

Occurrence and reduction of acrylamide in cereal-based products in Spain: evidence from long-term monitoring



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2002

2017

2026



L 304/24

EN

Official Journal of the European Union

21.11.2017

COMMISSION REGULATION (EU) 2017/2158

of 20 November 2017

establishing mitigation measures and benchmark levels for the reduction of the presence of acrylamide in food

(Text with EEA relevance)



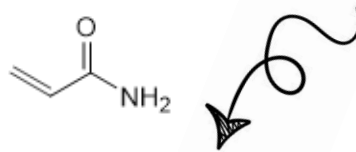
2002

2017

2026



Long-term monitoring of acrylamide levels in commercial products



Effectiveness of Regulation measures and their impact on consumer exposure



INNOVATIVE FORMULATIONS OF CEREAL-BASED FOODS

- Alternative cereals
- Pseudocereals
- Other ingredients



Whole grains, fibre, protein



Sugar content

CURRENT CONSUMER'S NEEDS TO BE MET

INNOVATIVE FORMULATIONS OF CEREAL-BASED FOODS

Sensorial changes



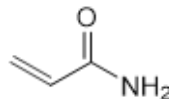
Nutritional improvements



Gluten-free products



Toxicological consequences



Acrylamide in commercial cereal-based products marketed in Spain

Relation with characteristics of each product

composition, format or thermal processing conditions



Acrylamide in commercial cereal-based products marketed in Spain



Compliance with the European Regulation



Changes in acrylamide levels over the past two decades



Commercial cereal-based products marketed in Spain

April 2025



Breakfast cereals
(n = 60)



Biscuits
(n = 80)



Crispbread-crackers
(n = 65)



Commercial cereal-based products marketed in Spain

- Samples containing chocolate coatings, dried fruits, or added nut were deliberately excluded (avoid confounding effects)

CHARACTERIZATION

- Nutritional data
(declared on packaging labels)
- Classification criteria



INFORMACIÓN NUTRICIONAL - DECLARAÇÃO NUTRICIONAL

○ Por 100g ○ Por porción 30g / Por porção 30g

Valor energético / Energia	1618 kJ 382 kcal	485 kJ 115 kcal
Grasas / Lípidos de las cuales saturadas / das quais saturadas	1,5 g 0,4 g	0,5 g 0,1 g
Hidratos de carbono de los cuales azúcares / dos quais açúcares	84 g 43 g	25 g 13 g
Fibra alimentaria / Fibra	4 g	1,2 g
Proteínas	6 g	1,8 g
Sal	0,08 g	0,02 g
VITAMINAS:	(% VRN)	(% VRN)
Vitamina D	4,2 µg (83)	1,3 µg (25)
Tiamina (B1)	0,91 mg (83)	0,28 mg (25)
Riboflavina (B2)	1,2 mg (83)	0,35 mg (25)
Niacina	13,3 mg (83)	4,0 mg (25)
Vitamina B6	1,2 mg (83)	0,35 mg (25)
Ácido fólico	166 µg (83)	50,0 µg (25)
Vitamina B12	2,1 µg (83)	0,63 µg (25)
MINERALES / MINERAIS:		
Calcio / Calcio	264 mg (33)	80 mg (10)
Hierro / Ferro	8,0 mg (57)	2,4 mg (17)

(% VRN) = % Valor de Referência de Nutrientes
(% VRN) = % Valor de Referência do Nutriente

EXPLICACIÓN INGESTAS DE REFERENCIA (DR) / EXPLICAÇÃO DOSES DE REFERÊNCIA (DR)

485 kJ / 115 kcal
6%

Aporte de energía en una porción.
Energía de una porção.
Este es el porcentaje de la ingesta diaria de energía que aporta una porción. Percentagem da dose diária de energia que uma porção fornece.



SAMPLES OF BREAKFAST CEREALS

CLASSIFICATION CRITERIA

- **Processing type** (rolled, extruded, granola, flakes, biscuits, sticks and puffed)
- **Major cereal** (oat, corn, rice, rye, spelt, wheat or mixed)
- **Type of grain** (refined or wholegrain)
- **Gluten-free status** (yes/ no)
- **Without added sugar** (yes/no)
- **Presence of honey** (yes/no)
- **Presence of sweeteners** (yes/no)



SAMPLES OF BISCUITS

CLASSIFICATION CRITERIA

- **Major cereal** (oat, corn, rice, rye, spelt, wheat or mixed, buckwheat)
- **Type of grain** (refined or wholegrain)
- **Gluten-free status** (yes/ no)
- **Without added sugar** (yes/no)
- **Presence of honey, egg, butter** (yes/no)
- **Presence of sweeteners** (yes/no)
- **Presence of leavening agents** (NaHCO_3 , NH_4HCO_3) (yes/no)

SAMPLES OF CRISPBREADS-CRACKERS

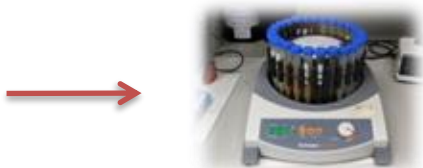
CLASSIFICATION CRITERIA

- **Type of product/format** (thin breads, round breads, crackers and slices)
- **Major cereal** (wheat, rice, rye, corn, mix, spelt, buckwheat, oat)
- **Type of grain** (refined or wholegrain)
- **Gluten-free status** (yes/ no)



ACRYLAMIDE ANALYSIS

SAMPLES

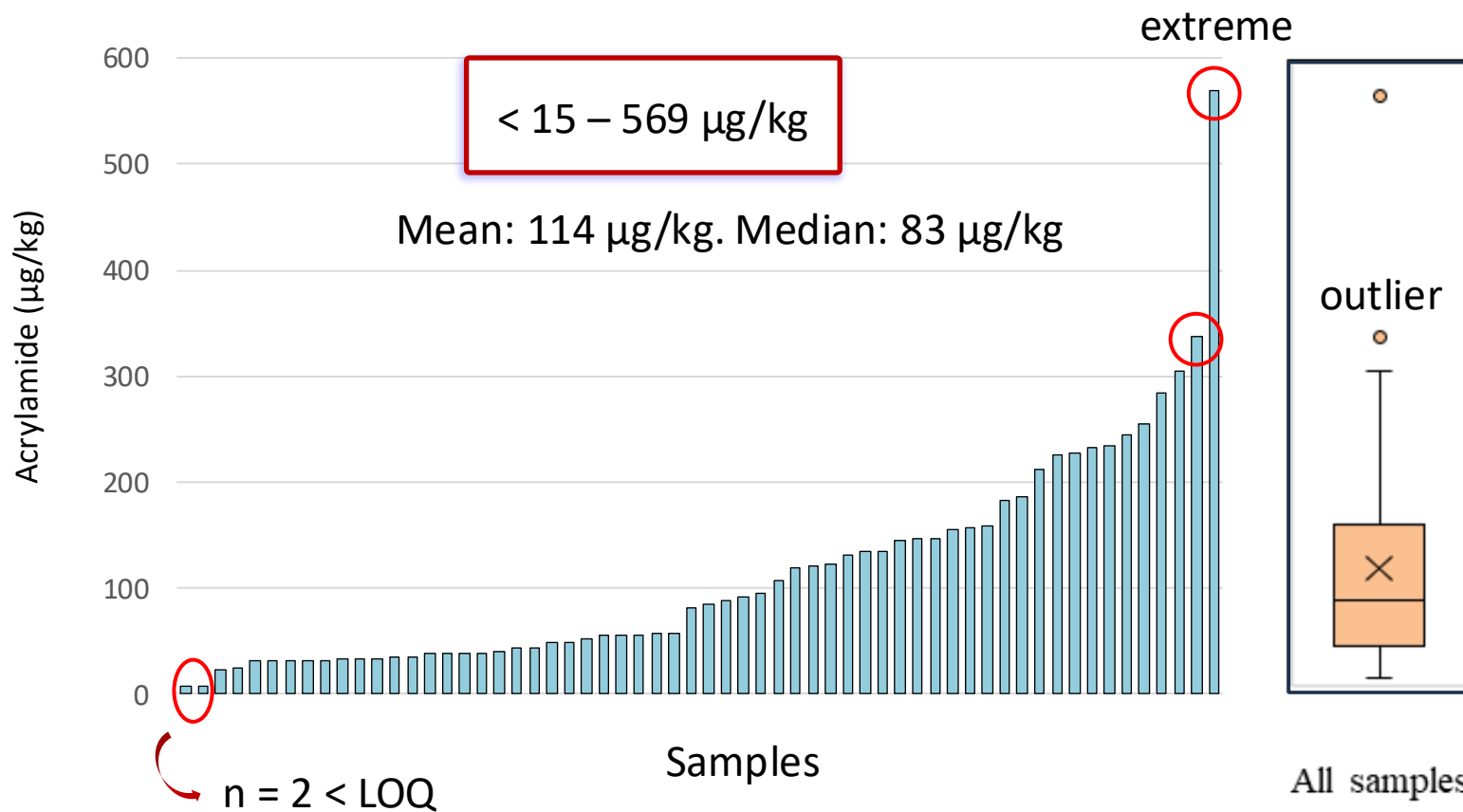


LC-MS/MS

Acrylamide in BREAKFAST-CEREALS



MARKET STUDY 2025



Mesías y col. (2025)

