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Celiachia

La Dieta Senza Glutine: dagli Aspetti Nutrizionali alla Clinica **7 novembre 2025** Milano

13° CONVEGNO NAZIONALE AIC

Metodologie di analisi del glutine

Gianfranco Mamone



Institute of Food Sciences
Consiglio Nazionale delle Ricerche

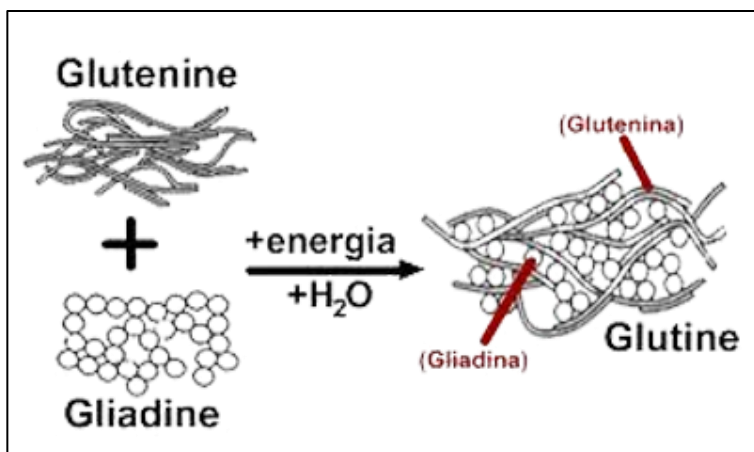


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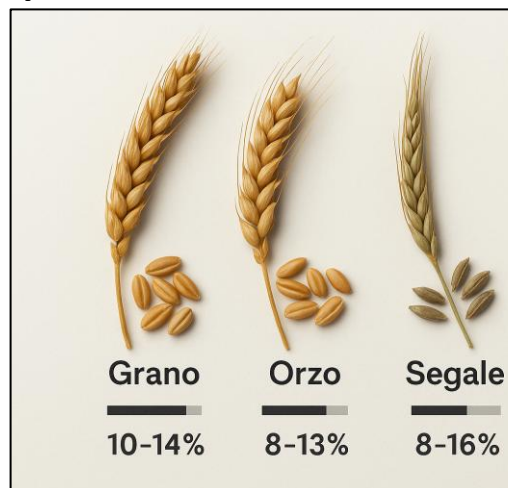
La Dieta Senza Glutine: dagli Aspetti Nutrizionali alla Clinica 7 novembre 2025 Milano

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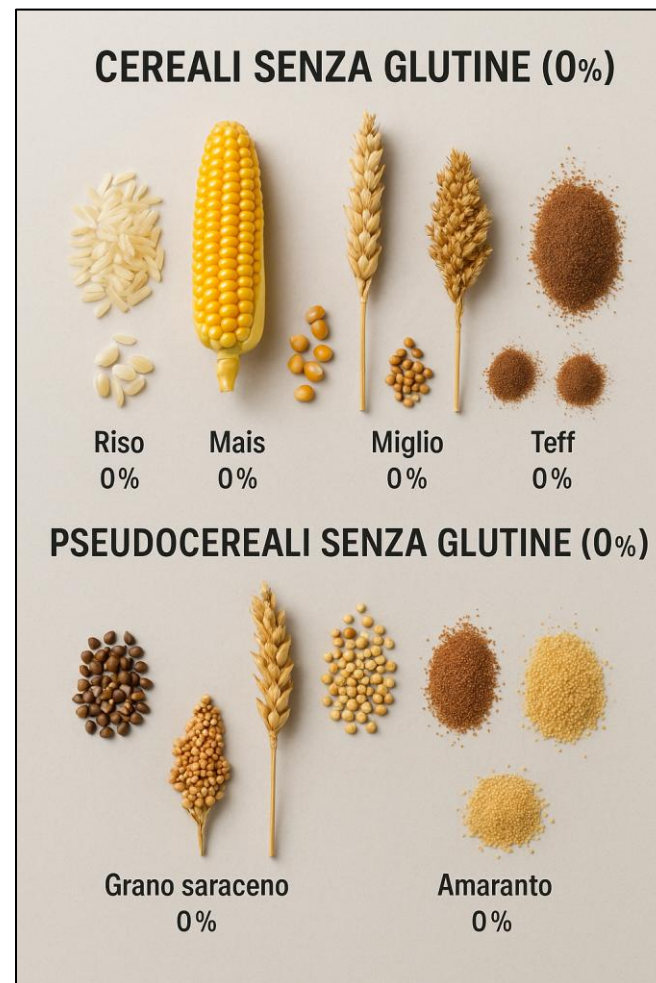
Cosa è il glutine



Cereali che contengono glutine o prolammine simili



cereali e pseudocereali senza glutine

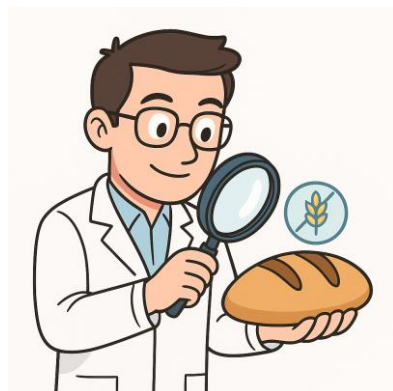


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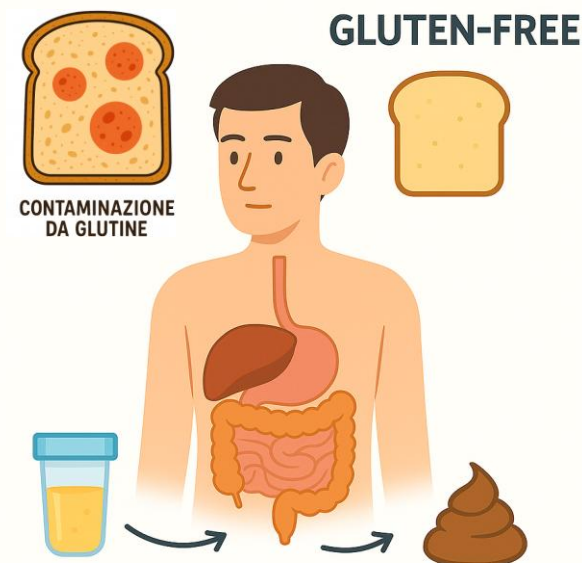
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Perché servono metodi sensibili per individuare il glutine?

Sicurezza Alimentare



Monitoraggio dell'aderenza alla dieta senza glutine



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Sicurezza Alimentare

THE CODEX DEFINITION OF GLUTEN-FREE AND WORLDWIDE STANDARD



Codex Alimentarius
(CXS 118-1979):
≤20 ppm in finished product



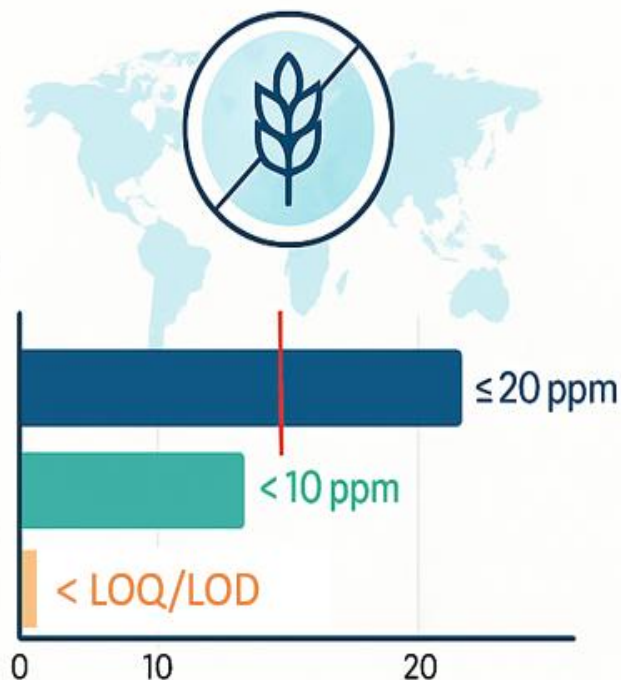
Europe, U.S., UK, Canada:
≤20 ppm



Argentina: < 10 ppm



Australia & New Zealand:
< no detectable gluten



principali tecniche analitiche per rilevare il glutine:

☐ ELISA

☐ lateral flow devices

☐ Spettrometria di massa (LC-MS/MS):

*Metodi
immunoenzimatici*



Sicurezza Alimentare

ELISA (enzyme-linked immunosorbent assay) il i metodi di riferimento per la certificazione *gluten-free* nell'industria alimentare.

specificità, sensibilità, semplicità e costo contenuto



Scelta dell'anticorpo

- Un anticorpo ideale per l'analisi del glutine deve:
 - Rilevare **prolamine** da specie cerealicole **tossiche per i celiaci**.
 - Riconoscere le **regioni intramolecolari** responsabili dell'**immunotossicità**.
 - Sono stati sviluppati **diversi anticorpi** contro differenti **epitopi delle prolamine**

Table 2. Commercial antibodies used to detect gluten and preferably recognized cereals and epitopes.

