

COST Foresight 2030

Food Safety Analytical methods for food safety

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Analytical methods for food safety

Outline

- ❖ Aspects Pertinent to Food Analysis: Trends and Demands
- ❖ Elements of analysis
- ❖ Analytical challenges to ascertain food safety risks
- ❖ MoniQA project: Food industries proximate analysis: HACCP survey
- ❖ Conclusion

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Trends and Demands to Food Analysis

❖ Consumer driven:

✓ Relationship between diet and health

- nutrient content used
- health claim information important

Examples:

♣ low fat foods have been developed to satisfy consumer requirement

- analytical methods determine and characterise fat content, making health claims possible
- fat substitutes produce challenges for accurate fat content measurement

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Trends and Demands to Food Analysis

❖ Food industry driven:

✓ management of quality from raw materials to final product

- **quality control** and **quality assurance** are only a part of a detailed quality management system

✓ analytical methods must be applied

✓ select suppliers of food ingredients

- they perform the analytical tests
- ensure compliance with food company's ingredient specifications

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Trends and Demands to Food Analysis

❖ Product and process development trials:

✓ knowledge of analytical methods used to assess the results is required

❖ Analytical information must be:

✓ obtained

✓ assessed

✓ integrated with other relevant information about the food system to address quality-related problems

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Food Safety Parameters: Elements of Analysis

❖ Analytical methodology:

▶ Method of analysis

▶ Validation of method

❖ Sample preparation:

▶ Homogenization

▶ Clean up

▶ Extraction

▶ Concentration

❖ Instrumental determination (Qualitative and quantitative)

❖ Quality of analytical data

❖ Analysts

✓ All the elements of analysis involve number of complexities and challenges

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Food Safety Parameters: Analytical challenges

Elements of analysis	Complexities	Challenges
Methodology		
❖ Analytical method	<ul style="list-style-type: none"> ❖ Multi residues/ multi element ❖ Complex matrices ❖ Varying matrices ❖ Low MRL values 	❖ Development of analytical methods for analysis of multi residues in complex matrices
❖ Workability of method	<ul style="list-style-type: none"> ❖ Suitable for given range ❖ Reproducible / precision ❖ Accuracy ❖ Specificity/ selectivity ❖ Robustness/ ruggedness ❖ Sensitive 	❖ Availability of validated method for various parameters

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Food Safety Parameters: Analytical challenges

Elements of analysis	Complexities	Challenges
Sample Preparation		
❖ Sampling	<ul style="list-style-type: none"> ❖ Homogeneous/ true sample ❖ Statistical sampling ❖ Quantity of sample for analysis 	❖ Representative sample for complete lot for accurate and precise results
❖ Sample extraction	<ul style="list-style-type: none"> ❖ Chemical nature of analytes ❖ Chemical nature of matrix ❖ Number of co-extractants ❖ Adsorption of analyte on to the matrix substrate 	<ul style="list-style-type: none"> ❖ Percent recoveries/ accuracy ➢ Selection of right solvent ➢ Optimization of extraction technique conditions
❖ Clean Up	<ul style="list-style-type: none"> ❖ Number of co extractants ❖ Interference ❖ Adsorption of analyte onto the matrix substrate 	<ul style="list-style-type: none"> ❖ Appropriate cleanup technique ❖ Adsorbant ❖ Solvent for elution
❖ Sample concentration	<ul style="list-style-type: none"> ❖ Nature of analytes ❖ Selection of technique 	❖ Achieve the desired LOD/ LOQ to meet the MRL values

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Food Safety Parameters: Analytical challenges

Elements of analysis	Complexities	Challenges
Instrumental		
❖ Determination for Qualitative/ Quantitative estimation	<ul style="list-style-type: none"> ❖ Interferences from other components ❖ Noise levels ❖ False negative/ false positive 	<ul style="list-style-type: none"> ❖ Selection of instrumental techniques ❖ Optimization of operational conditions ❖ Interpretation of results ❖ Confirmatory techniques ❖ Availability of reference standards
❖ Instrumentation	<ul style="list-style-type: none"> ❖ User friendly software ❖ Meet desired LOD/ LOQ ❖ Operation of instrument ❖ Cost of instrument ❖ Operational cost ❖ Calibration of equipment 	<ul style="list-style-type: none"> ❖ Availability and choice of right instrument/ instrumental techniques to meet the MRL values