Acrylamide in BREAKFAST-CEREALS

ANNEX IV

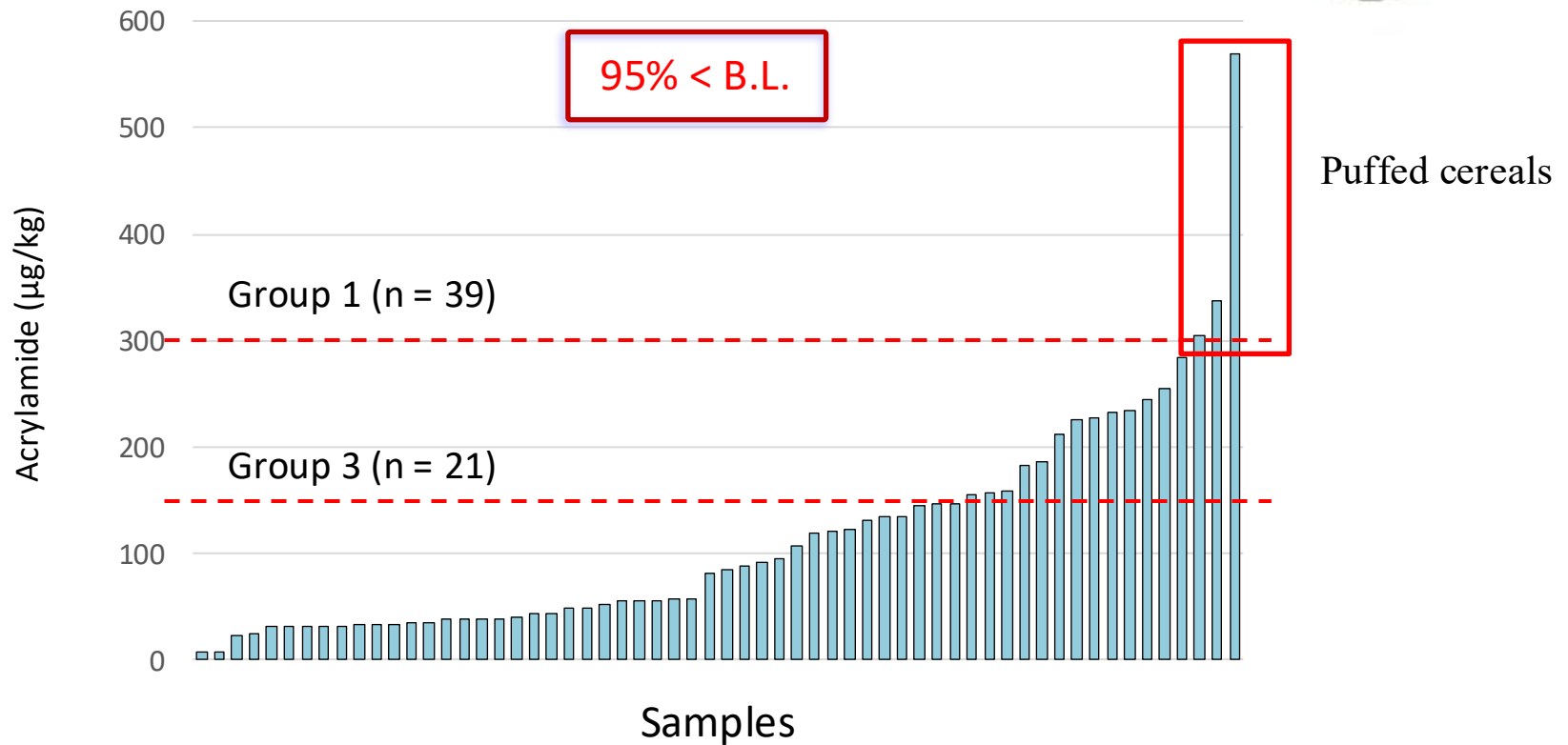
BENCHMARK LEVELS REFERRED TO IN ARTICLE 1(1)

Benchmark levels for the presence of acrylamide in foodstuffs referred to in Article 1(1) are as follows:

Food	Benchmark level [µg/kg]
French fries (ready-to-eat)	500
Potato crisps from fresh potatoes and from potato dough	750
Potato-based crackers	
Other potato products from potato dough	
Soft bread	
(a) Wheat based bread	50
(b) Soft bread other than wheat based bread	100
Breakfast cereals (excl. porridge)	
— bran products and whole grain cereals, gun puffed grain	300
— wheat and rye based products ⁽¹⁾	300
— maize, oat, spelt, barley and rice based products ⁽¹⁾	150

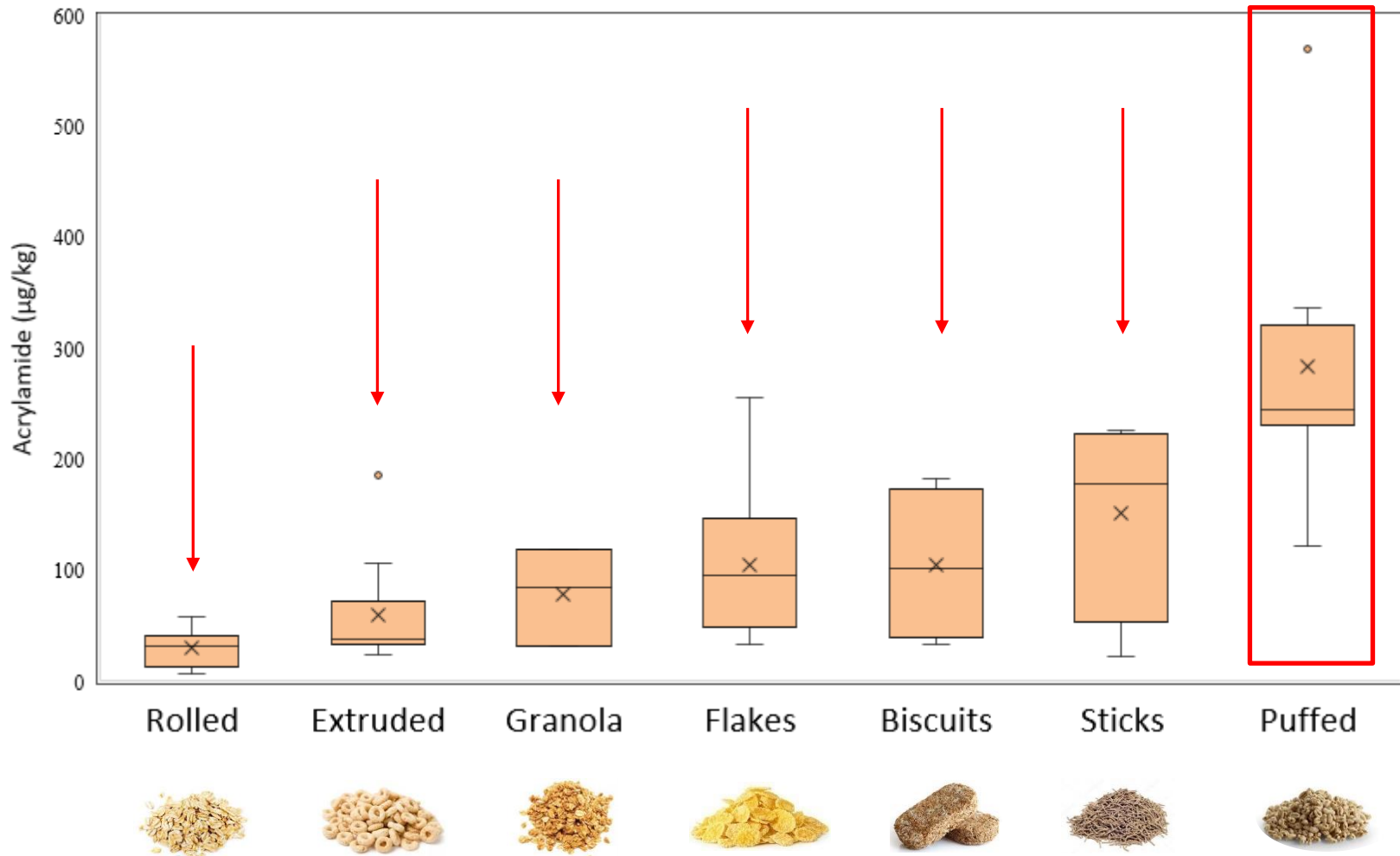
Acrylamide in BREAKFAST-CEREALS

MARKET STUDY 2025



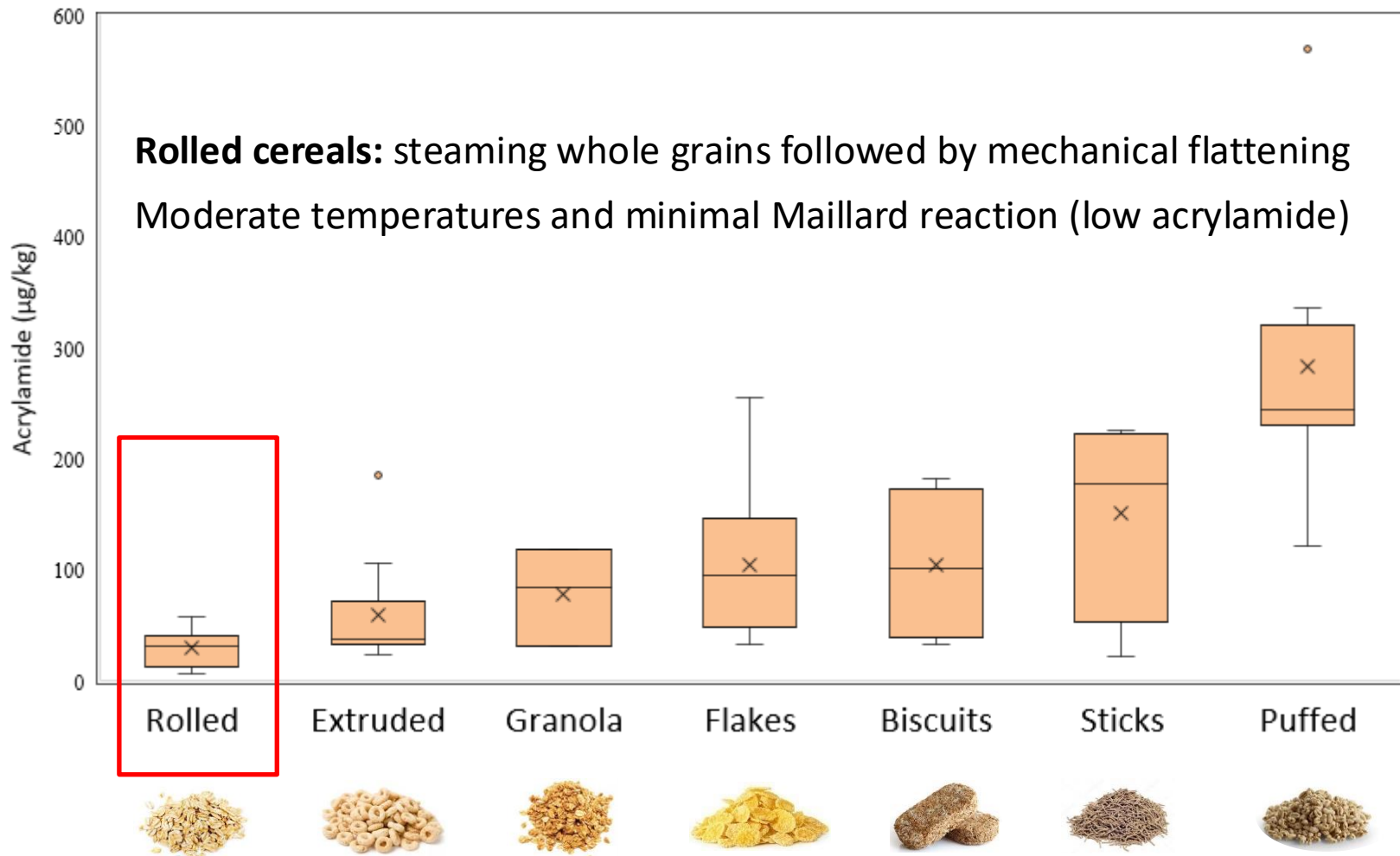
Mesías y col. (2025)