Monoclonal Antibodies	Preferred Epitope
G12	QPQ-(L/ Q)-P-(Y/F)
A1	Q-(Q/L)-P-(Y/F)-PQP
R5	QQPFP
401.21	PQ-(PQ/ QP)-PFP-(QE/ EES)
α20	F-RPQQPYP-Q
14G11	α-gliadin 33-mer, ND
13F6	α-gliadin 33-mer, ND

ND, not determined the minimal epitope. Red and black colors indicate different amino acid combination, respectively. Green color indicates four different amino acid combination epitopes.



Sicurezza Alimentare: metodo immunochimico

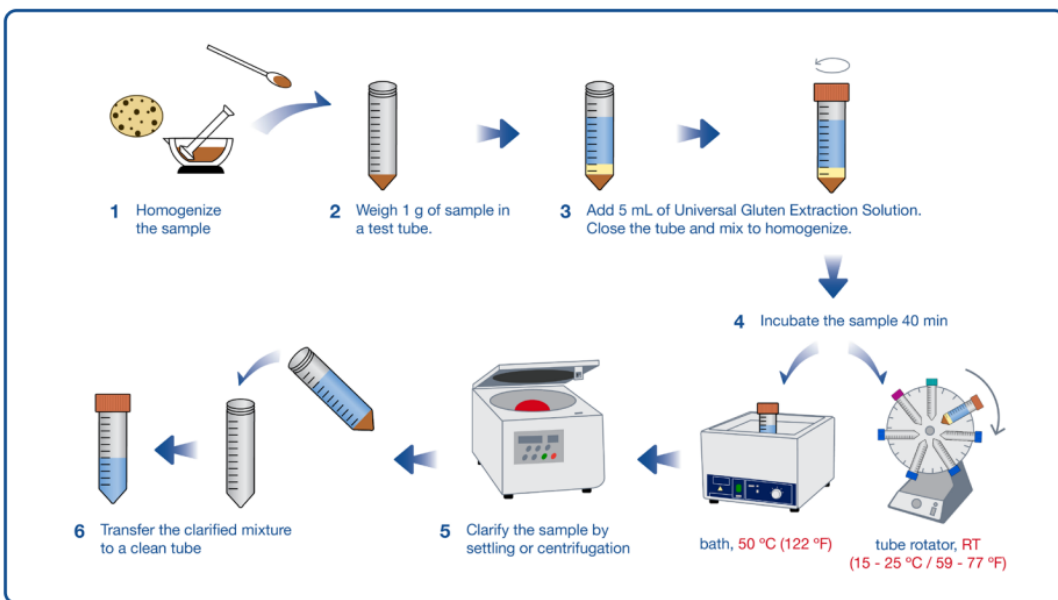
ELISA (Méndez method) – R5 (Sandwich) ELISA

- Officially approved by Codex Alimentarius Type I
- Adopted by AOAC International
- Validated by AACC International

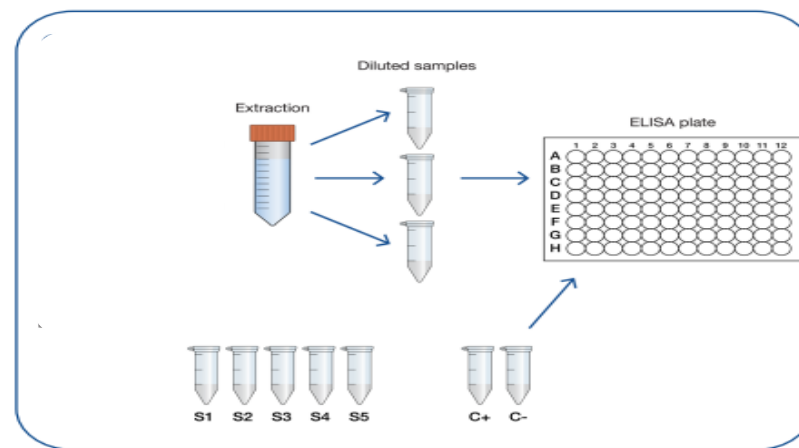
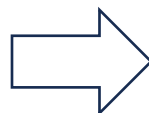


Example of amino acid sequence of α -gliadin

MKTLILTILAMATTIATANMQVDP SGQVQWPQ **QQPFP** QPQQPFCQQP
QRTIPQPHQTFHHQPQQTFPQPQQTYPHQPQQQFPQTQQP **QQPFP** QP
QQTFPQQPQLPFPQQP **QQPFP** QPQQP **QQPFP** QSQQP **QQPFP** QPQQQ
FPQPQQPQQSFPQQQQPAIQSFLQQQMNPCKNFLQCCNHVSLVSSLV
SIILPRSDCQVMQQQCCQQLAQIPQQLQCAAIHVAHSIIMQQEQQQGV
PILRPLFQLAQGLGIIQPQQPAQLEGIRSLVLKTLPTMCNVYVPPDCSTINV
PYANIDAGIGGQ **QQPFP**



Procedura di estrazione



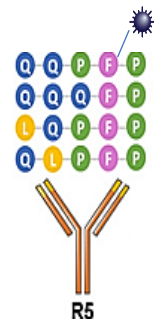
Procedura di analisi

DETERMINAZIONE DEL GLUTINE IN ALIMENTI FERMENTATI CONTENENTI GLUTINE PARZIALMETE FERMENTATO

R5 Competitive ELISA (Méndez method)

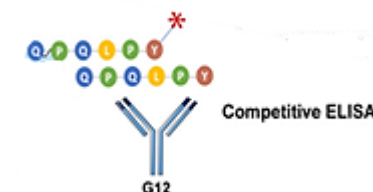
- Adopted by AOAC International
- Validated by AACC International

Competitive ELISA



G12 Competitive ELISA

LQLQFPQPQLPYPQPQLPYPQPQLPYPQPQPF





**Dedicated
Gluten-free Beer**



Brewed with the finest locally sourced, gluten-free grains such as millet and buckwheat



Brewed in a facility that only makes gluten-free beer, so there's no risk of cross contamination

**Certified
Gluten-Free**

Undergoes rigorous testing and is labeled certified gluten-free. Safe for sensitive consumers to drink.

VS.



Gluten-reduced Beer



Brewed with ingredients that contain gluten such as wheat, barley, and rye



Enzymes are added during the brewing process to break gluten proteins into smaller pieces; gluten is not removed



Contains gluten and cannot be labeled gluten-free. Common labels are "crafted to remove gluten" or "gluten-reduced." Can make consumers sick.

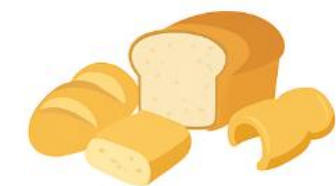
#getbeercurious

BEER	GRAIN	Ppm (based on ELISA)
Ale	Barley	0.05 – 35.0
Ale (wheat)	Wheat/barley	920 – 16,811
Dark lager	Wheat/barley	325
Gluten free	Barley, sorghum, or millet	0.05 – 1.95
Lager	Barley	0.06 – 341
Light	Barley	152
Light lager	Barley	0.07 – 1.82
Low alcohol	Wheat	258
Low carb. lager	Barley	191
Low gluten	Sorghum	0.07
Pilsner	Barley	0.1 – 0.8
Stout (barley)	Barley	220 – 470
Stout (wheat)	Wheat	13,530
Strong stout	Barley	464
Wheat	Wheat	7,700 – 20,200
Wild type	Barley	40,800 – 42,300

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Tipi di test ELISA per la rilevazione del glutine: Come scegliere un test diagnostico Anticorpo R5 (metodo di Mendez)



Prodotti non fermentati o non idrolizzati)

**Cocktail di estrazione di Mendez*

Sandwich ELISA



ELISA
Sandwich

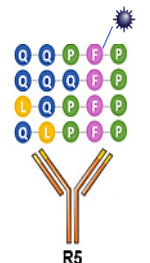
**Metodi ufficiale
(method type I) da
parte del
Codex Alimentarius**

Sensibilità
(grano, segale e orzo)
LOD: 3 mg/kg di glutine
LOQ: 5 mg/kg di glutine



Prodotti fermentati o non idrolizzati)

Competitive ELISA



ELISA
Competitivo

Sensibilità
(grano, segale e orzo)
LOD: 4,6 mg/kg di glutine
LOQ: 10 mg/kg di glutine


nutrients


Review

Food Safety and Cross-Contamination of Gluten-Free Products: A Narrative Review

 Herbert Wieser ^{1,†}, Verónica Segura ^{2,✉}, Ángela Ruiz-Carrión ^{2,✉}, Carolina Sousa ² and Isabel Comino ^{2,*}
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* Correspondence: icomino@us.es; Tel.: +34-954-55-64-52

† Retired.