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Food Safety Parameters: Analytical challenges

Elements of analysis	Complexities	Challenges
❖ Quality of analytical data	<ul style="list-style-type: none"> ❖ Heterogeneity of data ❖ Unacceptable large variation ❖ Uncertainty of results 	<ul style="list-style-type: none"> ❖ Ensure reproducibility of results ❖ Inter/Intra-laboratory tests ❖ Proficiency testing
❖ Analyst	<ul style="list-style-type: none"> ❖ Training and knowledge ❖ Experience ❖ Familiarity with problem ❖ Skill, attitude ❖ Motivation ❖ Judgement 	<ul style="list-style-type: none"> ❖ Capability building to ensure reliability and accuracy of analytical data

✓ Several analytical complexities exist at each step of analysis which poses challenges for accurate / precise results

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MoniQA project: Food industries proximate analysis

MoniQA Network of Excellence

Towards harmonisation of analytical methods to monitor and control quality and safety in the food supply chain

...in a nutshell

Scientists from 20 countries collaborate in the MoniQA network to harmonize worldwide food quality and safety monitoring and control strategies

Harmonised food quality and safety control adds value in the food chain and will improve consumer confidence

Socio-economic impact assessment will enhance effectiveness and efficiency of new food quality and safety regulations

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MoniQA Project_HACCP Survey

GOAL: reveal the current situation and the preparedness of the European market to implement modern technologies in food Q&S monitoring

✓ **U.K.:** 73 questionnaires collected of which:

- 58 were from businesses solely based in the United Kingdom
- 6 were from businesses which operated internationally
- 3 were from businesses based in the Republic of Ireland
- 2 from businesses in Spain
- 2 from businesses in the United States of America
- 1 from businesses in the Republic of South Africa
- 1 from businesses in the United Arab Emirates

✓ **Greece:** 41 questionnaires collected from over 200 sent to businesses based in Greece

✓ **Turkey:** 48 questionnaires collected

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MoniQA Project_ HACCP Survey... in Greece

Contaminants routinely analyzed:

Contaminant	Total % (n=41)	SMEs (%) (n=27)	Non SMEs (%) (n=14)
Microbiological	93	93	93
Heavy metals	56	59	50
Foreign bodies	56	52	64
Pesticides	51	59	36
Mycotoxins	37	41	29
GMO	32	37	21
Food contact contaminants	27	30	21

- ❖ In total basis, the most common analyte tested for was **microbiological (93%)** followed by **heavy metals and foreign bodies (56%)** and **pesticides (51%)**. As the choice of analyte does not depend on business size, almost the same ranking applied when SME and non SME businesses were analyzed with slightly different percentages in the tested analytes

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MoniQA Project_ HACCP Survey... in Greece

Ranking by industry sector of top analytes tested for

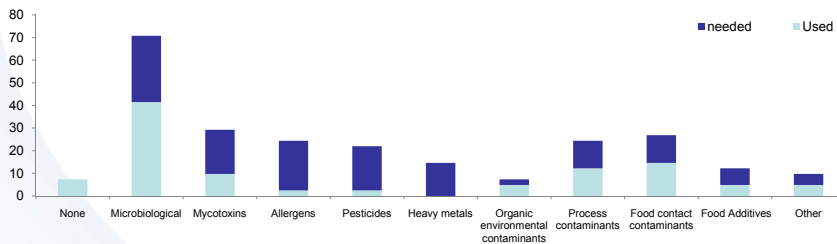
Dairy (%) (n=7)	Meat/Fish (%) (n=4)	Fruit/Vegetables (n=4)	Other (%) (n=5)	Multiple Products (%) (n=12)
Microbiological (100)	Microbiological (100)	Microbiological (100)	Microbiological (100)	Microbiological (100)
Foreign bodies (71)	Foreign bodies (75)	Foreign bodies(100)	Foreign bodies (60)	Foreign bodies (58)
Allergens (71)	Heavy metals (75)	Heavy metals(100)	Mycotoxins (60)	Heavy metals (50)
Heavy metals (57)	Pesticides (75)	Pesticides(100)	Heavy metals (40)	Pesticides (50)
Pesticides (57)	Organic environmental contaminants (75)	Mycotoxins (50)	Food contact contaminants (40)	Food contact contaminants (25)
Mycotoxins (57)		GMO (50)		

