FOOD ALLERGY AND SAFETY ASSESSMENT WORKSHOP

转基因作物营养成分评价
Compositional assessment of Genetically modified crops

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内容概要 Key content

1.基本原则：转基因作物营养成分分析

General concept: Compositional assessment of GMOs

2.新的挑战：营养改良型作物的营养成分分析

New challenge: Compositional assessment of nutritionally improved crops

3.未来方向：非期望效应检测

Prospect: Detection of unintended effect

1. 基本原则：转基因作物营养成分分析
Section 1. General concept：Compositional assessment of GMOs

- 比较性原则
- 受试物要求
- 主要营养成分分析
- 抗营养因子&天然毒素
- OECD共识文件
- ILSI 作物成分数据库
- 案例分析

- Comparative assessment principle
- Test substance
- Key nutrients
- Anti-nutrient & nature toxin
- OECD consensus document
- ILSI crop composition database
- Case Study

1.1 比较性原则
1.1 Comparative assessment principle

- 与在同等条件下生长和收获的传统对照物比较
  - 近等基因系
  - 安全食用历史
- 观察到的统计差异应参考自然差异范围评估其生物意义

- To be compared with a conventional counterpart grown and harvested under the same conditions.
  - Closest genetic comparator
  - history of safe use
- The statistical significance of any observed differences should be assessed in the context of the range of natural variations to determine its biological significance.
- CAC GL45-2003

1.2 成分分析受试物要求
1.2 Test substance

- 转基因植物可食部位的初级农产品
- 同一种植地点至少三批不同种植时间的样品，或三个不同种植地点的样品

- Primary agricultural products of edible parts
- From at least three batches of different planting time or different sites.

1.3 主要营养成分分析
1.3 Key nutrients

- 主要营养成分
  - 包括水分、灰分、蛋白质、脂肪、碳水化合物、纤维素
- 氨基酸
- 脂肪酸
- 微量营养成分
  - 矿物质
  - 维生素等

- Proximates
  - Moisture, ash, protein, fat, carbohydrate, fibre
- Amino acids
- Fatty acids
- Minor-nutrients
  - minerals
  - vitamins, etc.

1.4 抗营养因子与天然毒素
1.4 Anti-nutrients & Nature toxin

- 抗营养因子
  - 对营养素的吸收和利用有影响、对消化酶有抑制作用的一类物质；
  - 如：植酸、胰蛋白酶抑制剂等

- Anti-Nutrients
  - Substances which influence absorption and utilization of nutrients or inhibit effect of digestive enzymes;
  - e.g. phytic acid, trypsin inhibitor, etc.

1.4 抗营养因子与天然毒素
1.4 Anti-nutrients & Nature toxin

- 天然毒素及有害物质
  - 根据不同植物进行不同的毒素分析
  - 如：棉酚、芥酸、番茄碱等

- Nature toxin and harmful substances
  - various depending on different kinds of plants.
  - e.g. gossypol, erucic acid, tomatidine

1.5 OECD共识文件
1.5 OECD consensus documents

- 2001到2012年，共公布18种作物的成分文件
- 包括甜菜，土豆，玉米，小麦，水稻，棉花，大麦，苜蓿与其他饲料作物，蘑菇，向日葵，番茄，木薯，高粱，甘薯，木瓜，甘蔗，油菜籽，大豆.

- From 2001 to 2012, OECD established 18 kinds of crops compositional consensus documents.
- Including sugar beet, potato, maize, bread wheat, rice, cotton, barley, alfalfa and other temperate forage legumes, mushroom, sunflower, tomato, cassava, grain sorghum, sweet potato, papaya, sugarcane, rapeseed, soybean.