Abstract: A gluten-free diet (GFD) is currently the only effective treatment for celiac disease (CD); an individual's daily intake of gluten should not exceed 10 mg. However, it is difficult to maintain a strict oral diet for life and at least one-third of patients with CD are exposed to gluten, despite their best efforts at dietary modifications. It has been demonstrated that both natural and certified gluten-free foods can be heavily contaminated with gluten well above the commonly accepted threshold of 20 mg/kg. Moreover, meals from food services such as restaurants, workplaces, and schools remain a significant risk for inadvertent gluten exposure. Other possible sources of gluten are non-certified oat products, numerous composite foods, medications, and cosmetics that unexpectedly contain "hidden" vital gluten, a proteinaceous by-product of wheat starch production. A number of immunochemical assays are commercially available worldwide to detect gluten. Each method has specific features, such as format, sample extraction buffers, extraction time and temperature, characteristics of the antibodies, recognition epitope, and the reference material used for calibration. Due to these differences and a lack of official reference material, the results of gluten quantitation may deviate systematically. In conclusion, incorrect gluten quantitation, improper product labeling, and poor consumer awareness, which results in the inadvertent intake of relatively high amounts of gluten, can be factors that compromise the health of patients with CD.

Keywords: celiac disease; gluten cross-contaminations; dietary adherence; gluten-free diet; vital gluten; oat; hidden gluten



Citation: Wieser, H.; Segura, V.; Ruiz-Carrión, A.; Sousa, C.; Comino, I. Food Safety and Cross-Contamination of Gluten-Free Products: A Narrative Review. *Nutrients* **2021**, *13*, 2244. <https://doi.org/10.3390/nu13072244>

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1. Introduction

The consumption of gluten proteins drives adverse reactions in predisposed individuals who suffer from celiac disease (CD), wheat allergies, non-celiac gluten sensitivity, dermatitis herpetiformis, or gluten ataxia [1–3]. CD is one of the most frequent hypersensitivities, affecting around 1% of the world's population [4]. It is an immune-mediated systemic disorder caused by ingestion of gluten in genetically susceptible individuals and is based on a variable combination of intestinal and extra-intestinal signs and symptoms that are specific to CD antibodies, HLA-DQ2/8 haplotypes, and enteropathy [5,6].

A strict gluten-free diet (GFD) is currently the only safe and efficient therapy for patients with CD [7,8], which implies that all gluten-containing foods and meals, produced from wheat, rye, barley, and some varieties of oats, must be completely excluded from the diet. Nevertheless, such a diet is difficult to follow because of the unintended contamination of "gluten-free" products, improper labeling, social constraints, and ubiquity of gluten proteins in raw or cooked food and pharmaceuticals. Thus, accidental gluten encounters are likely. Most patients with CD can safely tolerate a daily cross-contamination of approximately 10 mg gluten, or 500 g of food containing 20 mg/kg of gluten. However, there is a tremendous degree of variability within this population, and some patients may have worsening histological changes with very low daily gluten exposure [9,10].

Nutrients **2021**, *13*, 2244

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Table 1. Studies on the rate of gluten contamination in natural and certified gluten-free foods, as well as food service products.

Type of Products	Study Country	n	Percentage of Food Containing >20 mg/kg of Gluten	References
Gluten-free-labeled products	Ireland	260	10%	McIntosh et al., 2011 [20]
	Italy, Spain, Germany, and Norway	205	0.5%	Gibert et al., 2013 [21]
	United States	78	21%	Lee et al., 2014 [22]
	Brazil	20	16%	Oliveira et al., 2014 [23]
	United States	275	10%	Sharma et al., 2015 [24]
	Spain	3141	12%	Bustamante et al., 2017 [25]
	Turkey	200	17.5%	Atasoy et al., 2017 [26]
	Italy	56	0%	Bianchi et al., 2018 [27]
	Brazil	180	3%	Farage et al., 2019 [28]
	United States	5624	32%	Lerner et al., 2019 [29]
Naturally gluten-free products	Indian	160	36%	Raju et al., 2020 [30]
	United States	22	32%	Thomson et al., 2010 [31]
	Canada	640	9.5%	Koerner et al., 2013b [32]
	United States	186	19%	Sharma et al., 2015 [24]
	Indian	160	10%	Raju et al., 2020 [30]
Naturally or certified gluten-free products	Lebanon	173	6%	Hassan et al., 2017 [33]
	Italy	200	9%	Verma et al., 2017 [34]
	Brazil	130	22%	Farage et al., 2017 [35]

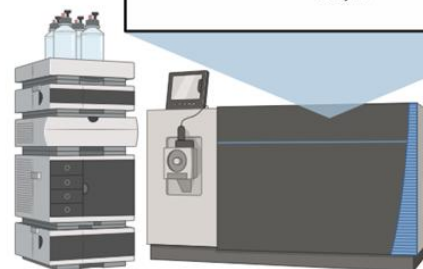


Gluten analysis in food matrices using mass spectrometry

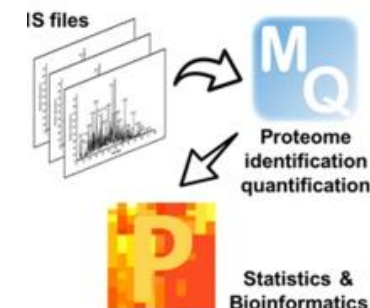
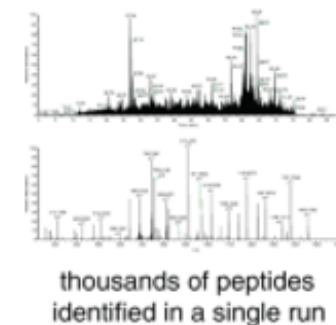
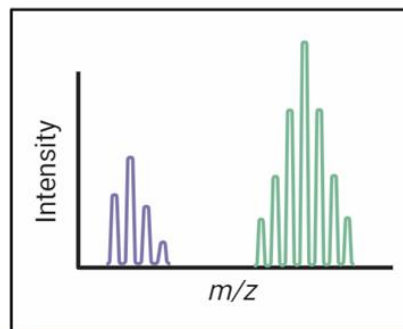


*Food containing /
contaminated by
gluten*

protein extraction and hydrolysis



Mass spectrometry
LC-MS/MS



Mapping of the food
proteome

Search for gluten proteins

Quantitative Analysis of gluten

ELISA vs LC-MS/MS

RESEARCH ARTICLE

Targeted liquid chromatography tandem mass spectrometry to quantitate wheat gluten using well-defined reference proteins

Kathrin Schalk, Peter Koehler, Katharina Anne Scherf*

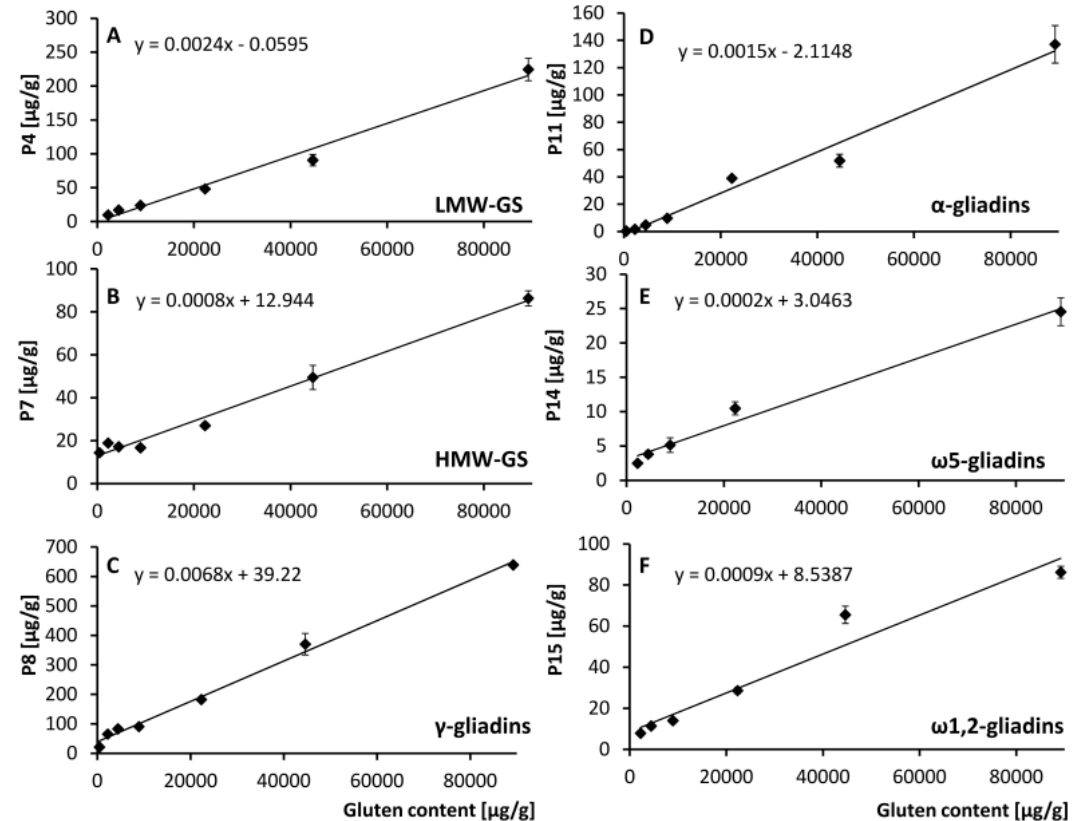
Leibniz-Institute for Food Systems Biology at the Technical University of Munich, Freising, Germany