Acrylamide in BREAKFAST-CEREALS

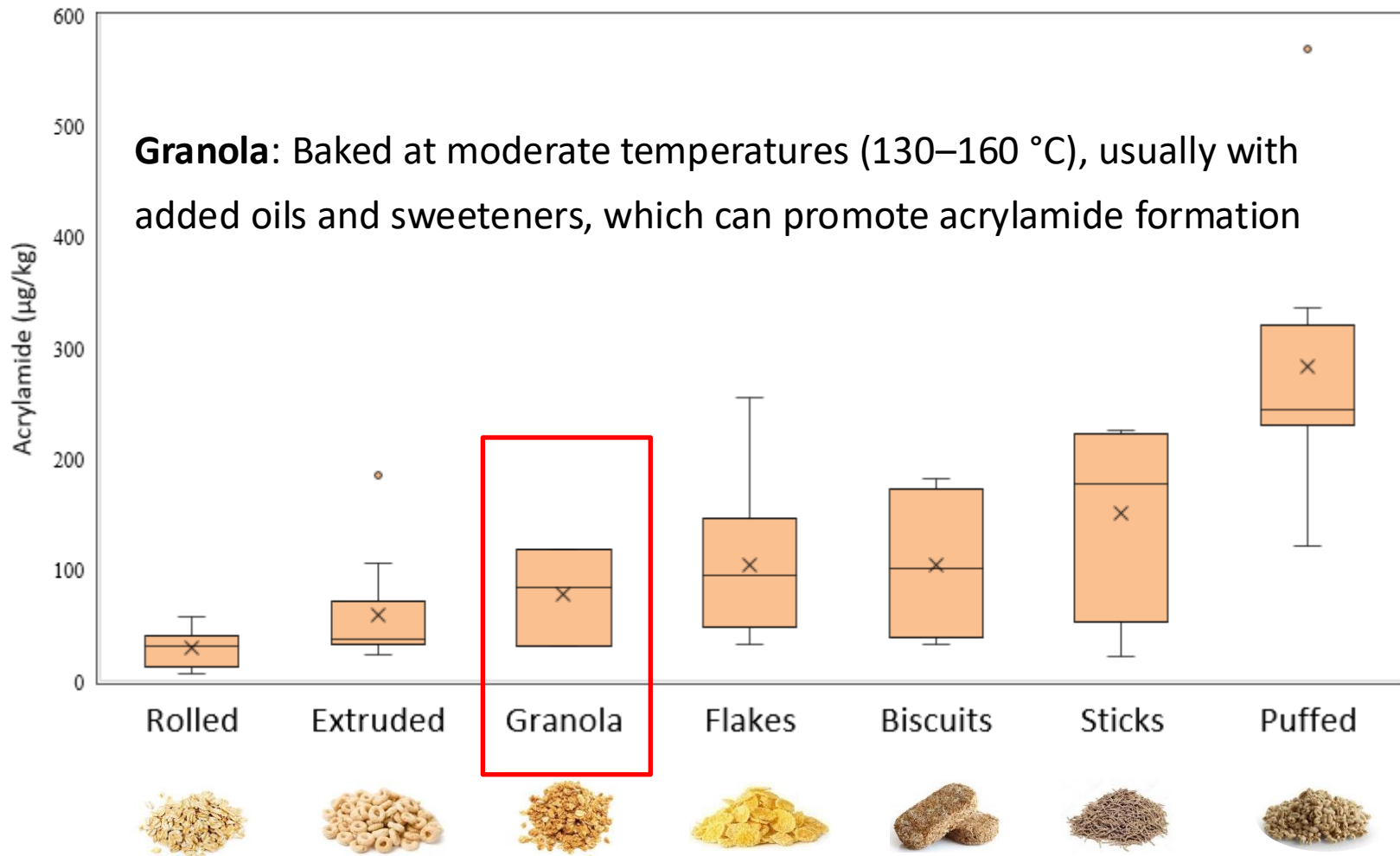


Type of breakfast cereal involve different **processing conditions**

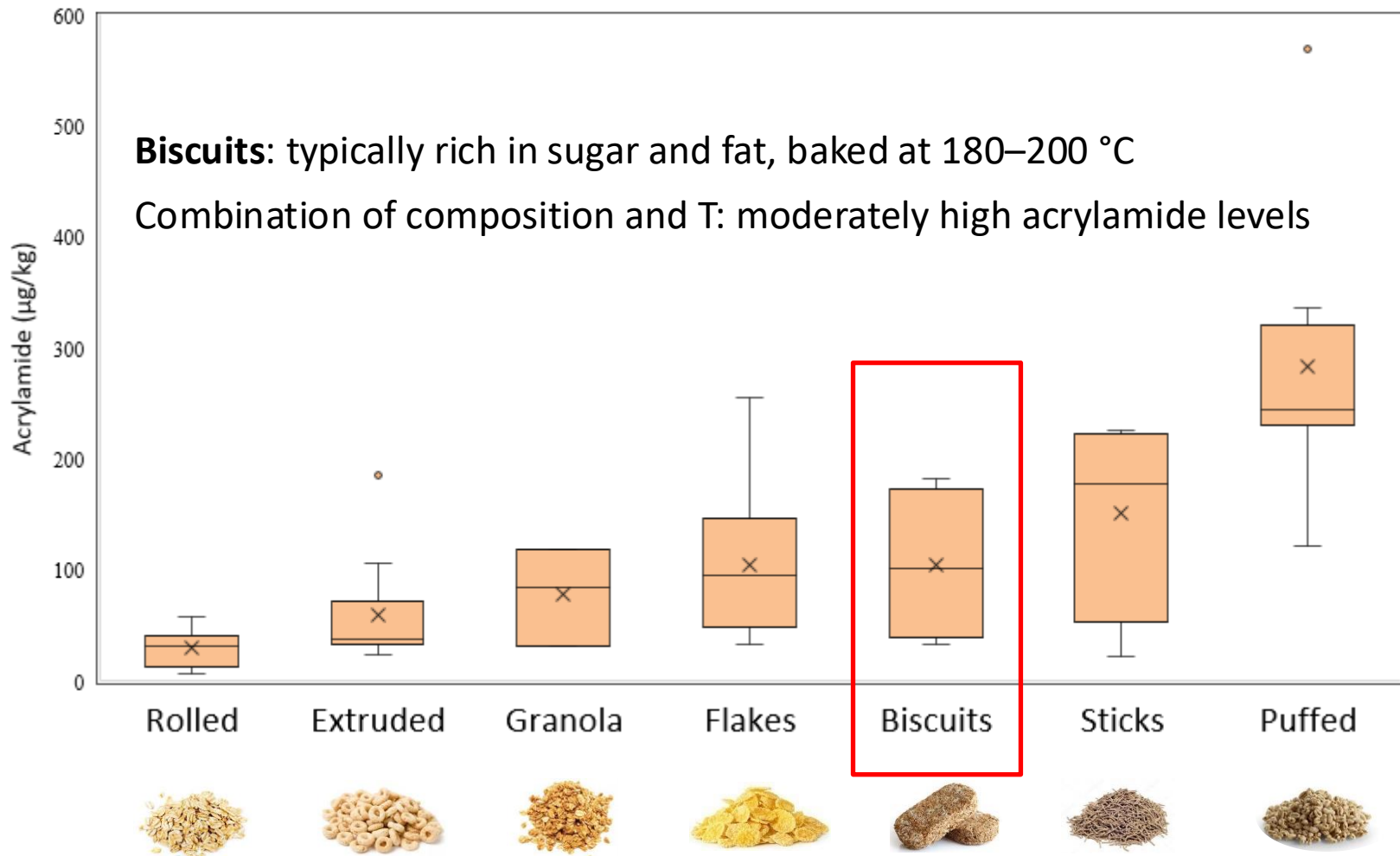
Acrylamide in BREAKFAST-CEREALS



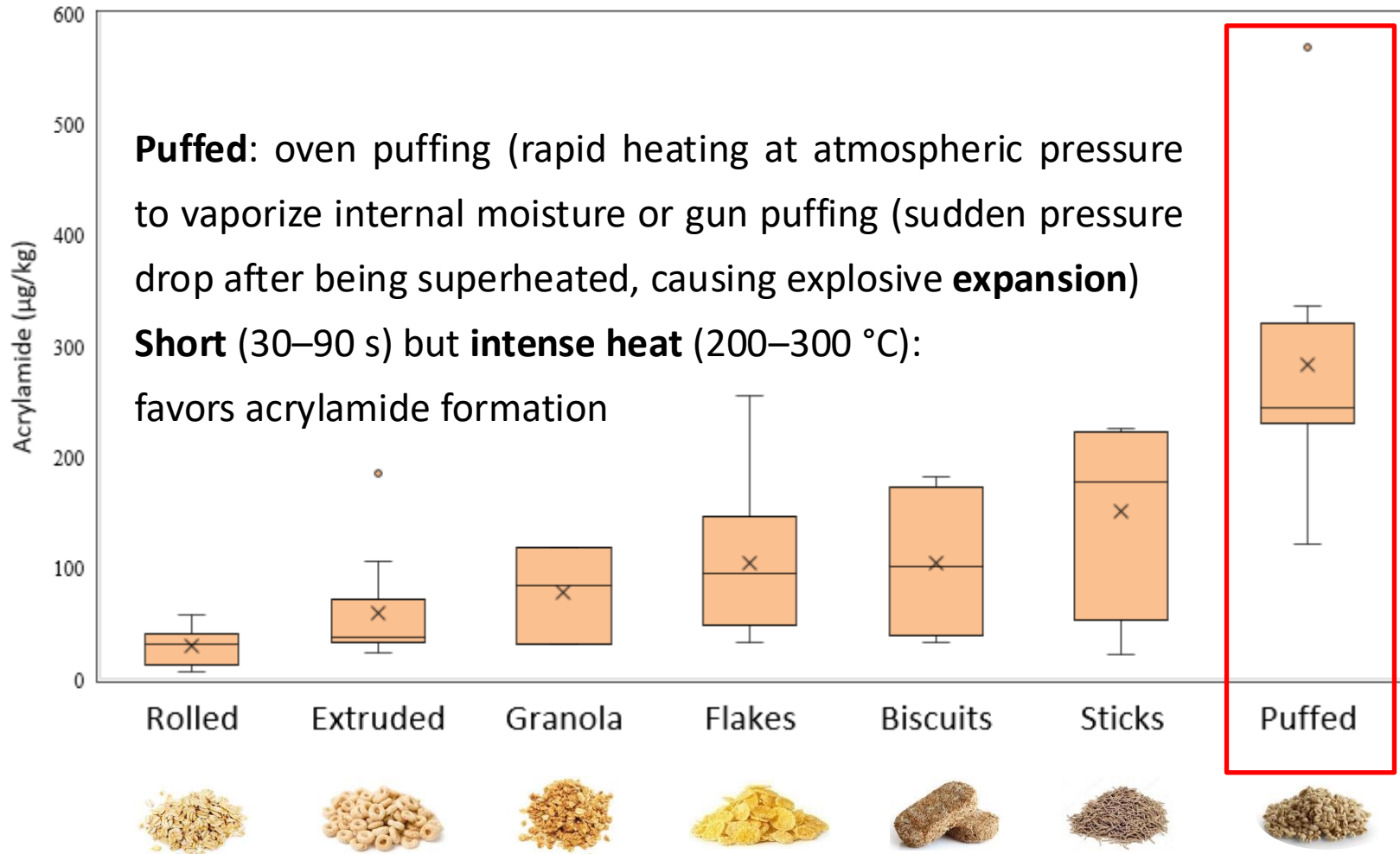
Acrylamide in BREAKFAST-CEREALS



Acrylamide in BREAKFAST-CEREALS

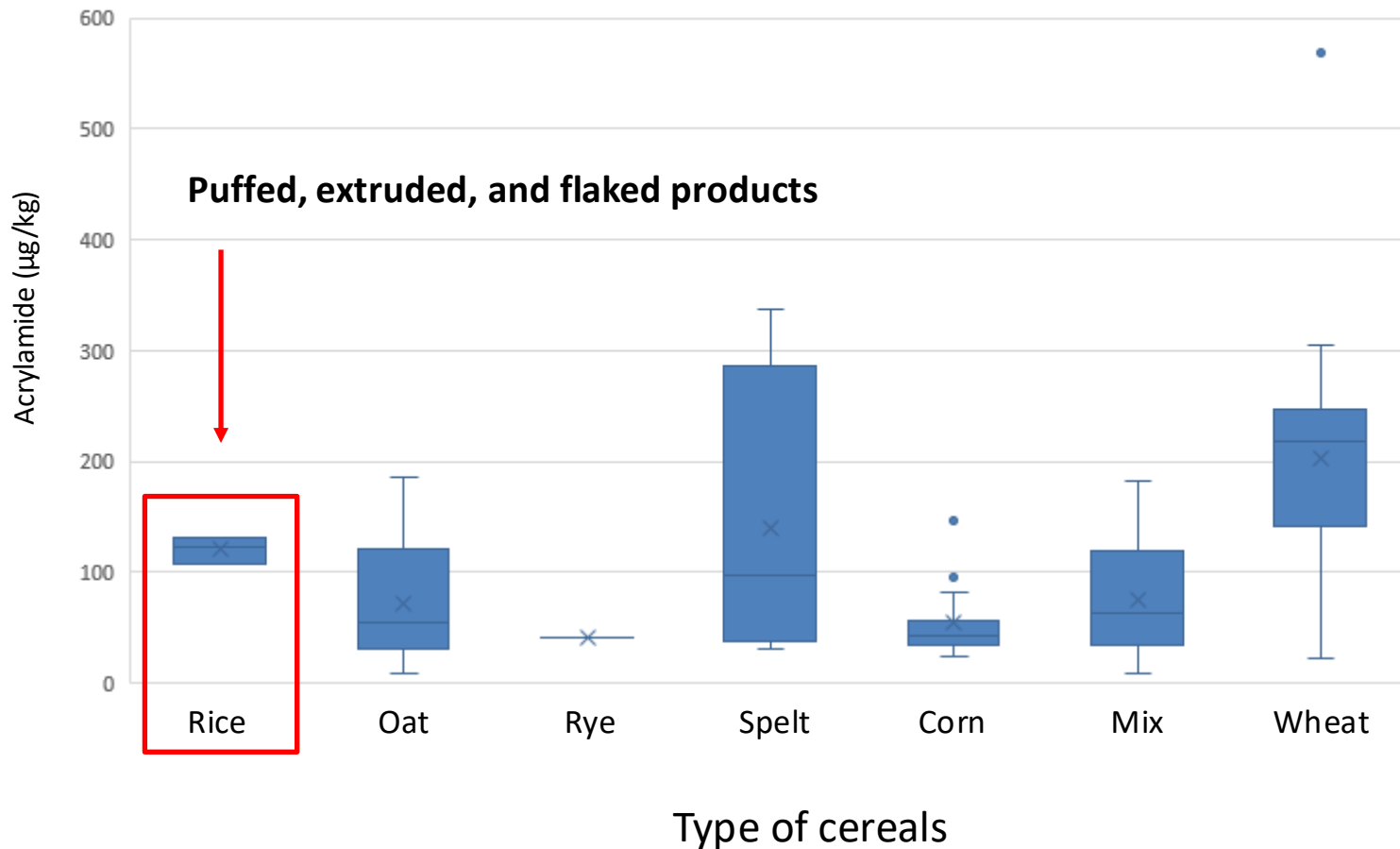


Acrylamide in BREAKFAST-CEREALS