... terms of routine laboratory analysis. **Microbiological** ranked high in all sectors followed by foreign bodies detection. Allergens ranked high in dairy companies while in all the other sectors pesticides and heavy metals are usually analyzed

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MoniQA Project_HACCP Survey... in Greece

Current use of rapid test kits on site, efficacy and future needs



- **64%** advised they were **using some form of rapid test kit**, while the remaining 15 performed analyses in external laboratories
- **73% considered** that introduction of **rapid test kits had contributed to improved food-safety** management, (4%) considered that they had not made any improvement while 8% did not know

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MoniQA Project_HACCP Survey... in UK

Contaminants routinely analyzed:

Contaminant	Total (%) (n=73)	SMEs (%) (n=35)	Non SMEs (%) (n=37)
Microbiological	92	94	92
Pesticides	58	60	57
Heavy metals	52	57	49
Mycotoxins	51	51	51
Foreign Bodies	45	49	43
Allergens	41	46	38

- ❖ In total basis, the most common analyte tested for was **microbiological (92%)** followed by **pesticides (58%)**, **heavy metals (52%)**, **mycotoxins (51%)** and **foreign bodies (45%)**. As the choice of analyte does not depend on business size, the same ranking applied when SME and non SME businesses were analyzed with slightly different percentages in the tested analytes. The choice of analyte is more dependent on the type of food processed.

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MoniQA Project_HACCP Survey... in UK

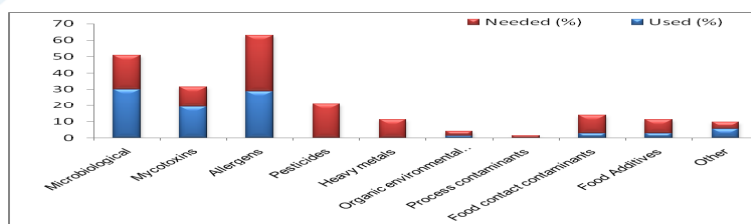
Ranking by industry sector of top analytes tested for

Ingredients (%) (n=13)	Bakery & Breakfast Cereals (%) (n=7)	Meat/Fish(%) (n=10)	Prepared Foods (%) (n=12)	Beverages (%) (n=4)	Multiple Products (%) (n=12)
Microbiological (77)	Microbiological (100)	Microbiological (100)	Microbiological (100)	Pesticides (100)	Microbiological (100)
Mycotoxins (69)	Mycotoxins (100)	Foreign bodies (70)	Pesticides (50)	Mycotoxins (75)	Pesticides (76)
Heavy metals (69)	Heavy metals (71)	Allergens (20)	Allergens (50)	Heavy metals (75)	Mycotoxins (71)
Pesticides (62)	Pesticides (57)	Food contact contaminants(10)	Foreign bodies (42)	Other (75)	Heavy metals (67)
Foreign bodies (54)	Foreign bodies (57)	Non-specified food additives (10)	Illegal food additives (33)	Microbiological (50)	Allergens (48)
	Allergens (57)			Allergens (50)	Illegal food additives (48)
	GMO (57)				

In terms of routine laboratory analysis, the analytes tested for ranked differently within the various sectors. **Microbiological ranked first** in all sectors except beverages companies where pesticides were more often analysed.

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MoniQA Project_HACCP Survey... in UK



- **59% advised to use** some form of **rapid test kit** as part of their food safety management system.
- The two most commonly types of test kits used were for microbiological and food allergen related analytes followed by mycotoxins.
- An assessment of needs ranks first the allergen test kits followed by microbiological and pesticide related analytes.
- Food allergen test kits are the ones that are used the most and at the same time are needed the most.
- Regarding pesticide and heavy metals analysis none of the respondents used rapid test kits, whereas they declared them as needed.