* k.scherf@leibniz-lsb@tum.de

Abstract

Celiac disease (CD) is an inflammatory disorder of the upper small intestine caused by the ingestion of storage proteins (prolamins and glutelins) from wheat, barley, rye, and, in rare cases, oats. CD patients need to follow a gluten-free diet by consuming gluten-free products with gluten contents of less than 20 mg/kg. Currently, the recommended method for the quantitative determination of gluten is an enzyme-linked immunosorbent assay (ELISA) based on the R5 monoclonal antibody. Because the R5 ELISA mostly detects the prolamin fraction of gluten, a new independent method is required to detect prolamins as well as glutelins. This paper presents the development of a method to quantitate 16 wheat marker peptides derived from all wheat gluten protein types by liquid chromatography tandem mass spectrometry (LC-MS/MS) in the multiple reaction monitoring mode. The quantitation of each marker peptide in the chymotryptic digest of a defined amount of the respective reference wheat protein type resulted in peptide-specific yields. This enabled the conversion of peptide into protein type concentrations. Gluten contents were expressed as sum of all determined protein type concentrations. This new method was applied to quantitate gluten in wheat starches and compared to R5 ELISA and gel-permeation high-performance liquid chromatography with fluorescence detection (GP-HPLC-FLD), which resulted in a strong correlation between LC-MS/MS and the other two methods.

**Strong correlation
between LC-MS/MS
and ELISA methods**



Gluten contents were expressed as sum of all determined protein type concentrations.

Table 6. Gluten contents [μg/g] of wheat starches W4, W6, W8, W11, W13, W14 and W15. Results from different methods, LC-MS/MS, GP-HPLC-FLD and R5 ELISA, were compared.

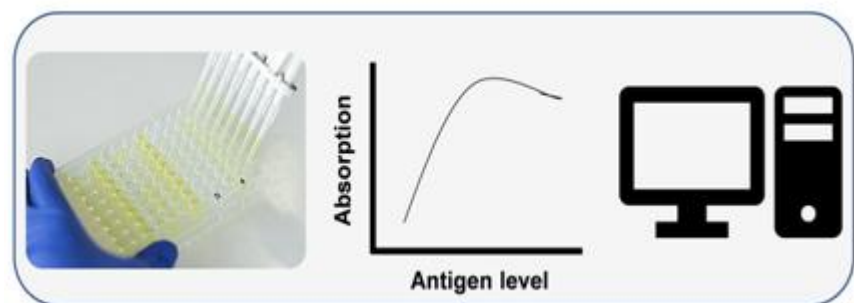
Sample	Method		
	LC-MS/MS ¹	GP-HPLC-FLD ²	R5 ELISA ³
	[μg/g]	[μg/g]	[μg/g]
W4	83.4 ± 0.7 ^A	158.6 ± 3.6 ^B	46.8 ± 2.1 ^C
W6	117.5 ± 2.8 ^A	103.6 ± 2.4 ^B	82.5 ± 0.5 ^C
W8	9114.4 ± 901.0 ^A	10371.8 ± 289.0 ^{AB}	11903.8 ± 1560.8 ^B
W11	433.8 ± 29.1 ^A	442.7 ± 13.7 ^A	424.4 ± 11.2 ^A
W13	2328.4 ± 105.3 ^A	196.0 ± 22.0 ^B	88.4 ± 1.5 ^C
W14	43.5 ± 2.2 ^A	87.2 ± 3.4 ^B	53.6 ± 2.1 ^C
W15	2665.7 ± 206.9 ^A	6543.3 ± 538.4 ^B	7022.0 ± 544.4 ^B

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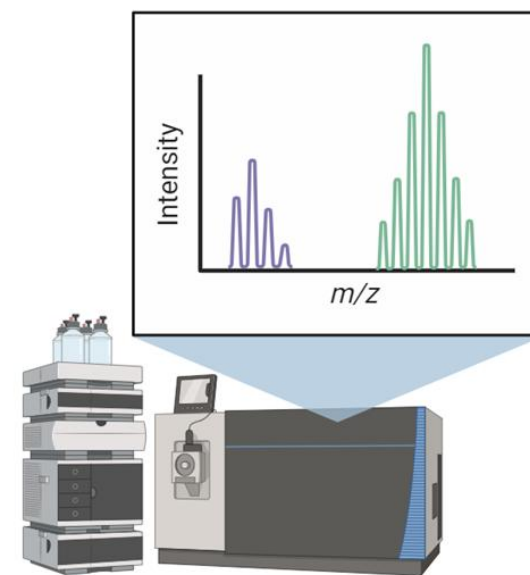
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Sicurezza Alimentare

Metodi alternativi o complementari nella ricerca del glutine negli alimenti?



ELISA

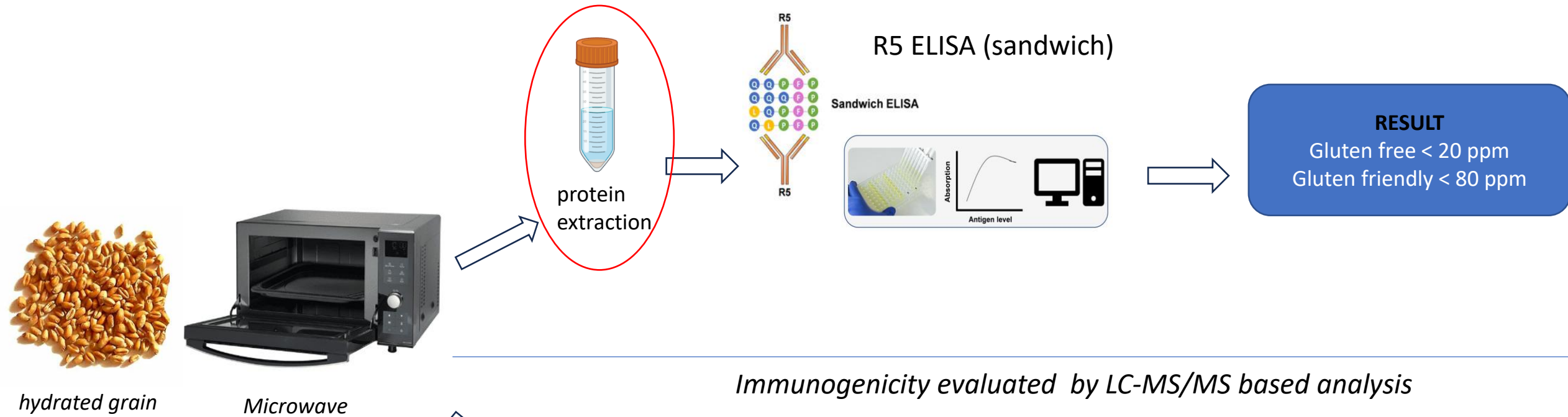


SPETROMETRIA DI MASSA
LC-MS/MS

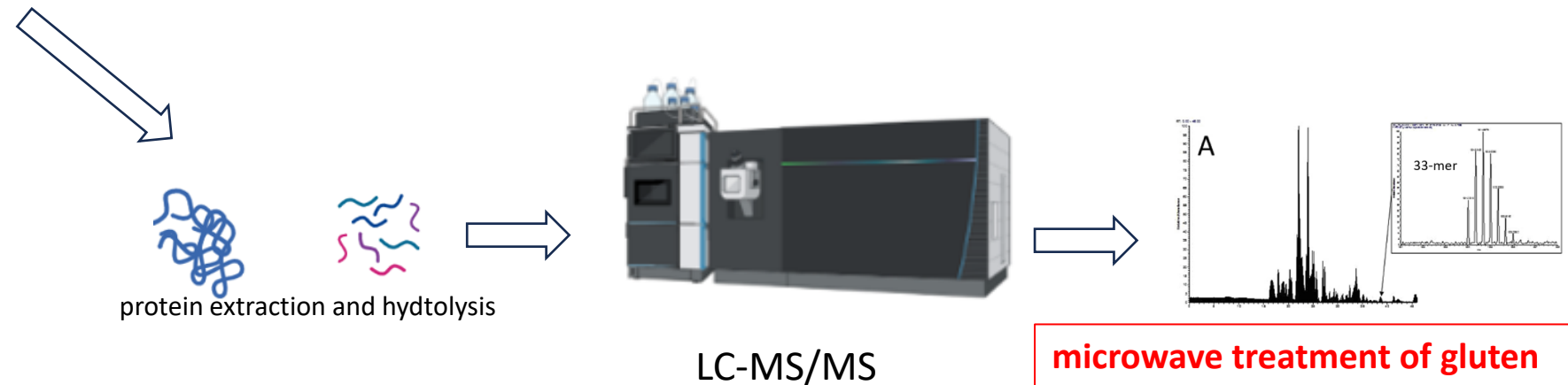
ELISA vs mass spectrometry (LC-MS/MS method):

Physical treatment of wheat using **microwave irradiation** has been proposed to reduce the immunoreactivity of gluten proteins

Immunogenicity assessed by sandwich R5 ELISA



Immunogenicity evaluated by LC-MS/MS based analysis



microwave treatment of gluten proteins cannot decrease its celiac-related toxicity.