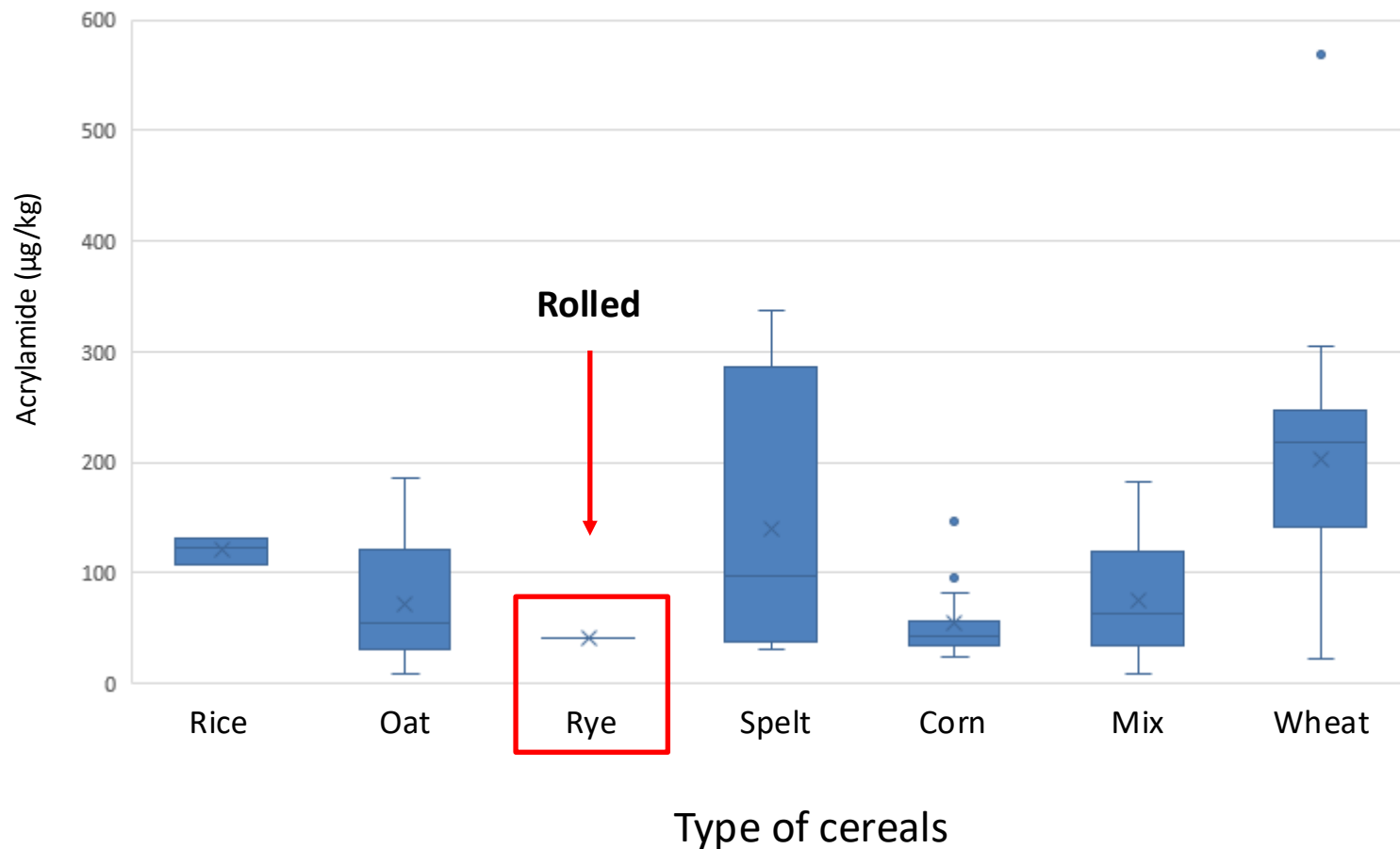
Acrylamide in BREAKFAST-CEREALS

MARKET STUDY 2025



Acrylamide in BREAKFAST-CEREALS

MARKET STUDY 2025



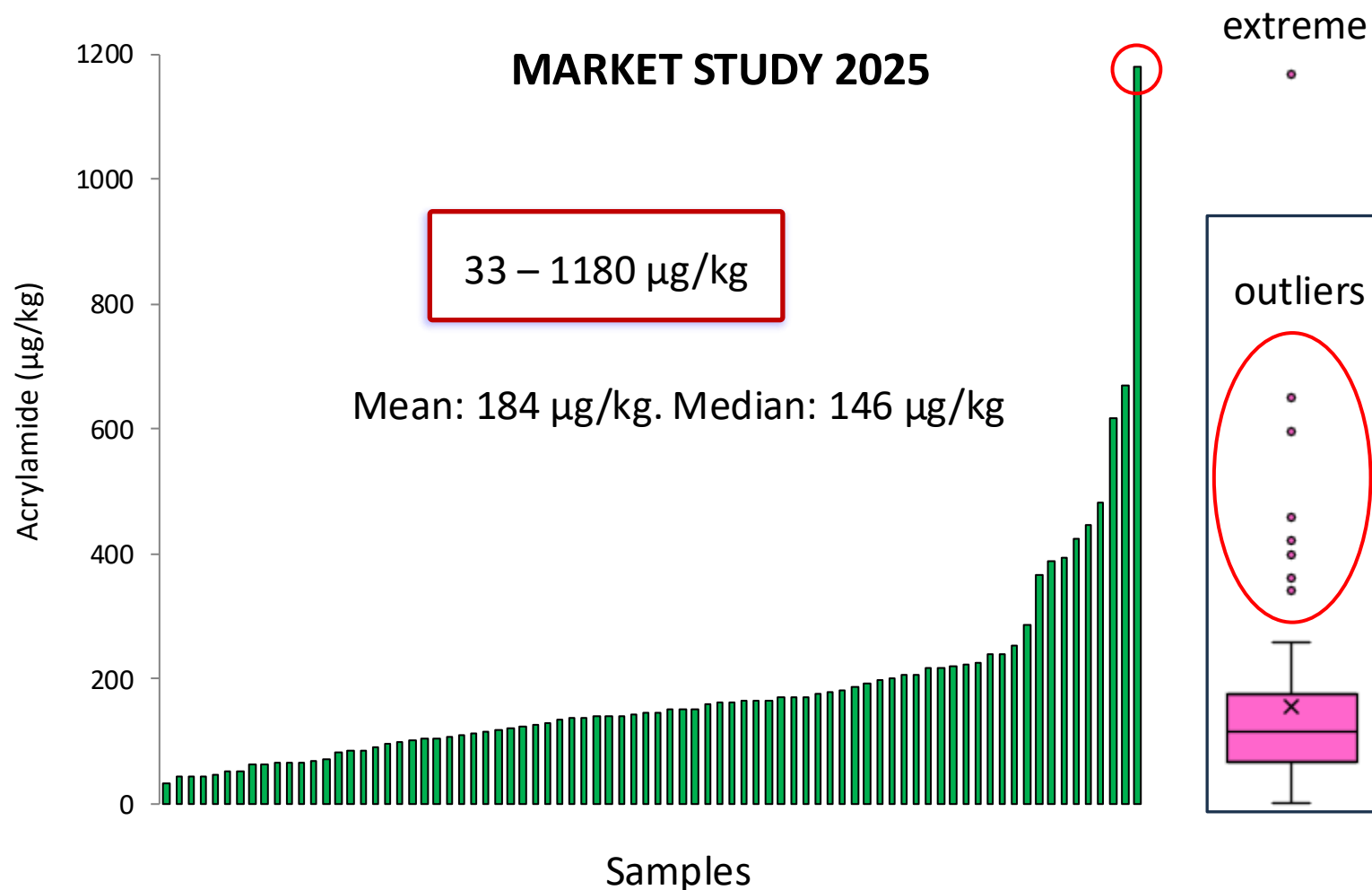
Acrylamide in BREAKFAST-CEREALS

Factor	Mean ACR ($\mu\text{g}/\text{kg}$) $\pm$ SD	Factor	Mean ACR ($\mu\text{g}/\text{kg}$) $\pm$ SD
Type of grain		Source of fibre	
Refined	125 $\pm$ 127a	< 3%	49 $\pm$ 34a
Whole grain	102 $\pm$ 70a	> 3%	119 $\pm$ 105b
