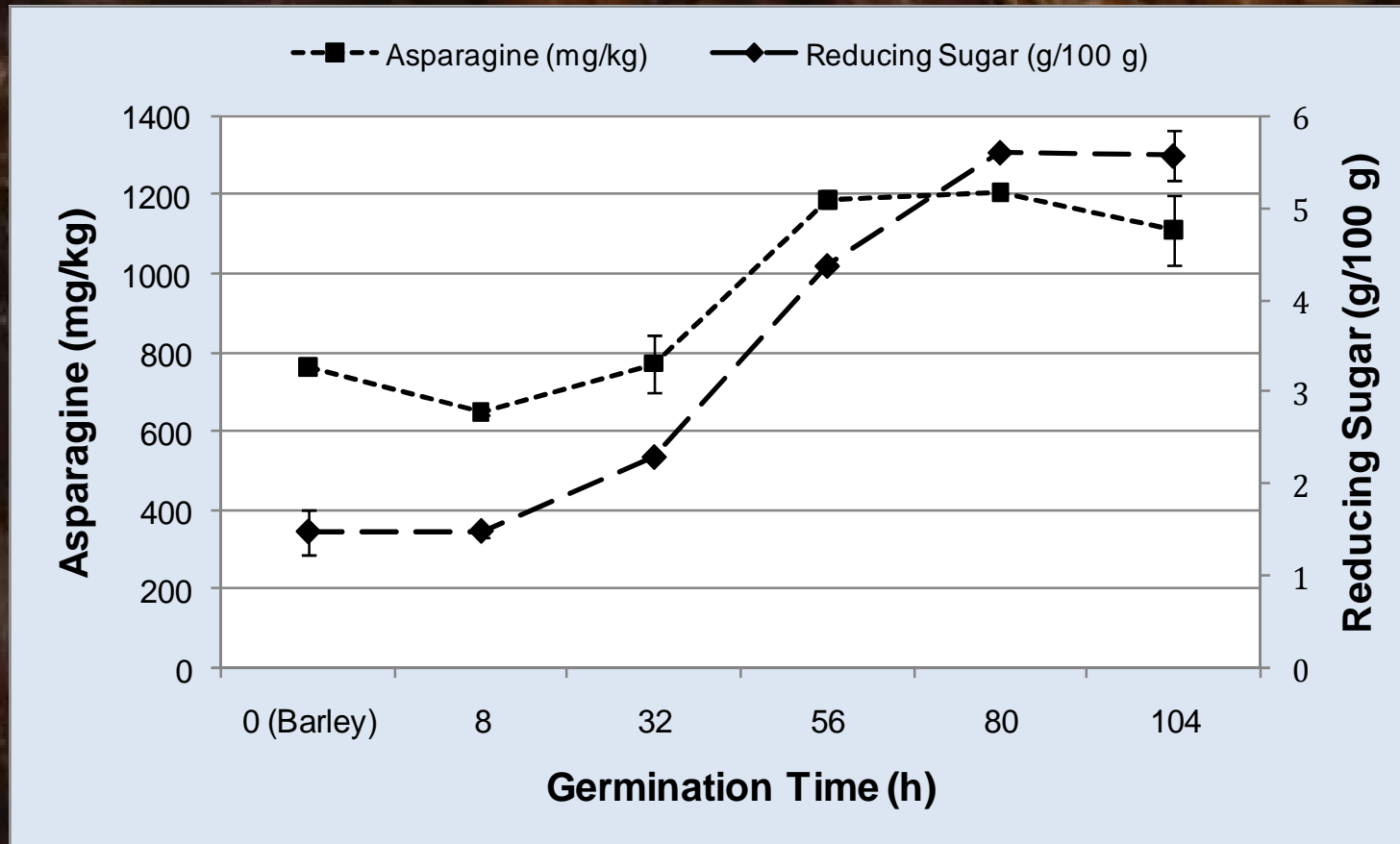
# MATERIALS and METHODS

- The barley sample (cv. Atilir)
  - steeped for 34 h
  - germinated for 110 hin an automatic micro-malting system (Danbrew, Denmark) at 15°C.
- Green malt was dried in drying oven (Memmert, Germany) for 16 h at 50°C.
- Acrylamide  $\longrightarrow$  at the temperatures between 60-200°C.