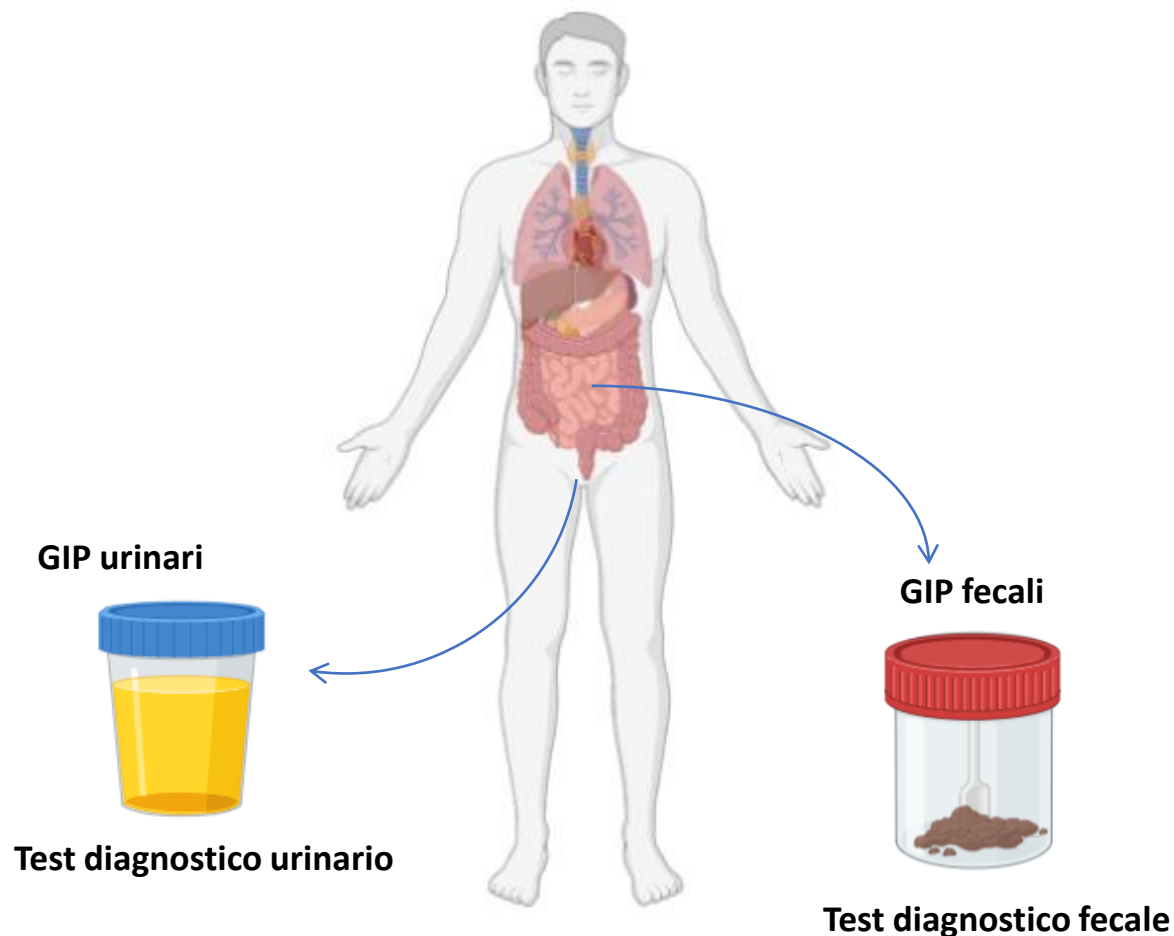
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13° CONVEGNO NAZIONALE AIC

Monitoraggio dell'aderenza alla dieta senza glutine: analisi dei peptidi immunogenici del glutine (GIP)

Ingestione accidentale di alimenti contenenti
glutine



Peptidi immunogenici del glutine (GIP)

I GIP (Gluten Immunogenic Peptides) sono frammenti del glutine che contengono sequenze immunogeniche e possono essere rilevati nelle feci e nelle urine in seguito all'ingestione di alimenti contenenti glutine.

La presenza di GIP nelle urine o nelle feci, indica un recente consumo di alimenti contenenti glutine.

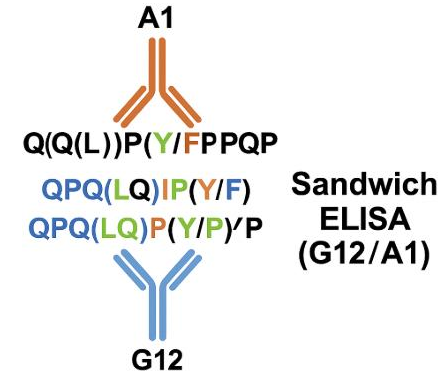
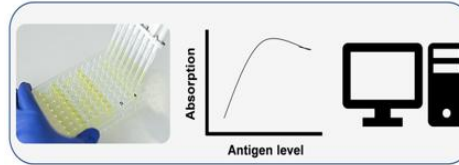
GIP : 33-mer peptide
LQLQFPQPQLPYQPQLPYQPQLPYQPQLPYQPQPF

GIP DETECTION in biological samples

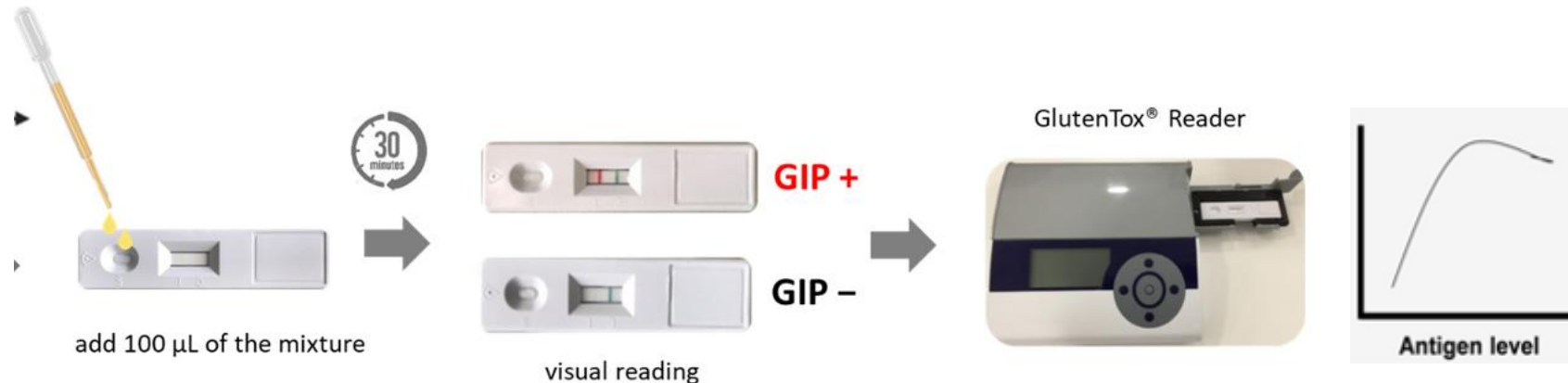
G12 monoclonal antibodies developed against a highly immunotoxic 33-mer peptide **LQLQFPF****QPQLPY****QPQLPY****QPQLPY****PQPQPF**



G12 ELISA: GIP Stool (G12)



Lateral flow immunoassay : G12/A1 Later-flow



Detection of gluten immunogenic peptides in the Urine and stool

Immunochemical methods

Detection of gluten immunogenic peptides in the urine and stool by lateral flow



Article

Stool Gluten Peptide Detection Is Superior to Urinary Analysis, Coeliac Serology, Dietary Adherence Scores and Symptoms in the Detection of Intermittent Gluten Exposure in Coeliac Disease: A Randomised, Placebo-Controlled, Low-Dose Gluten Challenge Study

Amy K. Russell¹, Erin C. Lucas¹, Lee M. Henneken², Catherine J. Pizzey², Dean Clarke³, Anna Myleus⁴ and Jason A. Tye-Din^{1,2,5,6,*}