Source of protein		Gluten free	
< 12% total E	112 $\pm$ 106a	Yes	44 $\pm$ 33a
> 12% total E	118 $\pm$ 94a	No	120 $\pm$ 104b
Low sugar content		Presence of honey	
< 5%	73 $\pm$ 74a	Yes	151 $\pm$ 159a
> 5%	134 $\pm$ 109b	No	103 $\pm$ 79a
Without added sugar			
Yes	76 $\pm$ 83a		
No	129 $\pm$ 106b		

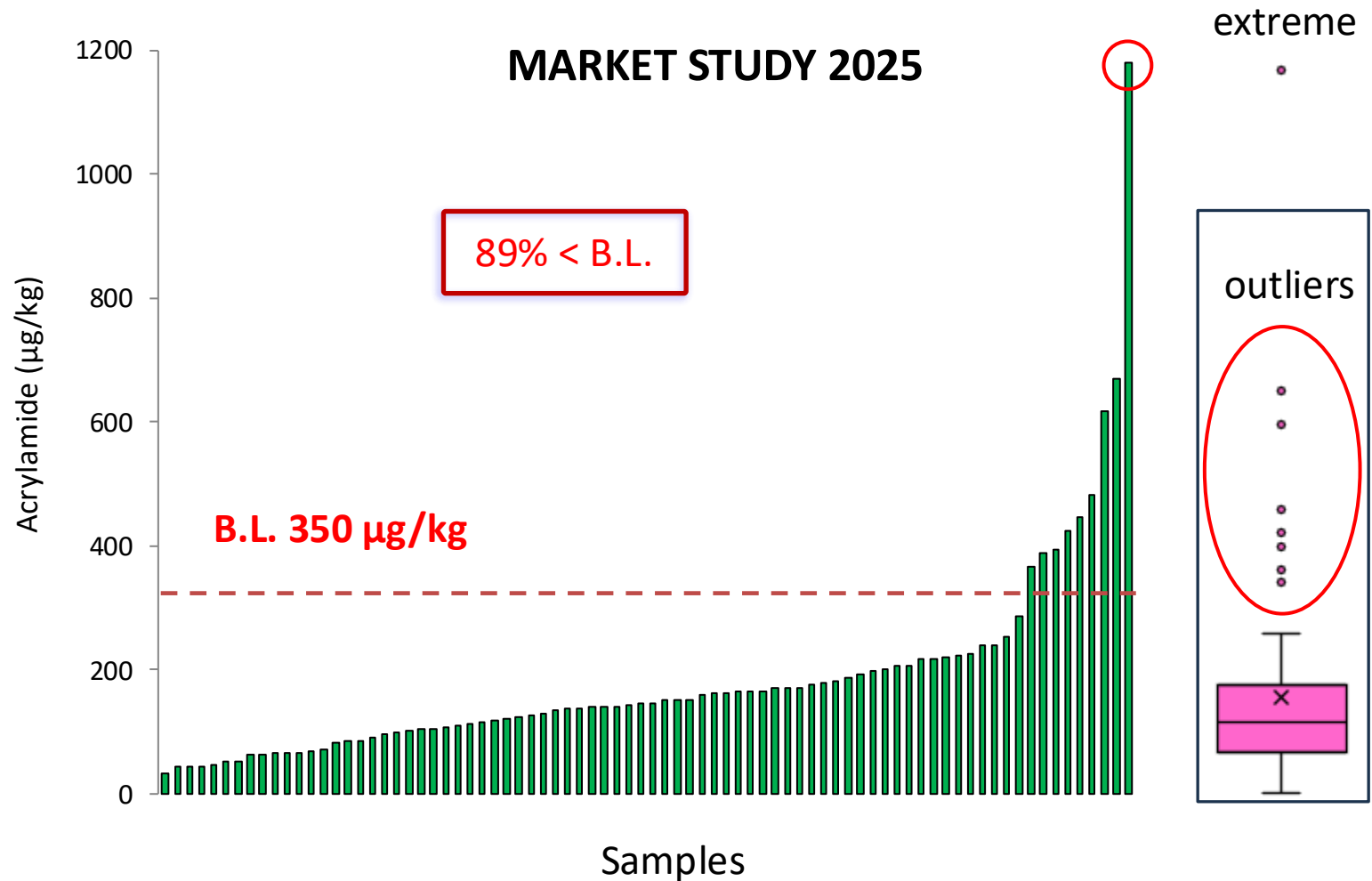
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No	129 $\pm$ 106b		