- Restriction of acrylamide,
  - asparaginase (3000 and 4000 ASNU/kg) and/or
  - glycine (4000 and 5000 ppm)were applied to green malt before kilning and the samples roasted at 150, 175 and 200°C for 2 h, separately.
- Analyses;
  - Asparagine and reducing sugar content: HPLC analysis,
  - Acrylamide content: LC/MS analysis,
  - Color values (CIE L\*, a\*, b\*): Matlab 7.0 (image analysis),
  - Statistical analyses: SPSS Data Editor 15.0 with One-Way ANOVA, Duncan Test.

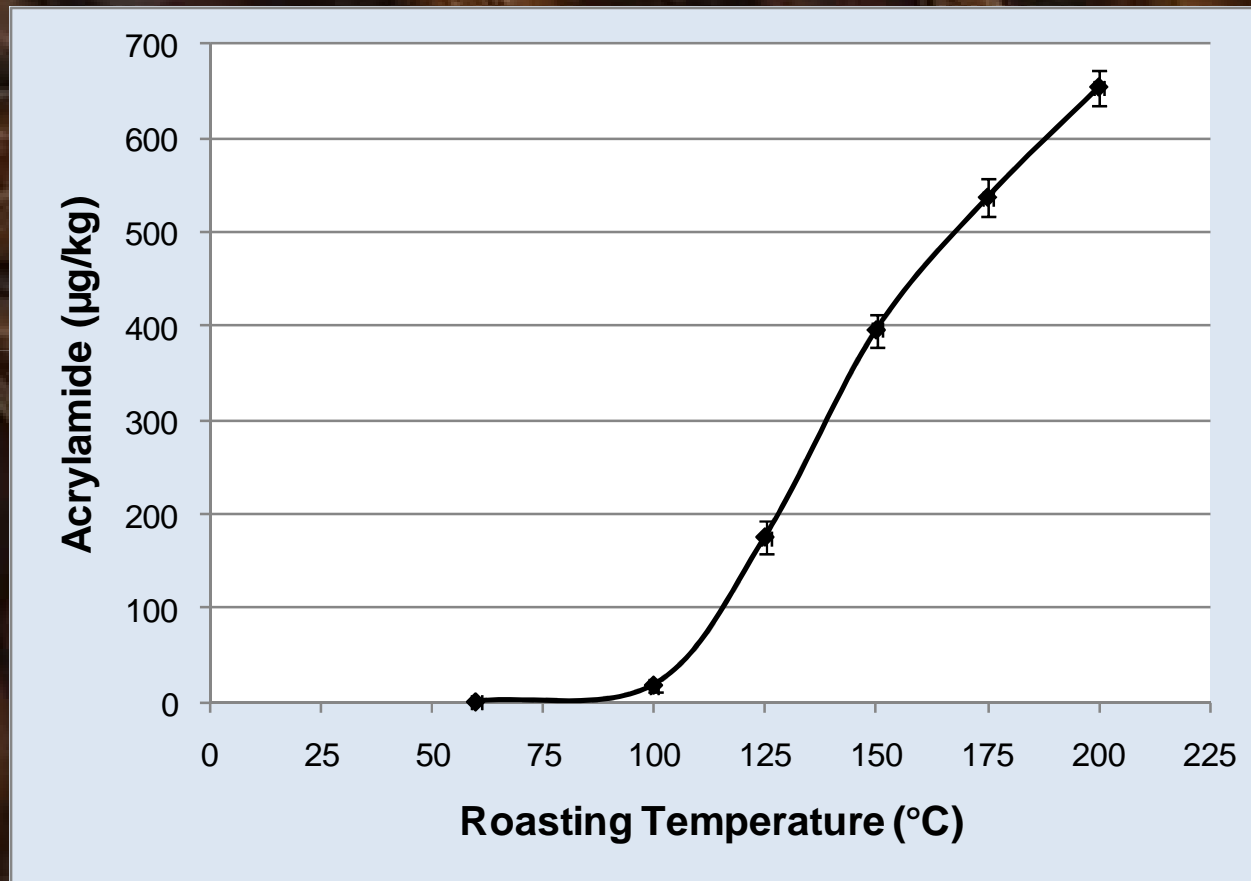