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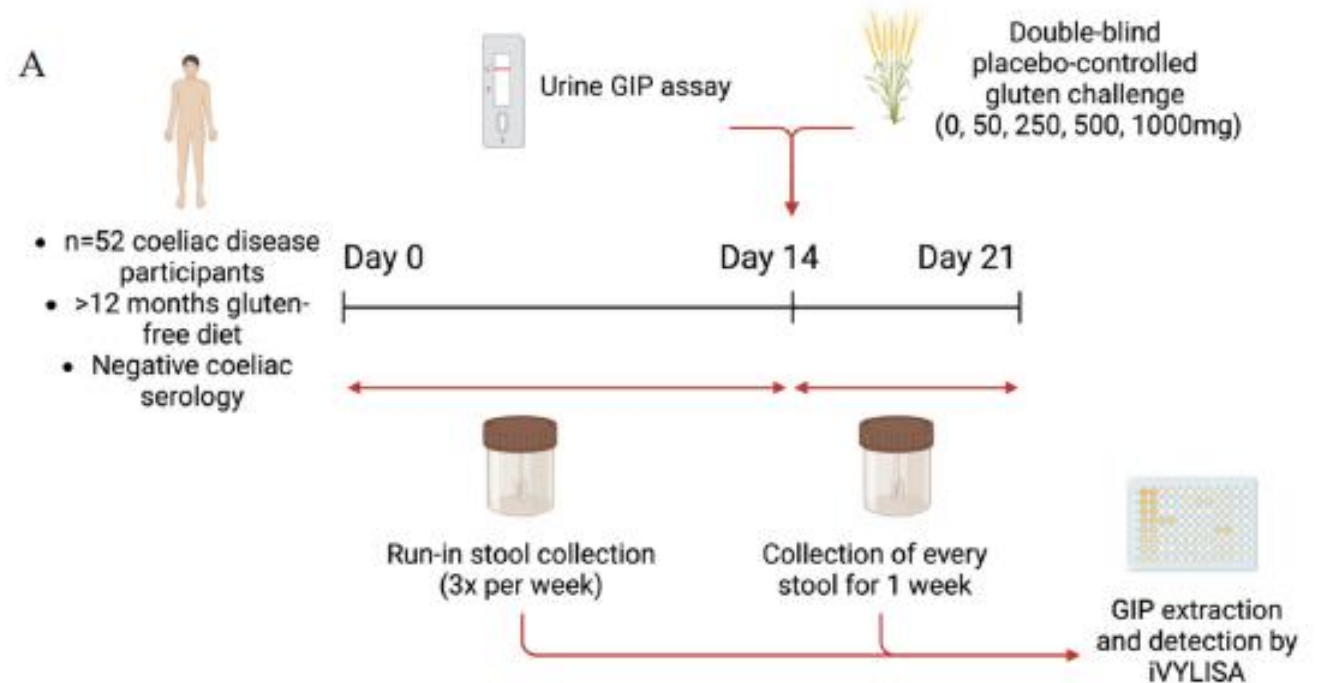
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⁶ The Murdoch Children's Research Institute, Parkville, VIC 3052, Australia

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Abstract: Monitoring adherence to a gluten-free diet is an important goal of coeliac disease management. Urine and stool gluten immunogenic peptide (GIP) assays provide an objective readout of gluten ingestion, with the former favoured due to its convenience and acceptability. This study assessed stool GIP excretion after low-dose gluten challenge designed to mimic accidental gluten exposure. A total of 52 coeliac participants undertook a randomised, double-blind gluten (50–1000 mg) or placebo challenge. Stool and urinary GIP, serology, dietary adherence and symptoms were assessed. Stool GIP was 100% sensitive for gluten intake ≥ 250 mg and 71% for 50 mg. Peak GIP detection was 12–36 h after gluten exposure. The mean stool GIP after 1000 mg gluten ingestion remained above the limit of quantification for 5 days. Urine GIP assessment had poor sensitivity for GIP excretion compared to stool. Serology, dietary adherence score and symptoms did not correlate with gluten excretion during lead-in. We conclude that stool GIP detection is highly sensitive, with levels related to gluten dose and time from ingestion. Weekly or bi-weekly testing will detect low-level exposure more effectively than urine GIP assessments or traditional methods. In this seronegative, apparently well-treated cohort, a high frequency of baseline-positive GIP suggests ongoing gluten exposure, but the assessment of patient behaviour and assay specificity is needed.

Keywords: coeliac disease; gluten immunogenic peptides; gluten excretion stool; gluten-free diet monitoring



12–36 h after gluten exposure. The mean stool GIP after 1000 mg gluten ingestion remained above the limit of quantification for 5 days. Urine GIP assessment had poor sensitivity for GIP excretion compared to stool. Serology, dietary adherence score and symptoms did not correlate with gluten excretion during lead-in. We conclude that stool GIP detection is highly sensitive, with levels related to gluten dose and time from ingestion. Weekly or bi-weekly testing will detect low-level exposure more effectively than urine GIP assessments or traditional methods. In this seronegative, apparently well-treated cohort, a high frequency of baseline-positive GIP suggests ongoing gluten exposure, but the assessment of patient behaviour and assay specificity is needed.

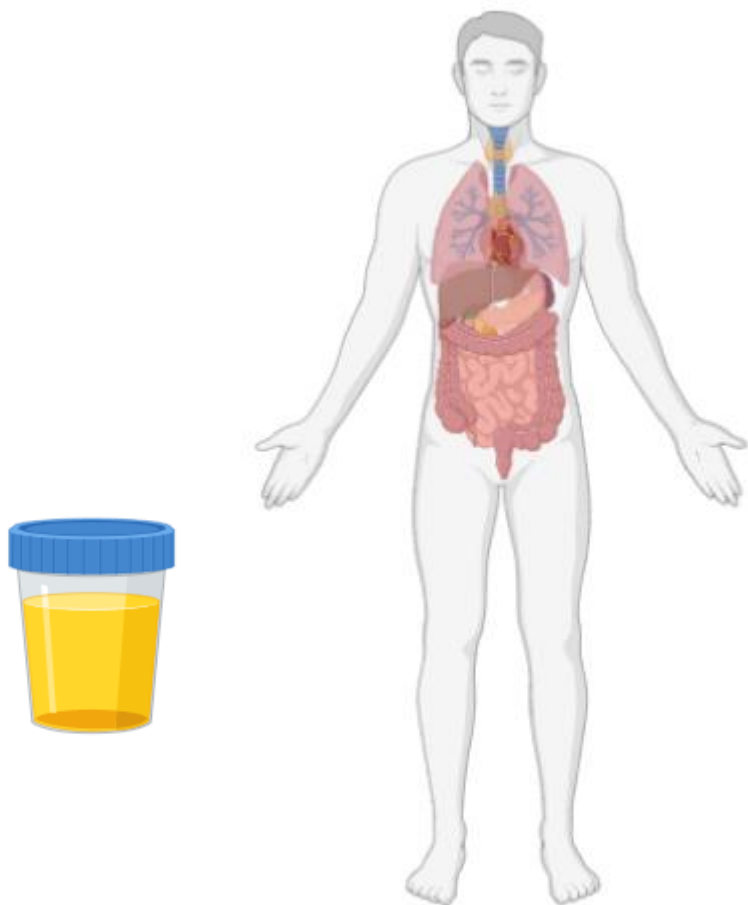


Citation: Russell, A.K.; Lucas, E.C.; Henneken, L.M.; Pizzey, C.J.; Clarke, D.; Myleus, A.; Tye-Din, J.A. Stool Gluten Peptide Detection Is Superior to Urinary Analysis, Coeliac Serology, Dietary Adherence Scores and Symptoms in the Detection of Intermittent Gluten Exposure in Coeliac Disease: A Randomised, Placebo-Controlled, Low-Dose Gluten Challenge Study. *Nutrients* **2024**, *16*, 279. <https://doi.org/10.3390/nu16020279>