Acrylamide in BISCUITS



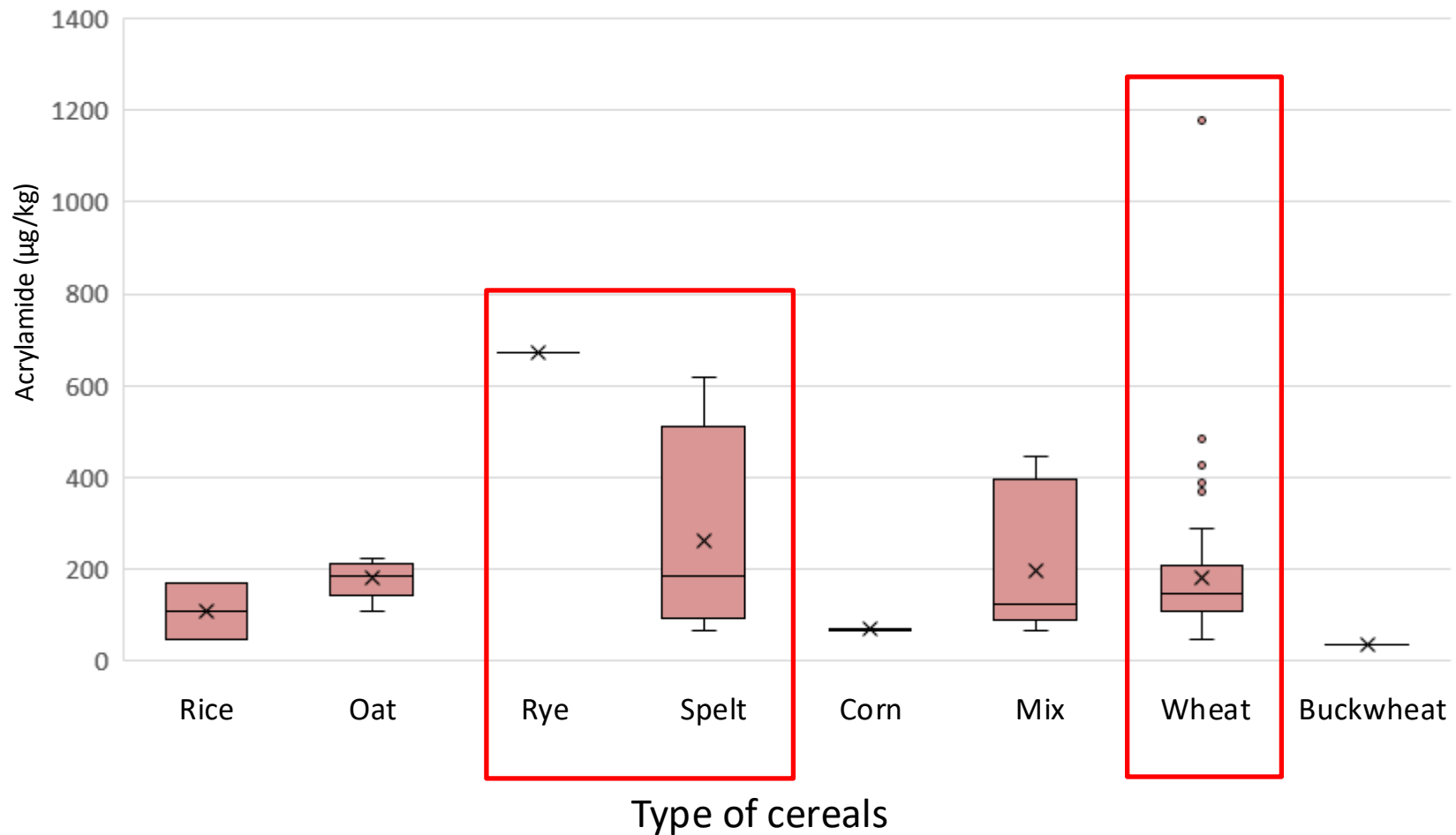
Acrylamide in BISCUITS



Acrylamide in BISCUITS



MARKET STUDY 2025



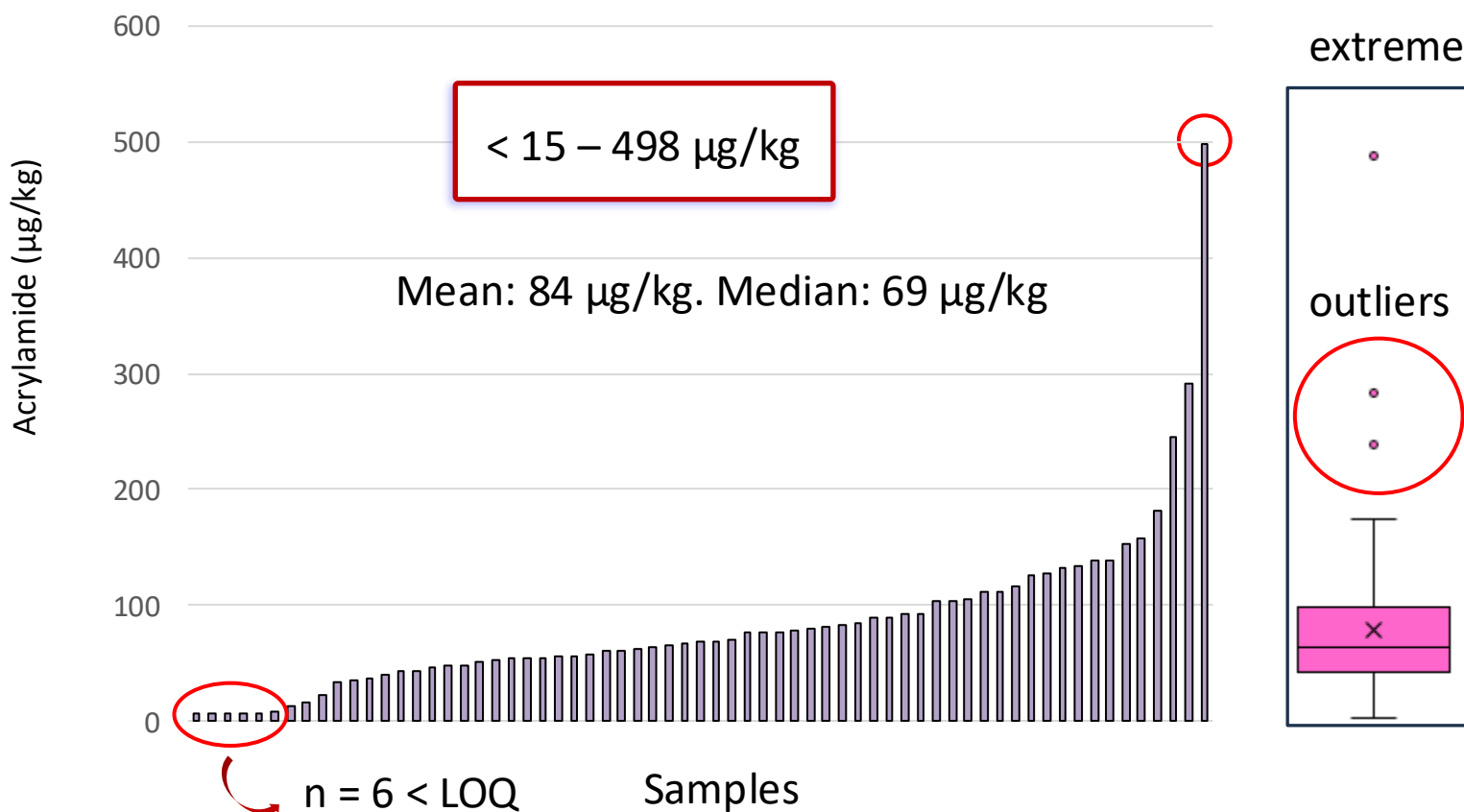
Acrylamide in BISCUITS

Factor	Mean ACR ($\mu\text{g/kg}$) $\pm$ SD	Factor	Mean ACR ($\mu\text{g/kg}$) $\pm$ SD
Type of grain		High fibre	
Refined	160 $\pm$ 154a	< 6%	156 $\pm$ 108a
Whole grain	251 $\pm$ 179b	> 6%	231 $\pm$ 225b
Low sugar content		Gluten free	
< 5%	164 $\pm$ 89a	Yes	171 $\pm$ 197a
> 5%	193 $\pm$ 188a	No	186 $\pm$ 162a
Without added sugar		Presence of honey	
Yes	163 $\pm$ 86a	Yes	273 $\pm$ 181a
No	194 $\pm$ 190a	No	178 $\pm$ 163a
Presence of butter		Presence of egg	
Yes	78 $\pm$ 22a	Yes	194 $\pm$ 146a
No	193 $\pm$ 169a	No	179 $\pm$ 174a
Presence of NaHCO₃		Presence of NH₄HCO₃	
Yes	245 $\pm$ 305a	Yes	276 $\pm$ 305b
No	173 $\pm$ 122a	No	168 $\pm$ 122a

Acrylamide in CRISPBREAD-CRACKERS



MARKET STUDY 2025



Acrylamide in CRISPBREAD-CRACKERS



BENCHMARK LEVELS REFERRED TO IN ARTICLE 1(1)

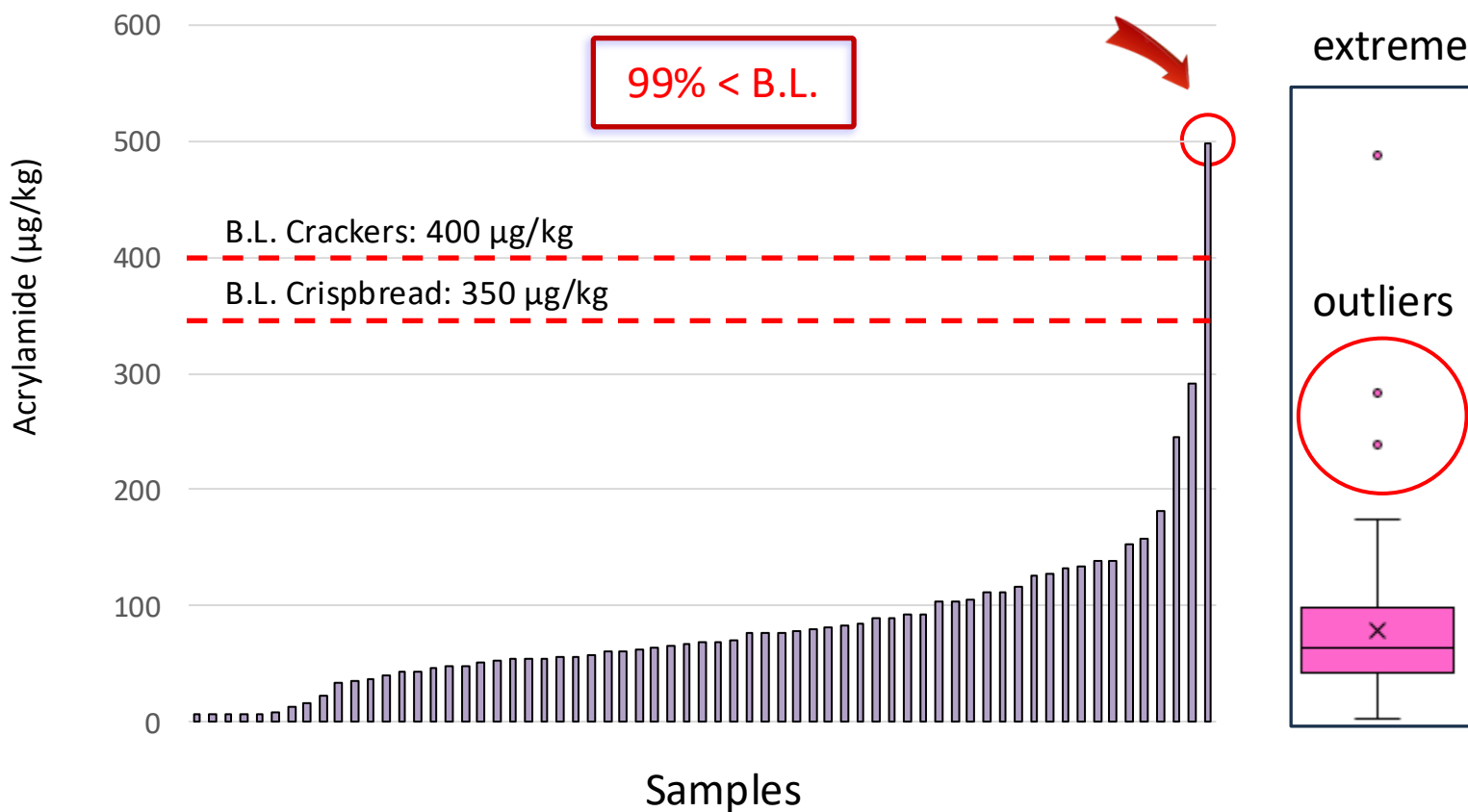
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Potato-based crackers	
Other potato products from potato dough	
Soft bread	
(a) Wheat based bread	50
(b) Soft bread other than wheat based bread	100
Breakfast cereals (excl. porridge)	
— bran products and whole grain cereals, gun puffed grain	300
— wheat and rye based products ⁽¹⁾	300
— maize, oat, spelt, barley and rice based products ⁽¹⁾	150
Biscuits and wafers	350
Crackers with the exception of potato based crackers	400
Crispbread	350
Ginger bread	800
Products similar to the other products in this category	300
Roast coffee	400
Instant (soluble) coffee	850
Coffee substitutes	
(a) coffee substitutes exclusively from cereals	500
(b) coffee substitutes from a mixture of cereals and chicory	⁽²⁾
(c) coffee substitutes exclusively from chicory	4 000