OECD

BETTER POLICIES FOR BETTER LIVES

Unclassified

ENV/JM/MONO(2004)15

Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

17-Aug-2004

English - Or. English

ENVIRONMENT DIRECTORATE
JOINT MEETING OF THE CHEMICALS COMMITTEE AND
THE WORKING PARTY ON CHEMICALS, PESTICIDES AND BIOTECHNOLOGY

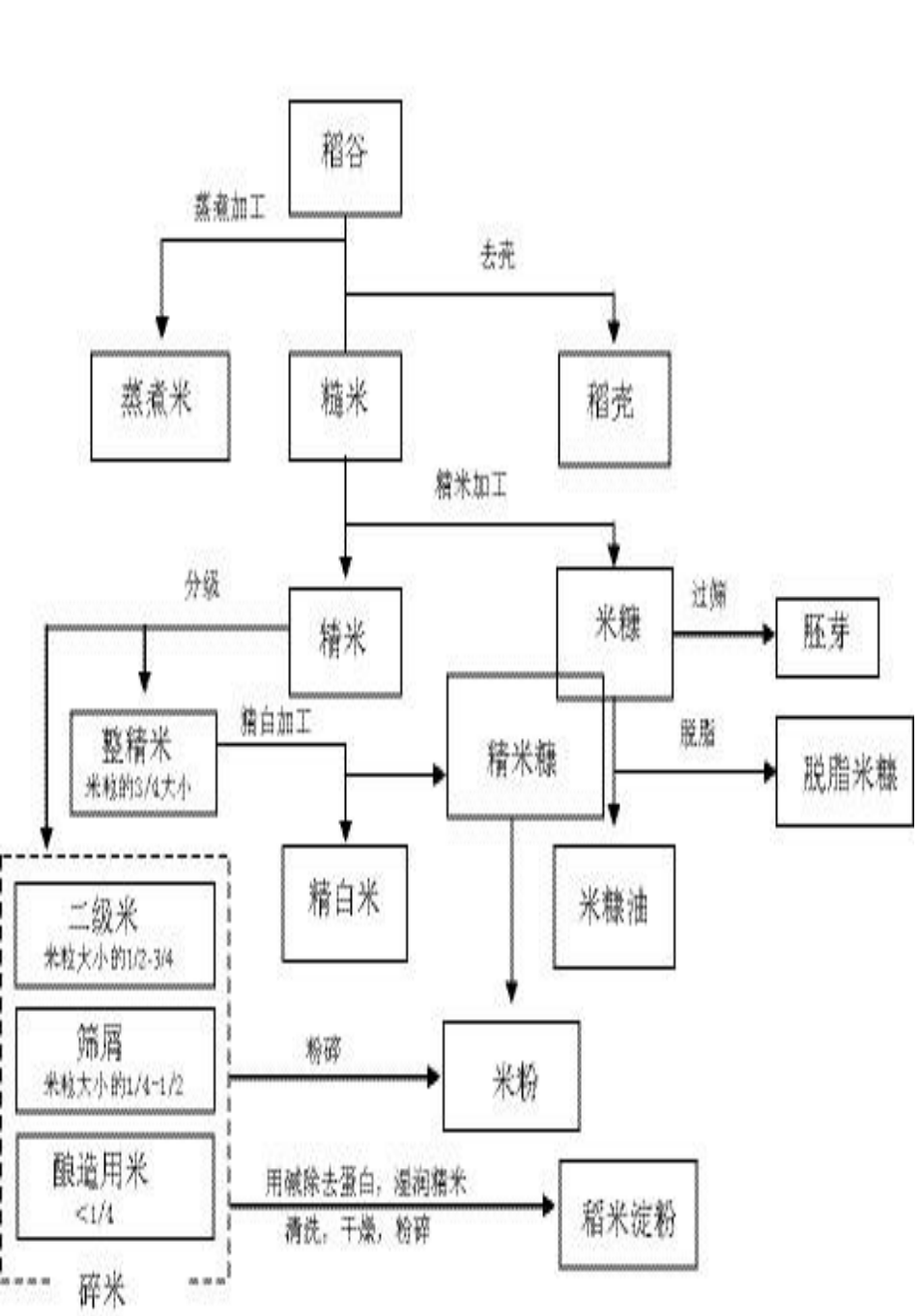
Series on the Safety of Novel Foods and Feeds, No. 10

CONSENSUS DOCUMENT ON COMPOSITIONAL CONSIDERATIONS FOR NEW VARIETIES OF RICE (Oryza sativa): KEY FOOD AND FEED NUTRIENTS AND ANTI-NUTRIENTS