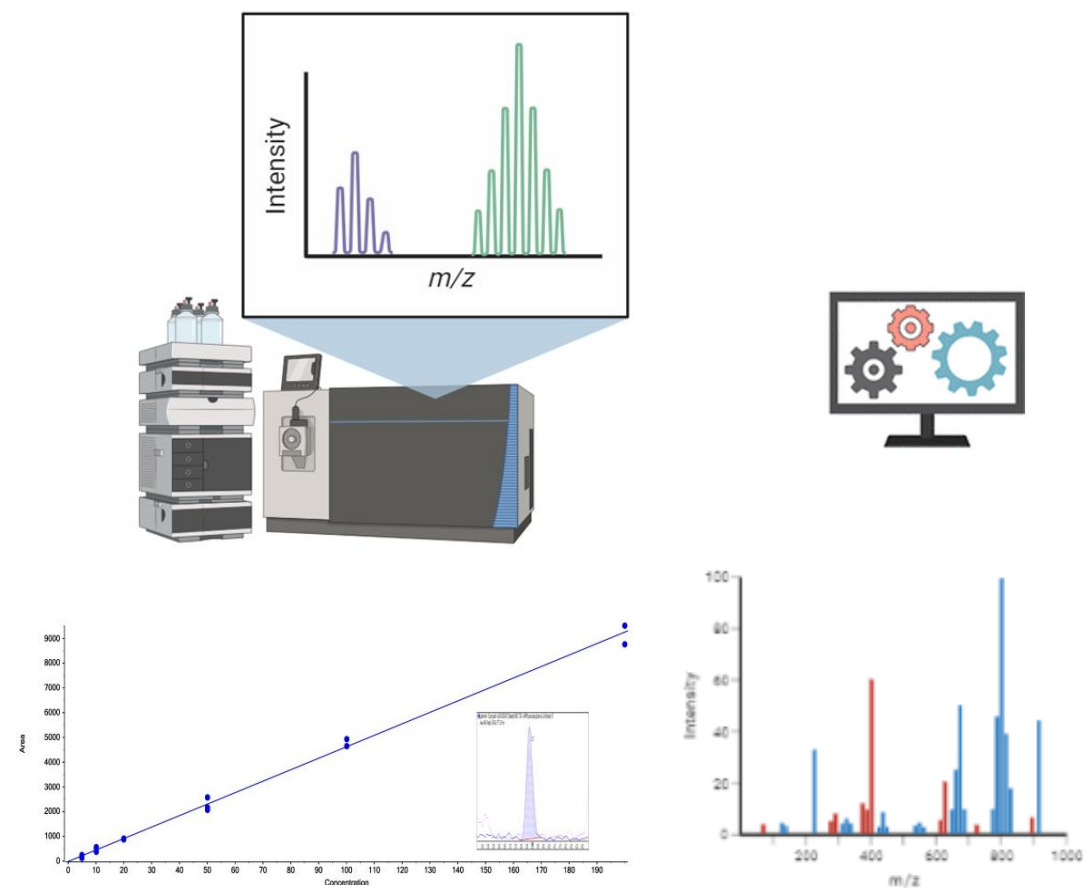
Academic Editor: Marios Hadjiavassiliou

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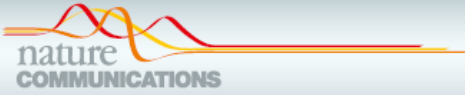
Ingestione accidentale di alimenti contenenti glutine



Analisi dei GIP nelle urine mediante spettrometria di massa



Analysis of Gluten Immunogenic Peptides (GIP) by Mass Spectrometry (LC.MS/MS):



ARTICLE

<https://doi.org/10.1038/s41467-022-28353-1>

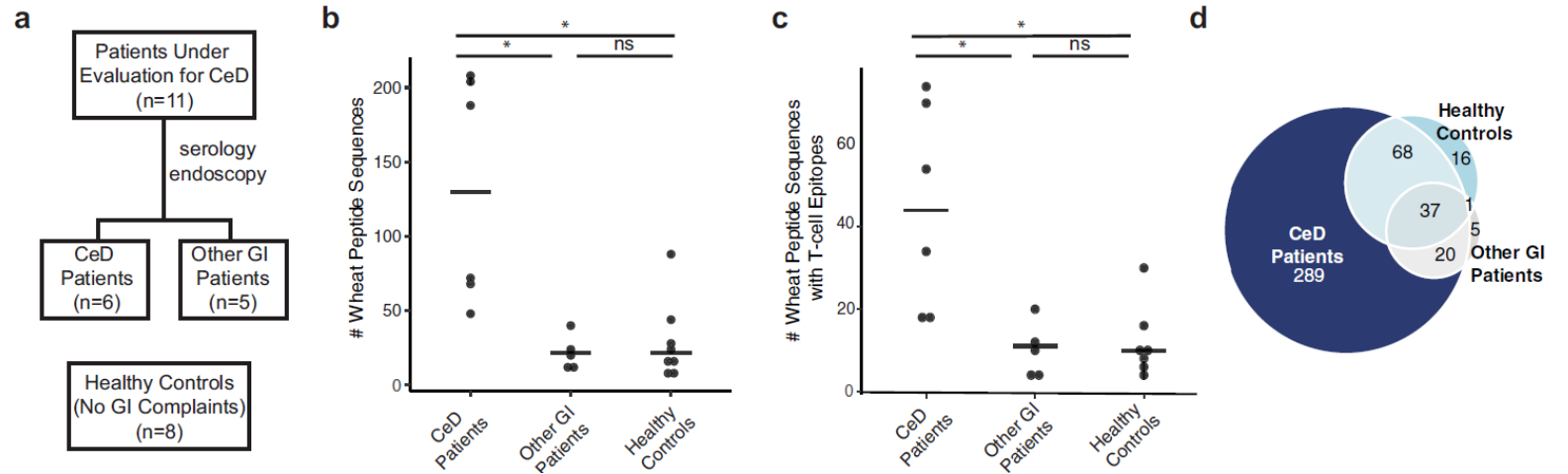
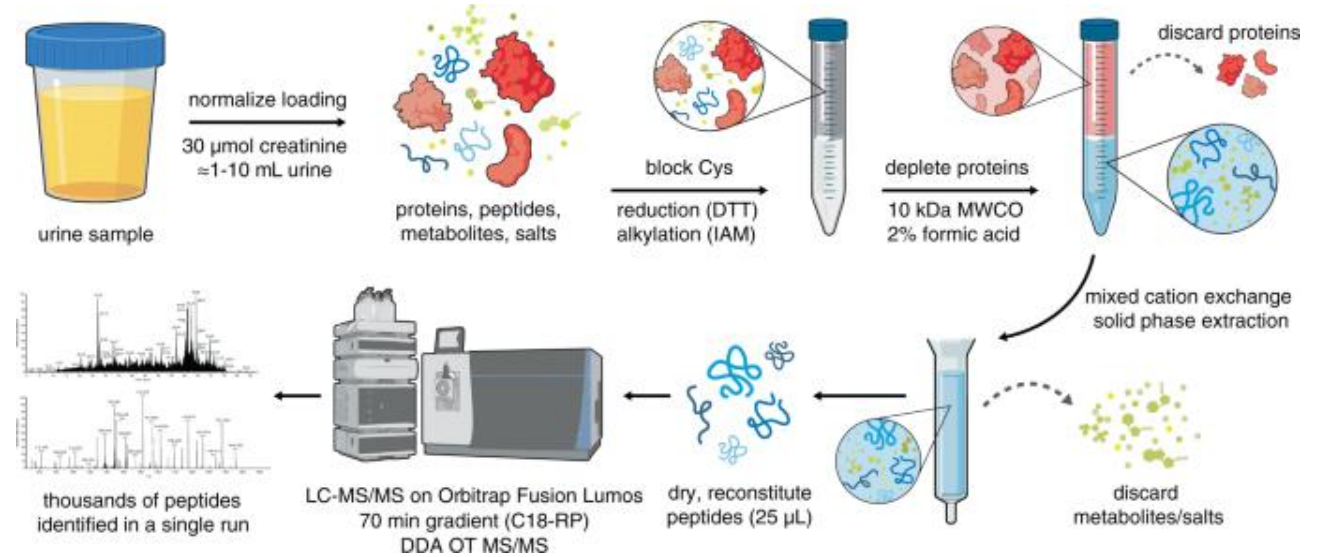
OPEN



An efficient urine peptidomics workflow identifies chemically defined dietary gluten peptides from patients with celiac disease

Brad A. Palanski^{1,13,14}, Nielson Weng^{1,2,3,14}, Lichao Zhang⁴, Andrew J. Hilmer¹, Lalla A. Fal⁵, Kavya Swaminathan⁶, Bana Jabri^{7,8,9}, Carolina Sousa¹⁰, Nielsen Q. Fernandez-Becker¹¹, Chaitan Khosla^{1,5,12,15} & Joshua E. Elias^{4,15}

Celiac disease (CeD) is an autoimmune disorder induced by consuming gluten proteins from wheat, barley, and rye. Glutens resist gastrointestinal proteolysis, resulting in peptides that elicit inflammation in patients with CeD. Despite well-established connections between glutens and CeD, chemically defined, bioavailable peptides produced from dietary proteins have never been identified from humans in an unbiased manner. This is largely attributable to technical challenges, impeding our knowledge of potentially diverse peptide species that encounter the immune system. Here, we develop a liquid chromatographic-mass spectrometric workflow for untargeted sequence analysis of the urinary peptidome. We detect over 600 distinct dietary peptides, of which ~35% have a CeD-relevant T cell epitope and ~5% are known to stimulate innate immune responses. Remarkably, gluten peptides from patients with CeD qualitatively and quantitatively differ from controls. Our results provide a new foundation for understanding gluten immunogenicity, improving CeD management, and characterizing the dietary and urinary peptidomes.