Acrylamide in CRISPBREAD-CRACKERS



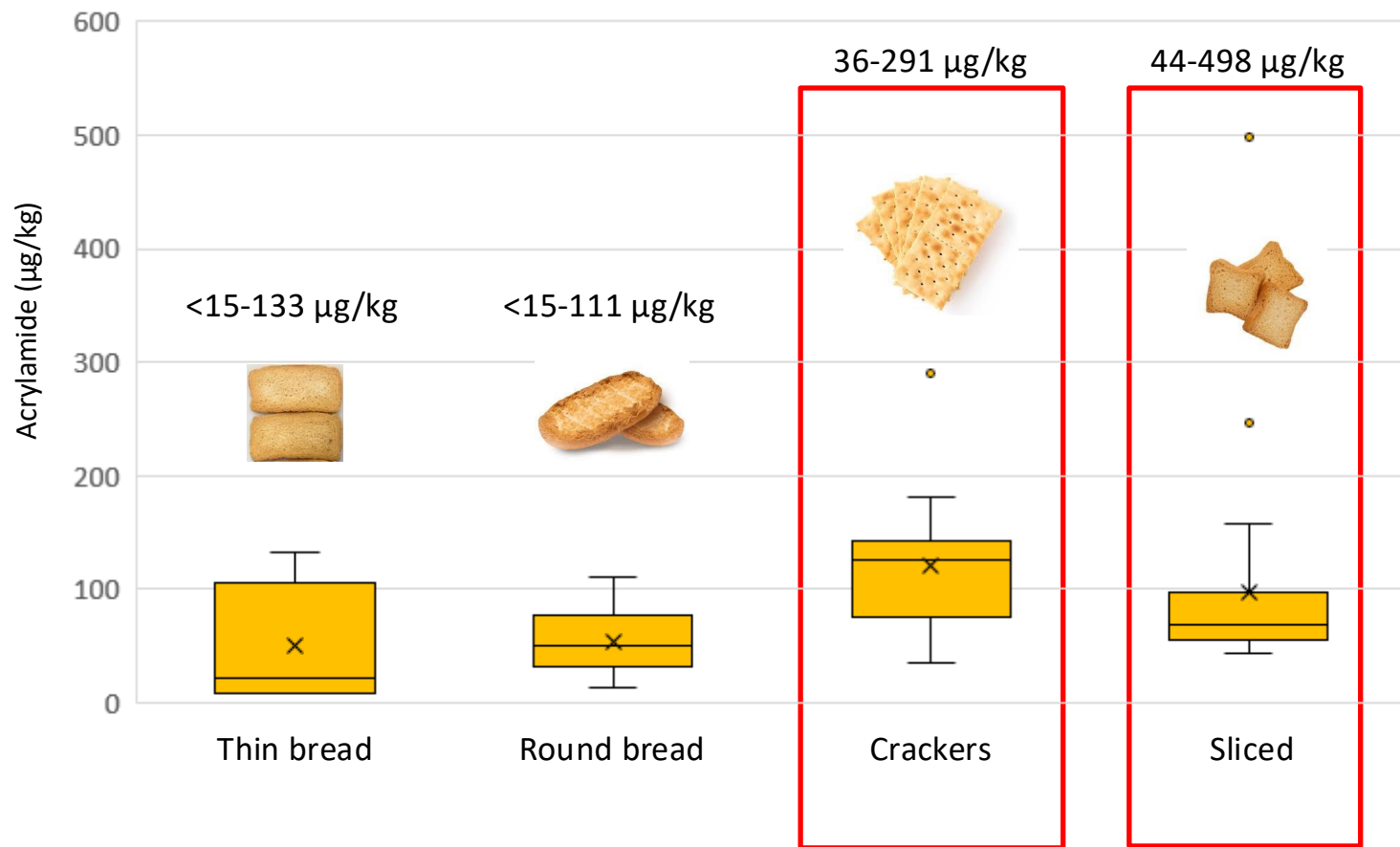
MARKET STUDY 2025



Acrylamide in CRISPBREAD-CRACKERS



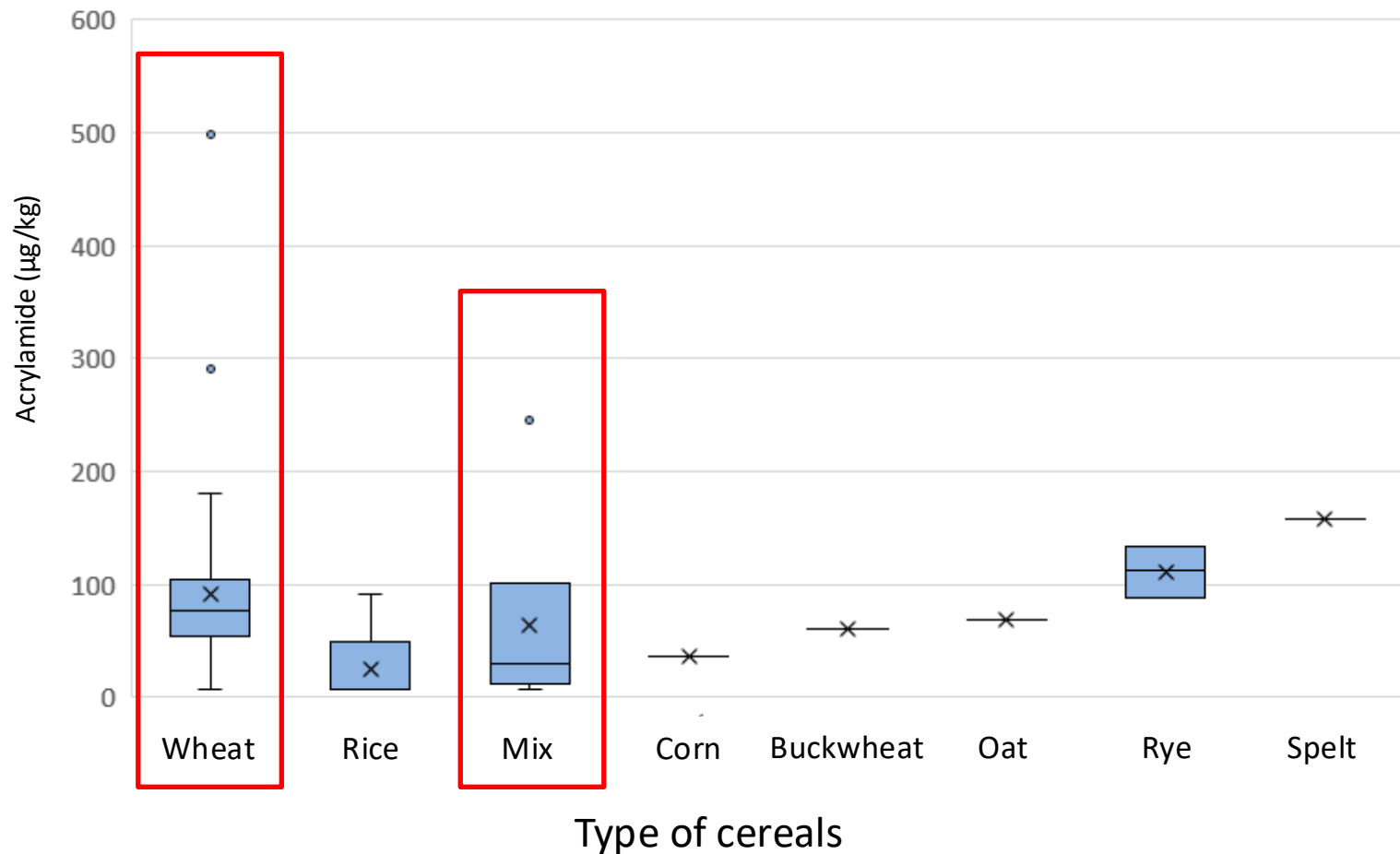
MARKET STUDY 2025



Acrylamide in CRISPBREAD-CRACKERS



MARKET STUDY 2025



Acrylamide in CRISPBREAD-CRACKERS



Factor	Mean ACR ($\mu\text{g/kg}$) $\pm$ SD	Factor	Mean ACR ($\mu\text{g/kg}$) $\pm$ SD
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Type of grain