JT00168114

ENV/JM/MONO(2004)15
Unclassified

English - Or. English



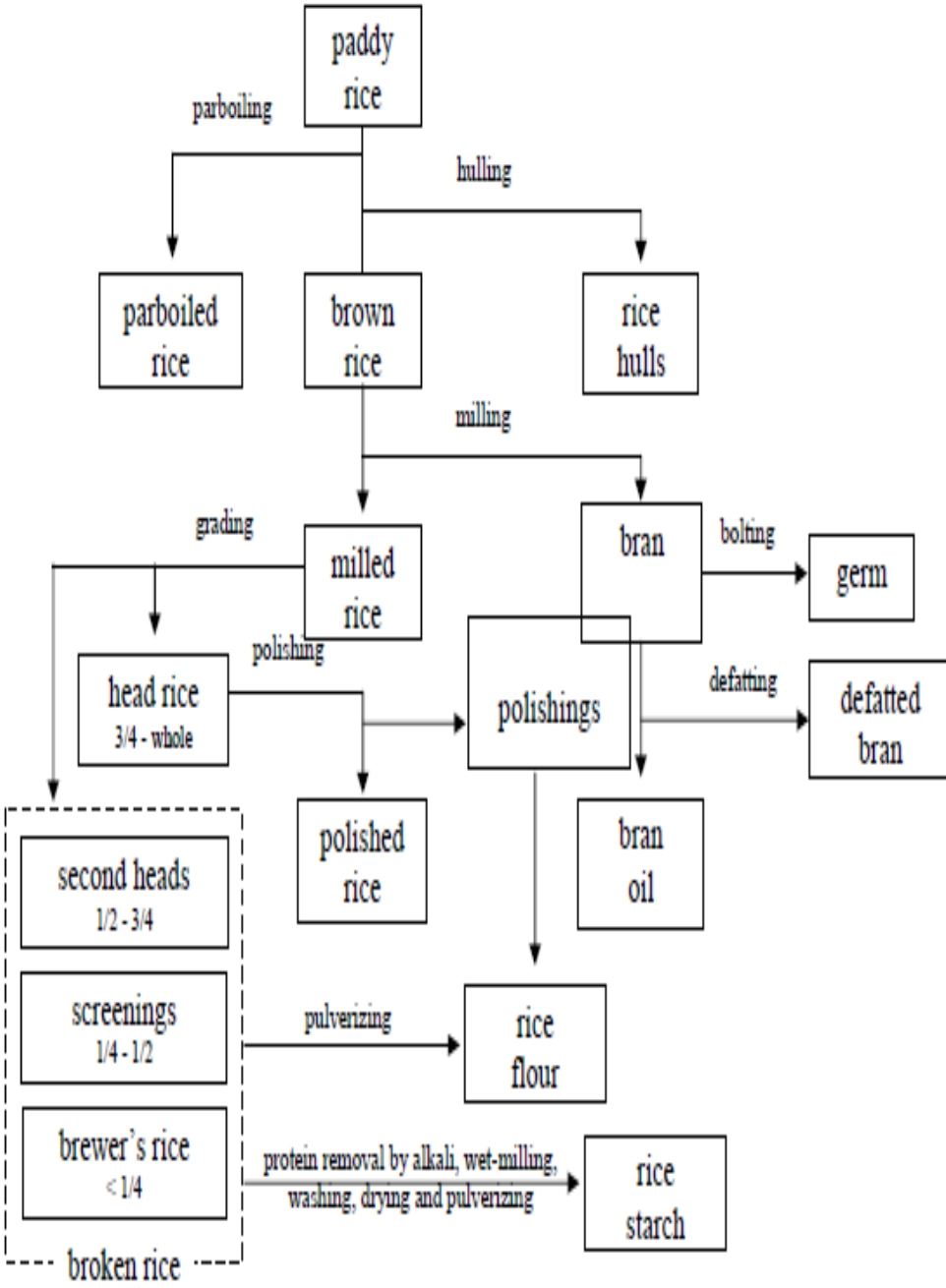


Figure 1 Rice Processing and the Resulting Products

	食用			饲用	
检测指标	麸油	米粉	稻谷	稻草	植株
总营养素		√	√	√	√
矿物质			√		
维生素			√		
氨基酸		√	√		
脂肪酸	√	√	√		
植酸磷			√		
直链淀粉		√	√		
钙			√	√	√
磷			√	√	√