# RESULTS and DISCUSSION

## Asparagine and Reducing Sugar Contents



Changes in asparagine and reducing sugar content during germination

## Acrylamide Content

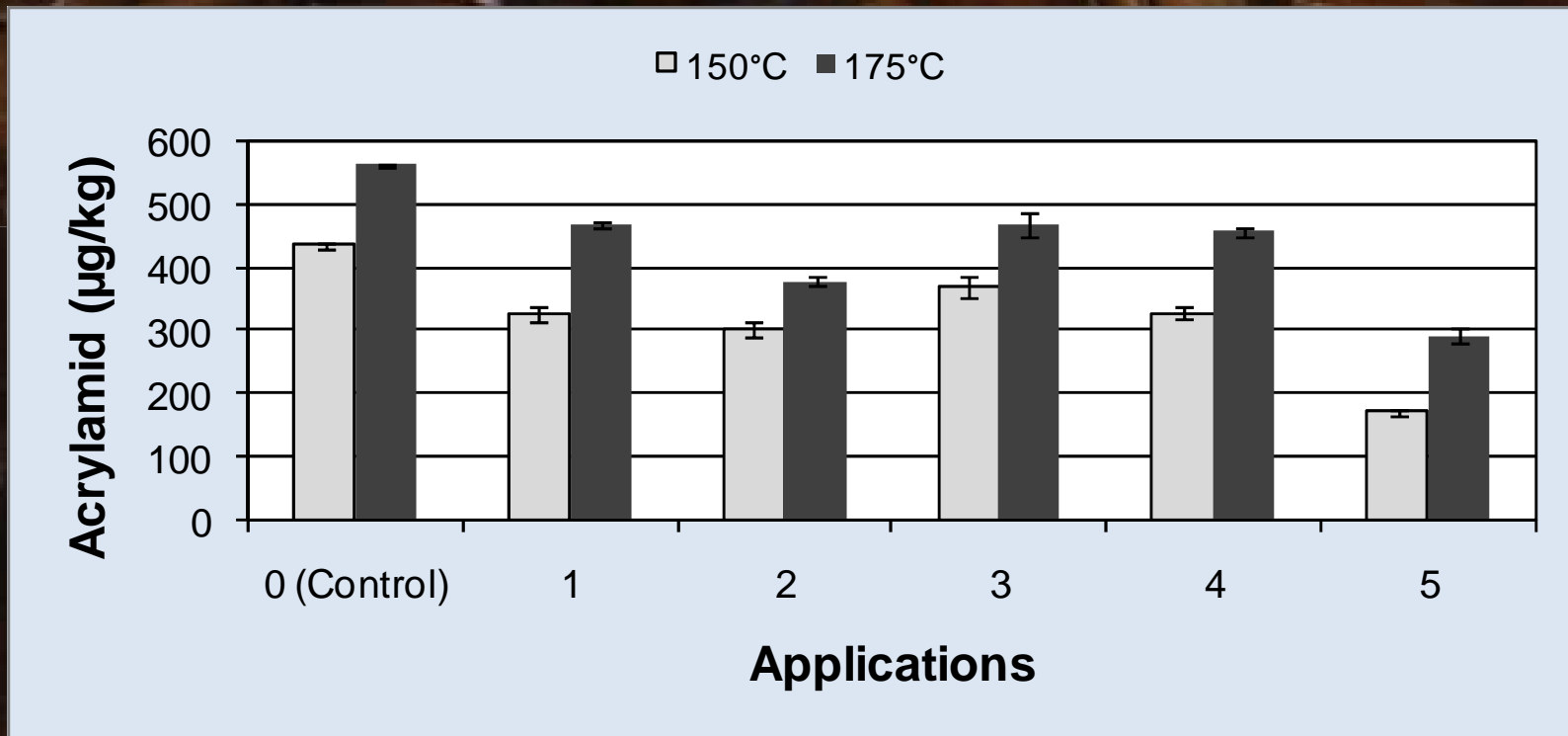


Changes in acrylamide content by the temperature

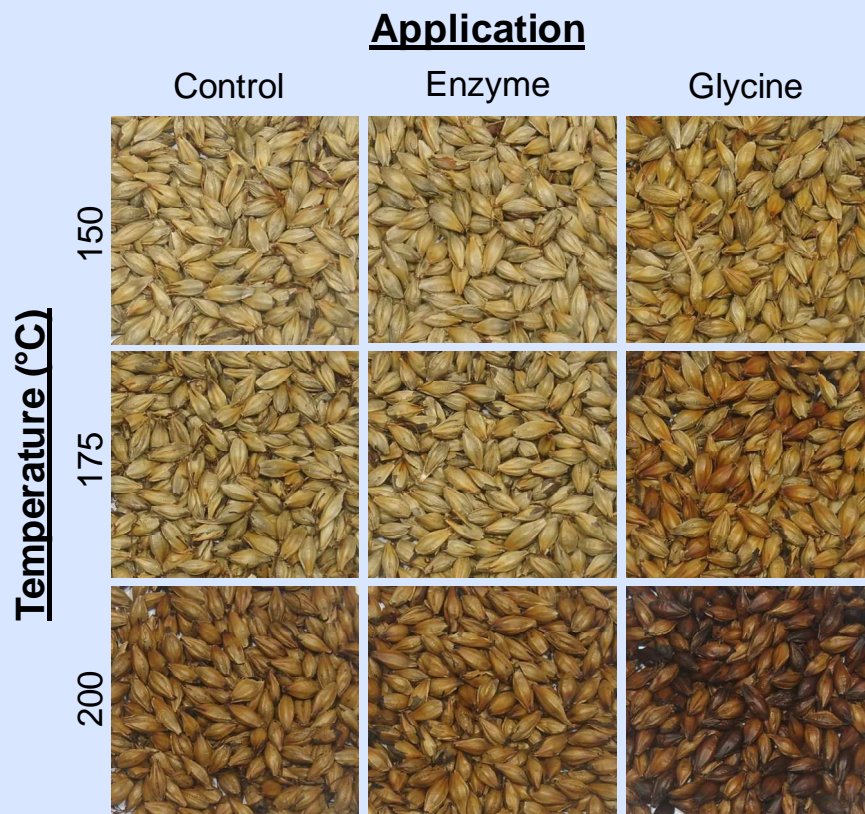
## Changes in color at different roasting temperatures.

Pictures of Ground Malt Samples						
Temperature (°C)	60 (Control)	100	125	150	175	200
$\Delta E$	-	3.80	17.3	26.1	29.5	31.9

## Acrylamide levels by the enzyme and/or glycine applications.



0: control; 1: 3000 ASNU/kg; 2: 4000 ASNU/kg; 3: 4000 ppm glycine; 4: 5000 ppm glycine; 5: 4000 ASNU/kg +5000 ppm glycine



Pictures of malts treated with enzyme (4000 ASNU/kg green malt) or glycine (5000 ppm) and roasted at 150, 175 or 200°C.

Acrylamide content of enzyme or glycine applied malt samples at different roasting temperatures.

Sample	Acrylamide* ( $\mu\text{g}/\text{kg}$ )		
	150°C	175°C	200°C
Control	435 a	561 a	630 a
1	303 b	378 c	456 c
2	328 b	457 b	490 b

\*Dry weight basis; 1: 4000 ASNU/kg green malt; 2: 5000 ppm glycine; Within each sample, different letters within a column indicate values significantly different from each other ( $p < 0.05$ ).