Refined	$69 \pm 49\text{a}$
Whole grain	$104 \pm 95\text{b}$

Source of protein

Yes	$111 \pm 101\text{b}$
No	$72 \pm 55\text{a}$

High fibre

> 6%	$106 \pm 88\text{a}$
< 6%	$58 \pm 41\text{b}$

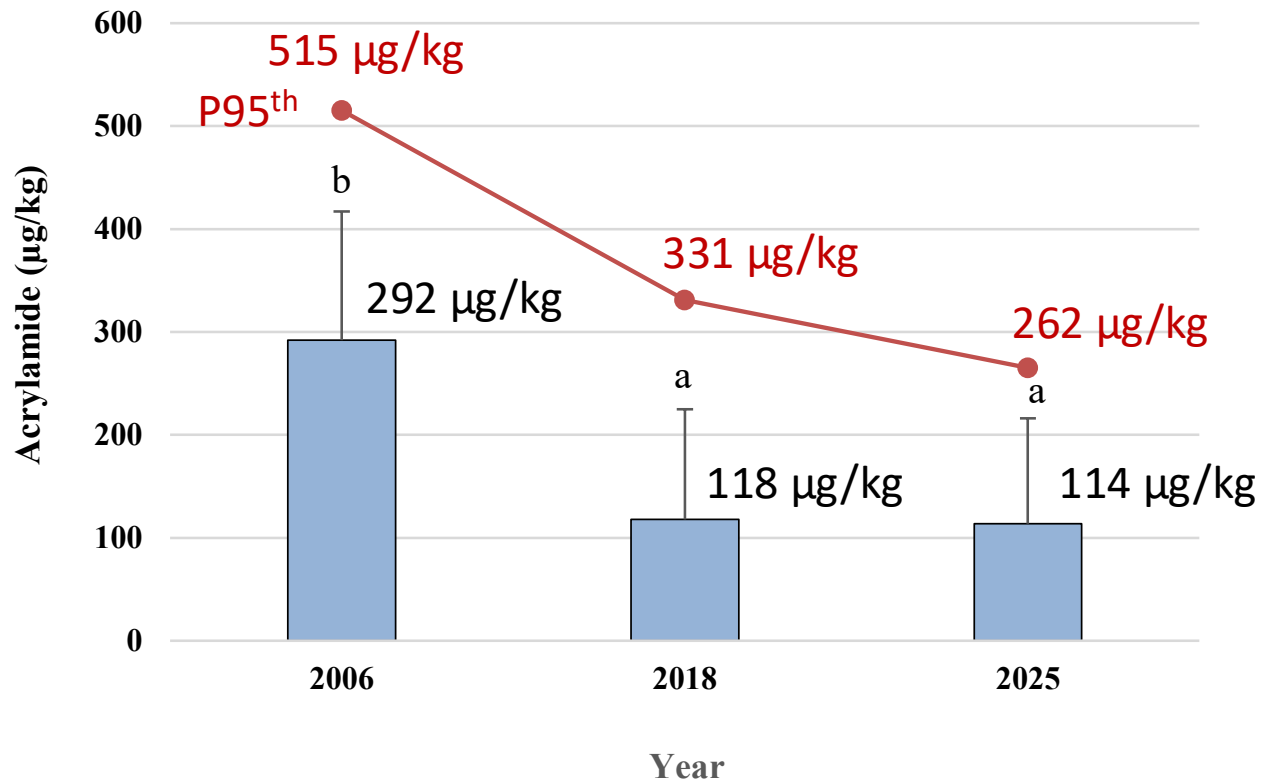
Gluten free

Yes	$32 \pm 30\text{a}$
No	$92 \pm 75\text{b}$



Acrylamide in BREAKFAST-CEREALS

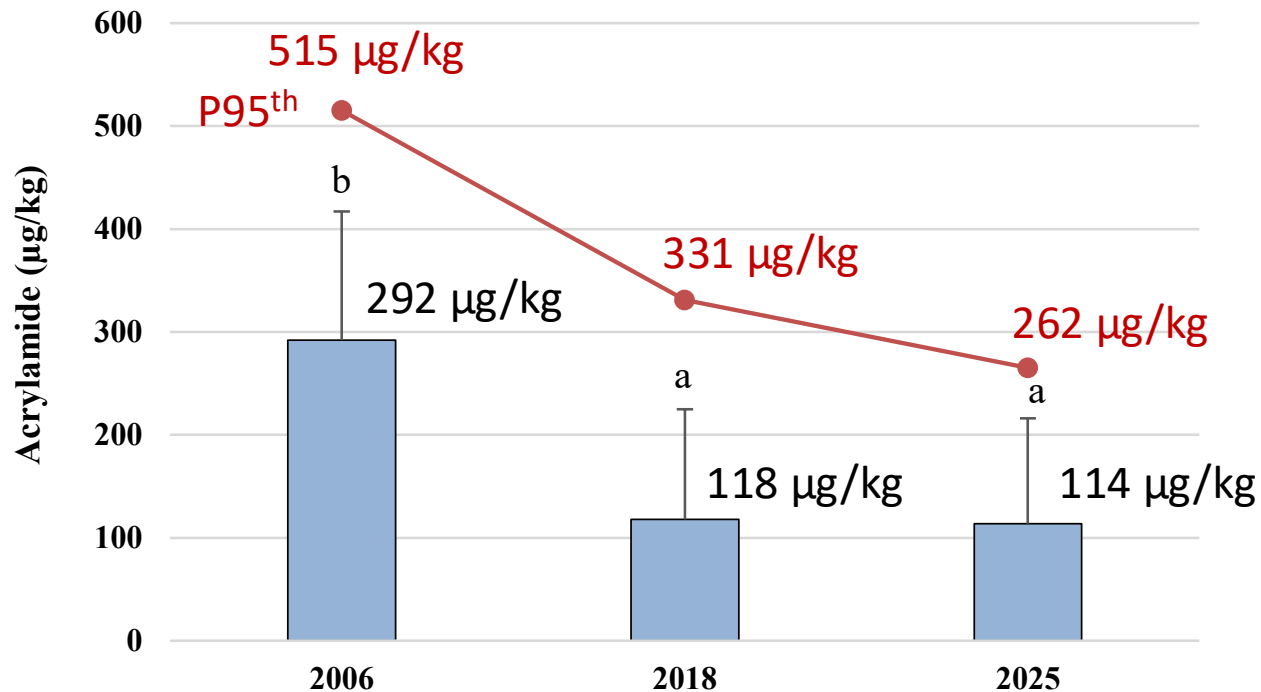
ACRYLAMIDE IN BREAKFAST CEREALS (2006-2025)



- Rufián-Henares et al. (2006). Mol Nutr Food Res 50, 756.
- Mesías et al. (2019). Food Control 105, 94.

Acrylamide in BREAKFAST-CEREALS

ACRYLAMIDE IN BREAKFAST CEREALS (2006-2025)



27 - 484 µg/kg

< 15 - 337 µg/kg

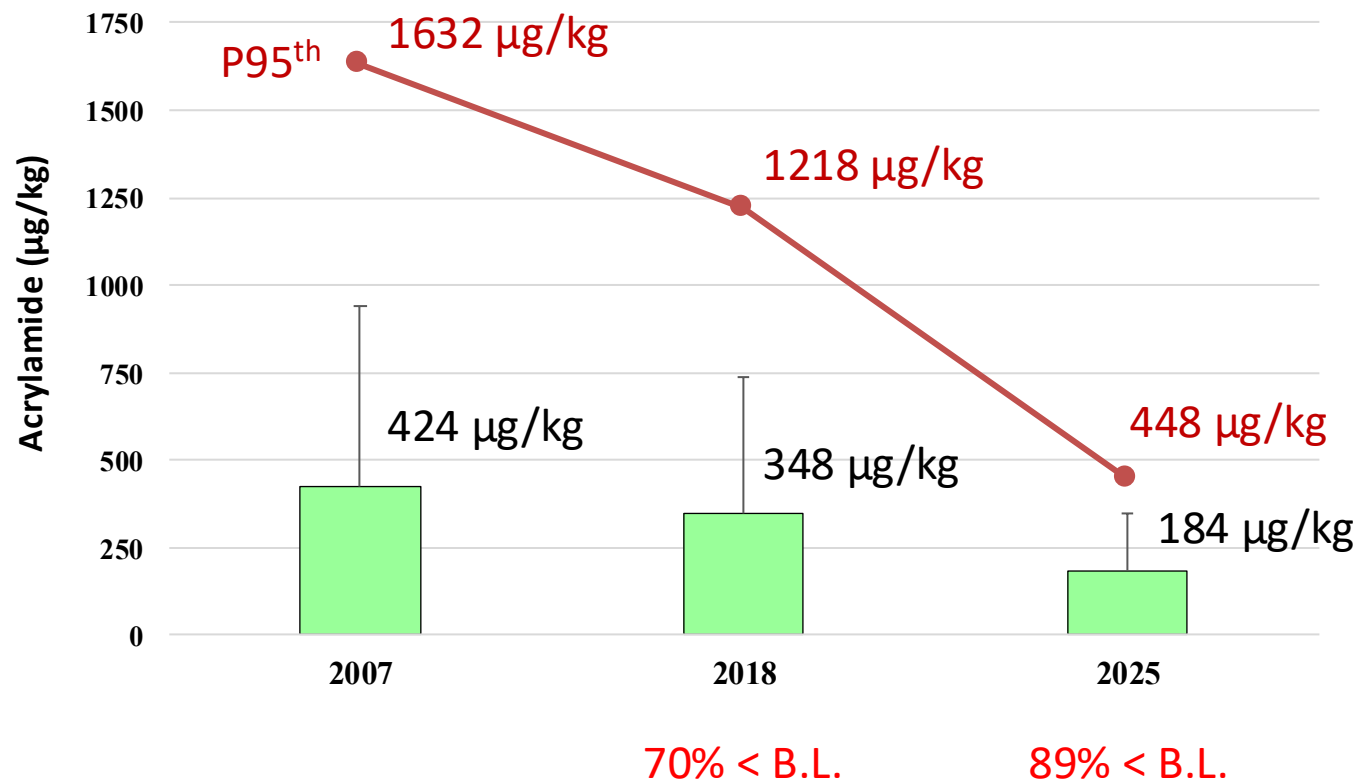
85% < B.L.

95% < B.L.

Acrylamide in BISCUITS



ACRYLAMIDE IN BISCUITS (2007-2025)



- Rufián-Henares et al. (2007). Food Addit. Contam. 24, 343
- Mesías et al. (2019). Food & Funct 10, 6624

CONCLUSIONS

- Acrylamide levels in cereal-based products have decreased in recent years and most samples show concentrations below the benchmark levels established by European regulations. However, it is important to continue monitoring both formulation and, especially, the thermal processing conditions used in the production of these foodstuffs to prevent the formation of high acrylamide levels.
- Effective mitigation strategies focused on ingredient selection, especially in innovative formulations, and optimized processing are essential to further reduce acrylamide content and, consequently, the potential health risks associated with chronic exposure to this contaminant.

Thank you for your attention



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