	Food			Feed	
Parameter	Bran oil	Rice flour	Paddy rice	Straw	Whole plant
Proximate		√	√	√	√
Minerals			√		
Vitamins			√		
Amino Acids		√	√		
Fatty Acids	√	√	√		
Phytic Phosphorus			√		
Amylose		√	√		
Calcium			√	√	√
Phosphorus			√	√	√

1.6 ILSI 谷物成分数据库
1.6 ILSI crop composition database

- ILSI谷物成分数据库: 玉米、棉花、大豆
- ILSI crop composition database: maize, cotton, soybean

http://www.cropcomposition.org

Search Crop Composition Database v4.2

Primary Search Criteria

The first step in searching the Crop Composition Database is to select your primary search criteria to filter the data sets.

You must select one Crop Type and one Tissue Type. You can further filter your results by optionally choosing one or more Crop Years, and Locations.

If you make no selections other than Crop Type and Tissue Type, all data sets for the chosen Crop-Tissue selection will be included.

Crop Source / Crop Type / Tissue Type

Help

Crop Type: Corn - Field - Maize - Zea mays

Tissue Type: Choose One

Crop Year

Help

Crop Year(s):

- All Years
- 2005
- 2004
- 2003
- 2002

Location

Help

Country(s):

- All Countries
- ARGENTINA
- AUSTRALIA
- BRAZIL
- BULGARIA

Region(s):

- All Regions

Analyte Filters (Optional)

View Summary of Search Results >

BY SUBMITTING SEARCH, YOU AGREE TO THE TERMS OF USE

Search Crop Composition Database v4.2

Query Summary

The Query Summary shows the criteria that was used to filter the result set.

Query Criteria

Help

Crop Type:	Corn - Field - Maize - Zea mays
Tissue Type:	Grain

Summary of Search Results

The Summary of Search Results shows the results of your initial search grouped by the Analyte Types for the Data Sets that were found.

You can expand each Analyte Type to see the total number of samples and the number of samples with data below LOQ (denoted as X < LOQ) reported for each analyte. Expanding an Analyte Type also reports the minimium, maximum, and mean values for the samples in the primary unit of measure; these minimum, maximum, and mean values derive from data that is above LOQ for that analyte.

All analytes in the database have been assigned a primary unit of measure, which is shown in the right column of the new Summary of Search Results tool. If secondary units of measure (or multiple units of measure for a single analyte) are preferred, Version 4.0 of the ILSI-CCDB requires that data with secondary units of measure be

Results matching your query criteria

Help

Analyte Type	Analyte	Samples	Min	Max	Mean	Units
☐ Amino Acids	-	-	-	-	-	-
☐ Bio Actives	-	-	-	-	-	-
☐ Carbohydrates	-	-	-	-	-	-
☐ Fatty Acids	-	-	-	-	-	-
☐ Fiber	-	-	-	-	-	-
☐ Minerals	-	-	-	-	-	-
☐ Other Metabolites	-	-	-	-	-	-
☑ Proximates	-	-	-	-	-	-
	Ash	1357(0<LOQ)	0.549	5.340	1.279	% FW
	Carbohydrate By Calculation	1357(0<LOQ)	49.6	83.0	75.2	% FW
	Crude Protein	1381(0<LOQ)	5.67	15.50	9.12	% FW
	Moisture	1381(0<LOQ)	6.1	40.5	11.3	% FW
	Total Fat	1381(0<LOQ)	1.470	5.340	3.213	% FW
☐ Vitamins	-	-	-	-	-	-

Search Crop Composition Database v4.2

Report Output

Output Format: HTML Go

Summary Report

Query Criteria:
Crop Type is Corn - Field - Maize - Zea mays
Tissue Type is Grain

Analyte Type	Analyte	Minimum Value	Maximum Value	Mean Value	Unit of Measure
Proximates	Ash	0.549	5.340	1.279	% FW
Proximates	Carbohydrate By Calculation	49.6	83.0	75.2	% FW
Proximates	Crude Protein	5.67	15.50	9.12	% FW
Proximates	Moisture	6.1	40.5	11.3	% FW
Proximates	Total Fat	1.470	5.340	3.213	% FW