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MoniQA Project_HACCP Survey... in Turkey

Contaminants routinely analyzed:

Contaminant	Total (%) (n=46)	SMEs (%) (n=30)	Non SMEs (%) (n=16)
Microbiological	91	90	94
Pesticides	70	70	69
Heavy metals	65	70	63
Foreign Bodies	54	60	44
Mycotoxins	48	40	63
Food contact contaminants	39	40	19
Allergens	37	40	25

- ❖ In total basis, the most common analyte tested for was **microbiological (91%)** followed by **pesticides (70%)**, **heavy metals (65%)**, **foreign bodies (54%)** and **mycotoxins (48%)**. As the choice of analyte does not depend on business size, the same ranking applied when SME and almost the same when non SME businesses were analyzed with slightly different percentages in the tested analytes.

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MoniQA Project_HACCP Survey... in Turkey

Ranking by industry sector of top analytes tested for

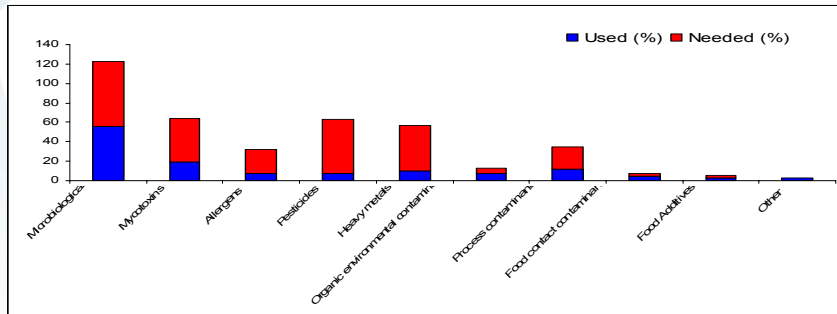
Dairy (%) (n=7)	Fruit/Vegetables (n=12)	Other (%) (n=14)	Multiple Products (%) (n=5)
Microbiological (100)	Pesticides(100)	Foreign bodies (71)	Microbiological (100)
Pesticides (57)	Microbiological (92)	Pesticides (57)	Foreign bodies (80)
Mycotoxins (57)	Heavy metals(83)	Heavy metals (57)	Heavy metals (60)
Food contact contaminants (57)	Foreign Bodies (83)	Microbiological (50)	Process contaminants (60)
Heavy metals (43)	Allergens (33)	Mycotoxins (50)	Mycotoxins (40)
Foreign Bodies (43)	Food contact contaminants (33)	Allergens (50)	Pesticides (40)
Process contaminants (43)		Food contact contaminants (43)	

In terms of routine laboratory analysis, the analytes tested for ranked differently within the various sectors. **Microbiological ranked first in dairy** and multiple products companies, while **pesticides** were the most tested analyte in **fruit/vegetables** companies followed by microbiological.

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MoniQA Project_HACCP Survey... in Turkey

Current use of rapid test kits on site, efficacy and future needs



- 92% of the respondents considered that introduction of rapid test kits had contributed to improved food-safety management while 7% did not know.
- Microbiological test kits are used the most and at the same time needed the most.
- The percentages of needed rapid test kits were higher than the ones used, for all the contaminants.

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MoniQA Project_HACCP Survey... Rapid Test Kits

General Points:

- ✓GMP/HACCP requires that efficacy of food-safety linked activities be verified
- ✓Verification includes measuring both historical compliance and contemporary efficacy to a relevant chemical/biological end-points
- ✓Food industry increasingly operates on 'Just In Time Principles'
Incompatible with laboratory-based verification approaches in terms of time and cost.

Current Applications:

- ✓ATP/protein (sanitation efficiency)
- ✓Microbiology (product safety)
- ✓Allergens (sanitation efficiency/product safety)
- ✓Mycotoxins (regulatory/specification compliance)

Future needs:

- ✓Increased use of rapid test kit data to facilitate commercial decisions
E.g. Acceptance of raw materials; positive release of finished product
- ✓Consequent need for increased reliability
- ✓Greater need for ease-of-use
- ✓Increased range of rapid test kits required (new technologies?)

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Conclusions related to Analytical Methods

- Reliable tools and methods to assess whether the food is safe and of high quality are needed.
- New analytical methods are emerging that offer high throughput and easy handling solutions for industry and control authorities.
- Complementing traditional methods, new rapid methods allow on-site testing of food Q&S → *new cost and efficiency issues and different validation procedures*
- Essential to develop procedures and define requirements for evaluating new methods with respect to reliability and performance

THANK YOU