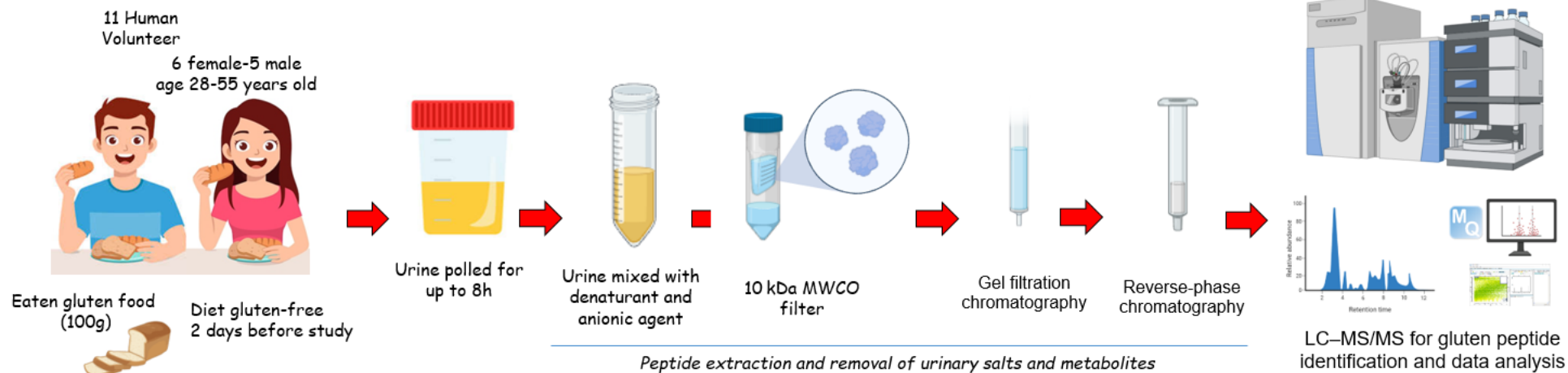


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Analysis of Gluten Immunogenic Peptides (GIP) by Mass Spectrometry (LC-MS/MS):



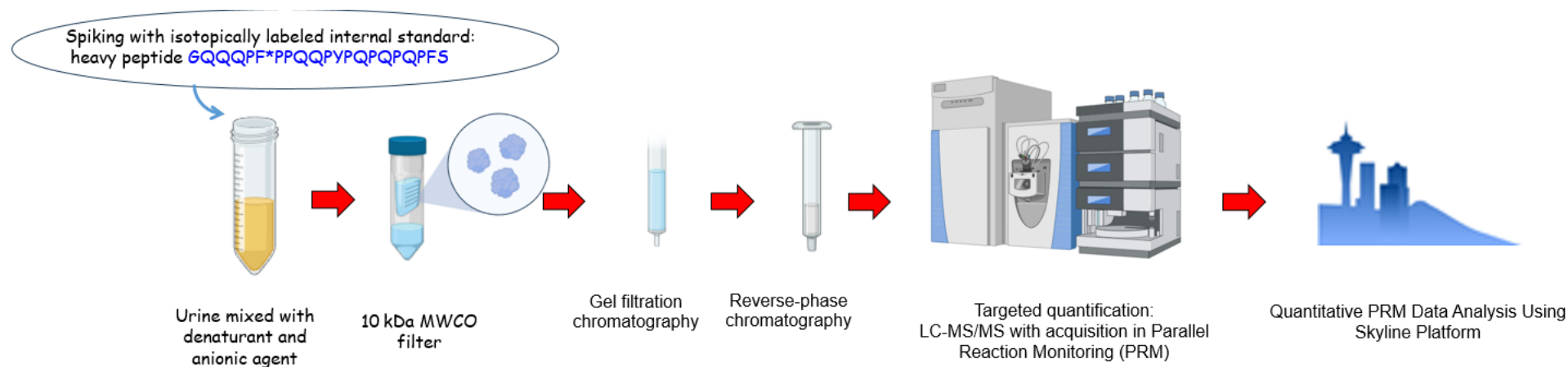
Number of
immunogenic
gluten peptides
detected in the
urine of human
volunteers

	<u>α-gliadin</u> (P04721)	<u>γ-gliadin</u> (R9XUR5)	<u>ω-gliadin</u> (U5U6M9)	<u>HMW-GS</u> (W6AY13)	<u>gliadin</u> (A0A0M4FCD1)
Volunteer_1	2	2		1	
Volunteer_2	2	2			
Volunteer_3	3	3	2		
Volunteer_4	4				
Volunteer_5	5	7	2		
Volunteer_6	1	1			
Volunteer_7	5	2	6	1	
Volunteer_8	2	2		4	1
Volunteer_9	4	2	3		
Volunteer_10	7	5	2	4	
Volunteer_11	3	2		1	

	³² GQQQPFPPQQPYQPQPFPS ⁵¹
Volunteer_1	detected
Volunteer_2	detected
Volunteer_3	detected
Volunteer_4	detected
Volunteer_5	detected
Volunteer_6	detected
Volunteer_7	detected
Volunteer_8	detected
Volunteer_9	detected
Volunteer_10	detected
Volunteer_11	detected



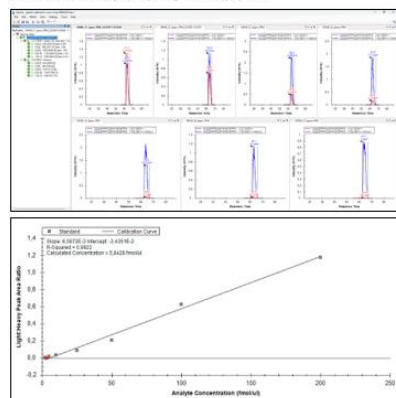
Analysis of Gluten Immunogenic Peptides (GIP) by Mass Spectrometry:



heavy peptide **GQQQPF*PPQQPYQPQPQPF_S** MW= 2292,11
(isotopically labeled F residue)

light peptide **GQQQPFPPQQPYQPQPQPF_S** MW= 2302,12

Calibration curves were constructed by spiking blank urine samples with different concentrations of the synthetic light peptide and a constant amount of the heavy isotopically labeled peptide.



	replicate 1 (fmol/μl)	replicate 2 (fmol/μl)	replicate 3 (fmol/μl)	mean value (fmol/μl)	ng/ml urina
Volunteer 1	17,05	17,65	18,61	17,77	40,73
Volunteer 2	17,6	19,54	18,29	18,48	42,35
Volunteer 3	15,1	19,65	18,25	17,67	40,49
Volunteer 4	32,94	40,45	35,64	36,34	83,30
Volunteer 5	18,15	24,02	21,41	21,19	48,58
Volunteer 6	14,32	15,04	13,94	14,43	33,08
Volunteer 7	25,79	29,78	25,56	27,04	61,98
Volunteer 8	20,53	24,98	21,48	22,33	51,18
Volunteer 9	22,36	22,7	22,67	22,58	51,75
Volunteer 10	38,72	n.d	29,54	34,13	78,23
Volunteer 11	19,3	16,7	n.d	18,00	41,26

CONCLUSIONI

IMMUNOENZIMATICO

- ✓ **Conforme alle normative:** metodo ufficiale (R5 Sandwich) per il controllo degli alimenti senza glutine (es. Codex Alimentarius).
- ✓ **Sistemi ELISA e Lateral Flow** (anticorpo G12) sono utilizzati anche per il monitoraggio dei peptidi immunogenici del glutine (GIP) in campioni biologici (es. urine, feci).
- ✓ **Semplicità e rapidità:** analisi standardizzate e facilmente eseguibili in laboratori di controllo qualità.
- ✓ **Costi relativamente bassi** rispetto alla spettrometria di massa.
- ✗ **Dipendenza dagli anticorpi:** alcuni anticorpi potrebbero non riconoscere tutte le varianti del glutine, causando sottostime o falsi negativi.
- ✗ **Interferenze della matrice alimentare:** sottostima del dato quantitativo in matrici alimentari complesse,
- ✗ **Standard analitico di riferimento** applicabile a tutte le matrici alimentari, fermentate e non fermentate, per garantire risultati comparabili e accurati.

Spettrometria di Massa LC-MS/MS

- ✓ **Elevata specificità:** permette di identificare e quantificare peptidi specifici del glutine, inclusi quelli immunogenici rilevanti per la celiachia.
- ✓ **Ampia applicabilità:** in matrici complesse o fortemente processate.
- ✓ **Utile per la ricerca su frammenti resistenti alla digestione:** campioni biologici e per la ricerca dei peptidi immunogenici, con future applicazioni quantitative.
- ✗ **Maggiore complessità e tempi di analisi più lunghi** alti costi.
- ✗ **Potenzialmente utile per la quantificazione del glutine,** ma necessita di ulteriore validazione e standardizzazione prima del riconoscimento ufficiale
- ✗ **Strumentazione costosa e necessità di personale altamente specializzato.**



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Grazie per l'attenzione



Institute of Food Sciences
Consiglio Nazionale delle Ricerche