< Revise Report Options | New Query

案例：抗除草剂大米营养成分分析

Case study: Compositional analysis of herbicide-tolerance rice

	Brown Rice			Milled Rice		
	D68	Bar68-1	OECD reference range	D68	Bar68-1	OECD reference range
Moisture	12.3 ± 0.3	12.4 ± 0.3	14	11.2 ± 0.6	11.6 ± 0.4	14
Protein	8.69 ± 0.29	9.08 ± 0.24	7.1-8.3	8.21 ± 0.20	8.73 ± 0.29	6.3-7.1
Lipid	2.42 ± 0.06	2.64 ± 0.05	1.6-2.8	0.58 ± 0.03	0.62 ± 0.03	0.3-0.5
Ash	1.37 ± 0.03	1.22 ± 0.04	1.0-1.5	0.94 ± 0.03	0.84 ± 0.04	0.3-0.8
Fiber	0.79 ± 0.05	0.77 ± 0.03	0.6-1.0	0.39 ± 0.02	0.39 ± 0.01	0.2-0.5
Carbohydrates	87.5 ± 0.2	87.1 ± 0.2	87.4-90.3	90.3 ± 0.2	89.8 ± 0.3	91.1-92.9

Li Xin et al. J Food Comps and Anal， 2008，21 ， 535– 539

2. 新的挑战：营养改良型转基因作物
Section 2: New challenge: Compositional assessment of nutritionally improved GM crops

- 提出挑战
- 评估考虑
- 案例分析

- New challenge
- Assessment consideration
- Case study

2.1提出挑战
2.1 New challenge

- 营养改良型转基因作物
  - 以改善营养成分为目的
- 对实质等同性原则的挑战
  - 营养成分发生明显变化
  - 对照物的选择
  - 参考范围
  - 次生代谢产物

- Nutritionally improved GM crops:
  - For the purpose of improved nutritional composition
- Challenge to the substantial equivalence concept:
  - Composition changed significantly
  - Choose of comparator
  - Reference range
  - Secondary metabolite

2.2 评估考虑
2.2 Assessment consideration

- 直接作为传统作物的替代物时
  - 采用近等基因系
- 成分改变较大，同类作物无合适的比较物时
  - 来自其他食物的成分

- The modified crop is used as a direct replacement of the comparator.
- Use the closest genetically related or near isogenic variety
- The nutrient composition is altered to an extent that no suitable comparator can be identified within the same crop
- A specific food component derived from another food

2.3 案例分析：转Sb401基因高赖氨酸玉米
2.3 Case study: Lysine-rich maize with sb401 gene

- 对照物的选择
  - –在中国广泛种植的优质蛋白玉米农大108
  - –优质蛋白玉米*o2*
- 参考范围
  - –ILSI谷物成分数据库

- Choose of comparator
  - –Conventional quality protein maize (QPM) Nongda 108, which has been cultivated widely in China
- Reference range
  - –ILSI crop composition database

2.3 案例分析：转Sb401基因高赖氨酸玉米
2.3 Case study: Lysine-rich maize with sb401 gene

Nutrients	Inbred 642	Hybrid Y642	Nongda 108	ILSI Reference range
Moisture	94.7±1	104±1	102±1	104-162
Protein	122.6±0.0*	107.8±0.2*	90.6±0.6	61.5-172.6
Fiber	6.6±0.0	6.7±0.0	5.6±0.0	4.9-32.6
Fat	56.2±0.0*	53.3±0.9	49.3±0.2	24.7-59
Ash	15.2±0.1*	13.6±0.1	13.8±0.1	6.16-62.82
Carbohydrate	703.1±0.3*	714.6±2.5	737.1±0.3	774-895

Tang M. et al. J Sci Food Agr, 2013, 93(5), 1049-1054

2.3 案例分析：转Sb401基因高赖氨酸玉米
2.3 Case study: Lysine-rich maize with sb401 gene

Amino acids score*	642	Y642	Nongda108
Lysine	0.76	0.70	0.61
Leucine	1.18	1.39	1.36
Valine	1.26	1.24	1.25
Isoleucine	1.35	1.34	1.27
Histidine	1.78	1.84	1.96
Methionine + Cystine	2.08	2.33	2.51
Threonine	3.57	3.44	3.39
Phenylalanine + Tyrosine	3.67	3.52	3.60