## Color of actual malts applied enzyme or glycine and roasted at 150, 175 and 200°C

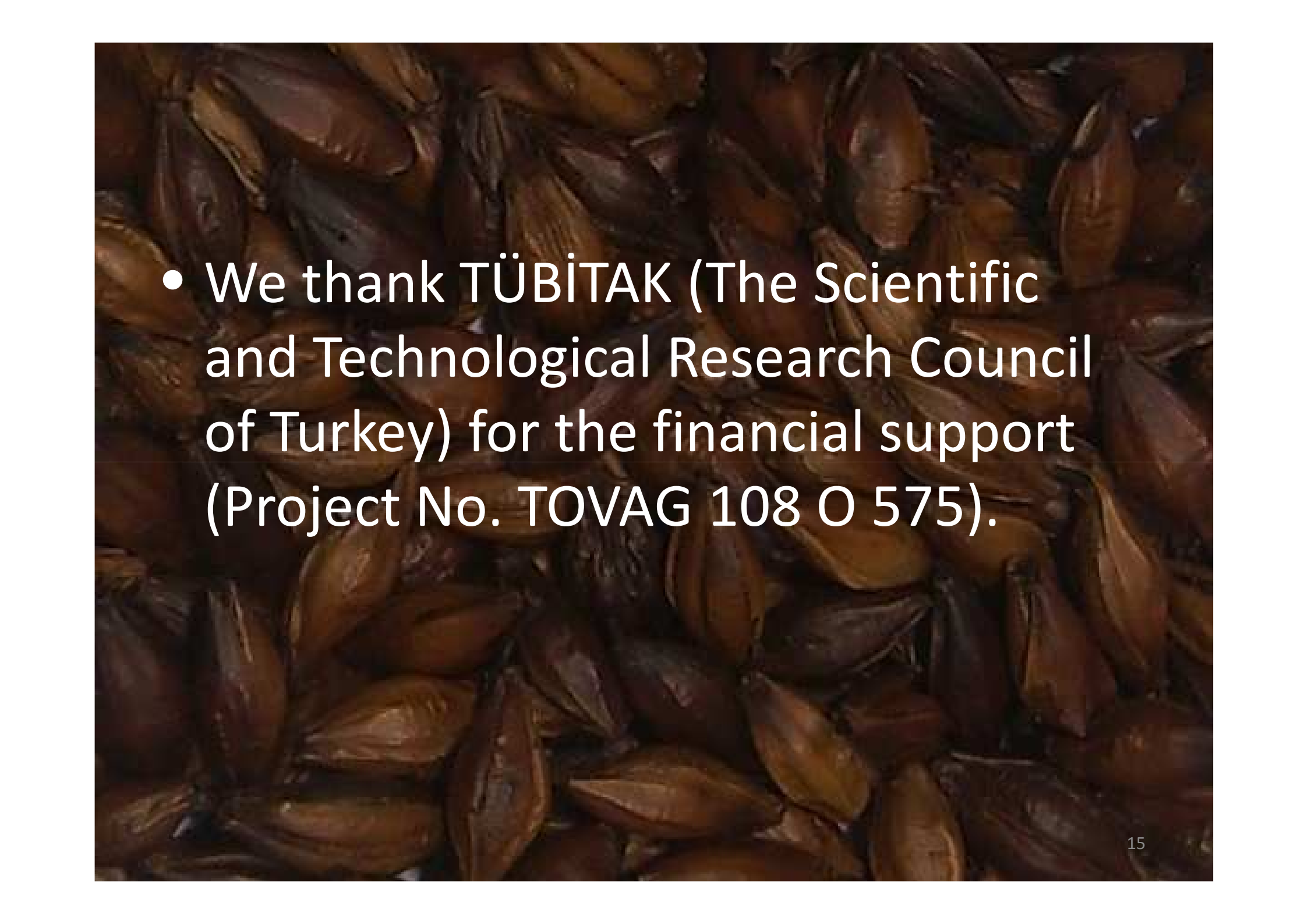
Sample	150°C				175°C				200°C			
	L*	a*	b*	ΔE	L*	a*	b*	ΔE	L*	a*	b*	ΔE
Control	62 a	3.8 b	29 b	-	60 a	4.3 b	32 b	-	46 a	11 a	32 a	-
Enzyme <sup>1</sup>	63 a	4.3 b	32 ab	2.8	60 a	6.1 b	36 a	4.1	46 a	13 a	34 a	2.6
Glycine <sup>2</sup>	55 b	9.6 a	39 a	14	48 b	13 a	37 a	16	32 b	11 a	18 b	22

1: 4000 ASNU/kg green malt; 2: 5000 ppm glycine;

Within each sample, different letters within a column indicate values significantly different from each other ( $p < 0.05$ ).

# CONCLUSION

- Asparaginase and/or glycine applications had limiting effect on acrylamide formation.
- Mixture of enzyme and glycine was the most effective way to reduce acrylamide content of dark roasted malt samples.
- It was possible to mitigate acrylamide formation during roasting of malt without deterioration in color properties.

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***THANK YOU.***