***WHO technical report 935**

3. 未来发展：非期望效应检测
Section 3： Detection of unintended effect

- 非期望效应概念
- 非期望效应检测方法
  - 定向方法
  - 非定向方法
- 案例分析
- 展望

- Definition
- Detection methods
  - Targeted approaches
  - Non-targeted approaches
- Case Study
- Prospect

3.1 非期望效应定义
3.1 Definition of unintended effect

- 在考虑目的基因插入产生的可预料效应的情况下
- 转基因生物与非转基因亲本之间在表型、代谢反应和物质组成上产生的生物学意义上的显著性差异。

- When taking the expected effect of the insertion of target gene into account,
- Biologically significant differences in the phenotype, metabolic response or composition of the GMOs compared with the parent

3.2 非期望效应检测方法
3.2 Detection of unintended effect

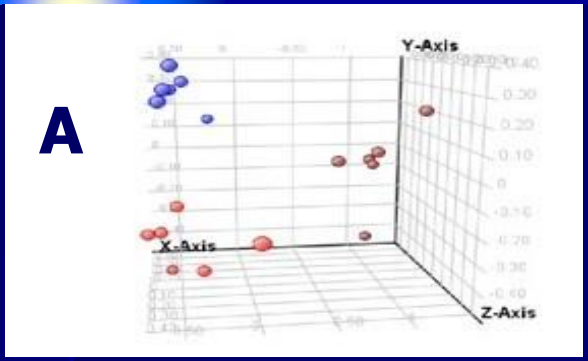
- 定向方法
  - 营养成分
  - 抗营养因子
  - 天然毒性物质

- Targeted approaches
  - Nutrients
  - Anti-nutrients
  - Natural toxins

3.2 非期望效应检测方法
3.2 Detection of unintended effect

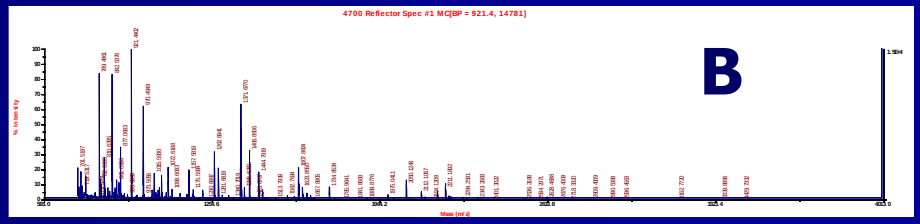
- 非定向方法
  - 功能基因组学
  - 蛋白质组学
  - 代谢组学
- Non-targeted approaches
  - Functional Genomics
  - Proteomics
  - Metabonomics

3.3 案例分析
3.3 Case study



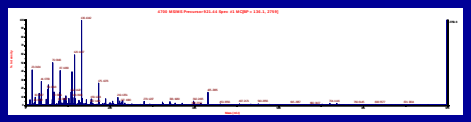
A：转Cry1C或Cry2A基因水稻与其亲本的代谢物比较

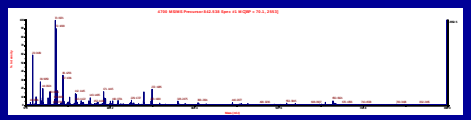
A：Metabolites of rice with Cry1C or Cry2A gene compared with the isogenic line



B：差异点主要为谷蛋白，淀粉合成酶等

B: The difference was glutelin, Starch synthase, etc.





4. 展望
4. Prospect

- 定向方法在目标成分检测中仍将发挥重要作用
- 组学技术可用于复杂代谢途径及互联性检测
- 或定向检测某种成分或代谢物

- Targeted approaches are recommended for the detection of alterations of targeted composition.
- Profiling techniques might be applied to characterize complex metabolic pathways and their interconnectivities.
- Profiling techniques can also be used in a targeted fashion to generate information on specific nutrients or other metabolites.

4. 展望
4. Prospect

- 需要收集组学的基础数据
- 建立公认的组学检测方法

- However, before using profiling methods, baseline data need to be collected.
- The methods must be validated and harmonized globally.


THANKS