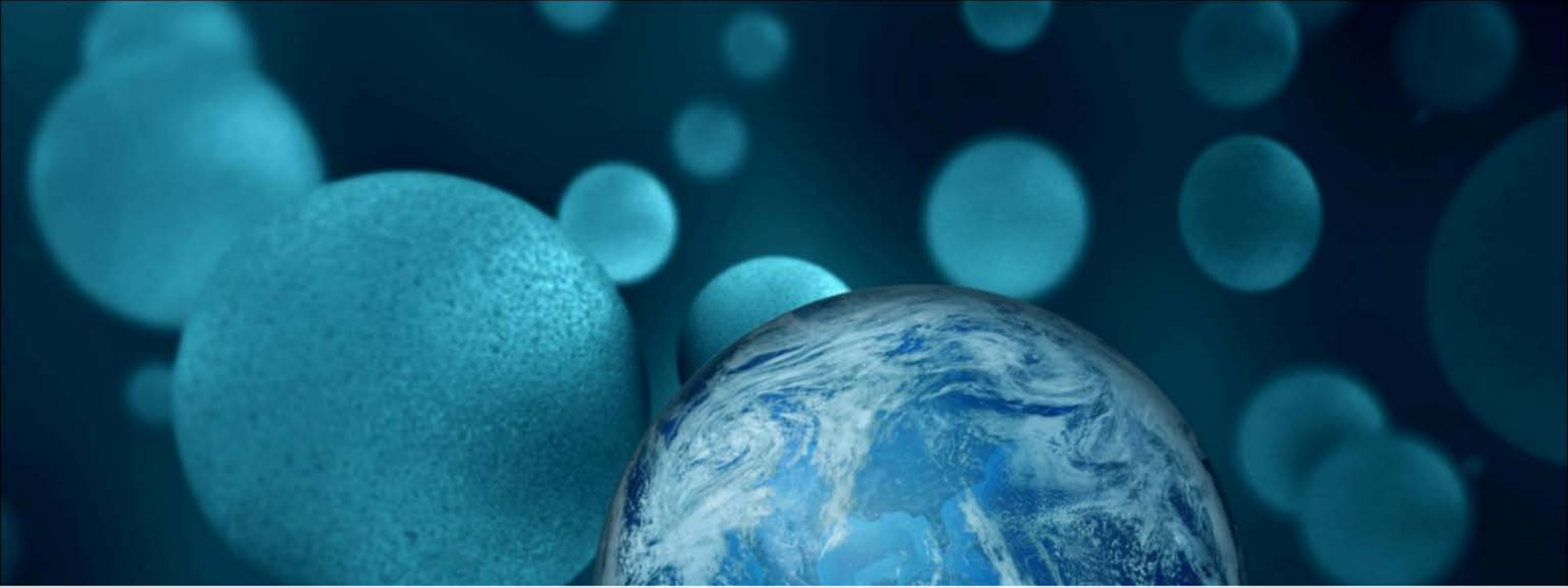

ThermoFisher SCIENTIFIC

Organic Elemental Analyzer for Food Analysis

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Mass Spectrometry (Senior Manager, SEA)

Food Applications

- Cereals, beans and seeds
- Milk and dairy products
- Meat and meat products
- Animal feed
- Beverages
- Beer (wort, malt and barley)
- Food supplements

FLASH 2000 N/Protein Users

Cargill
Barilla
Nestlé
Unilever
nutella FERRERO
ALcontrol Laboratories
parmalat
Coca-Cola
Plasmon
KERRY INGREDIENTS
Nutricia

Animal Feed

Cargill, international colossus leader in animal feed field,
has chosen Thermo Scientific FLASH instruments:
more than 15 instruments for N/Protein determination.
The Flash N/Protein becomes therefore, for Thermo Scientific,
an international reference in order to evaluate the protein content.

Organic Elemental Analysis (OEA): Determination of Carbon, Hydrogen, Nitrogen, Sulfur and Oxygen in **every** type of materials (organic and inorganic).

Quantification of the sample	**Weighing**
Quantitative oxidation of the sample	**Combustion**
Reduction of combustion gases	**Reduction**
Separation of the oxidation gases	**Chromatography**
Generation of signal	**Detection**

Micro Elemental Analysis:
Simultaneous analysis of CHNS/ with small sample weights (low mg)

Macro Elemental Analysis:
Analysis of NC and N with large sample weights (high mg)

Fully Automatic Technology
Based on Dumas Method

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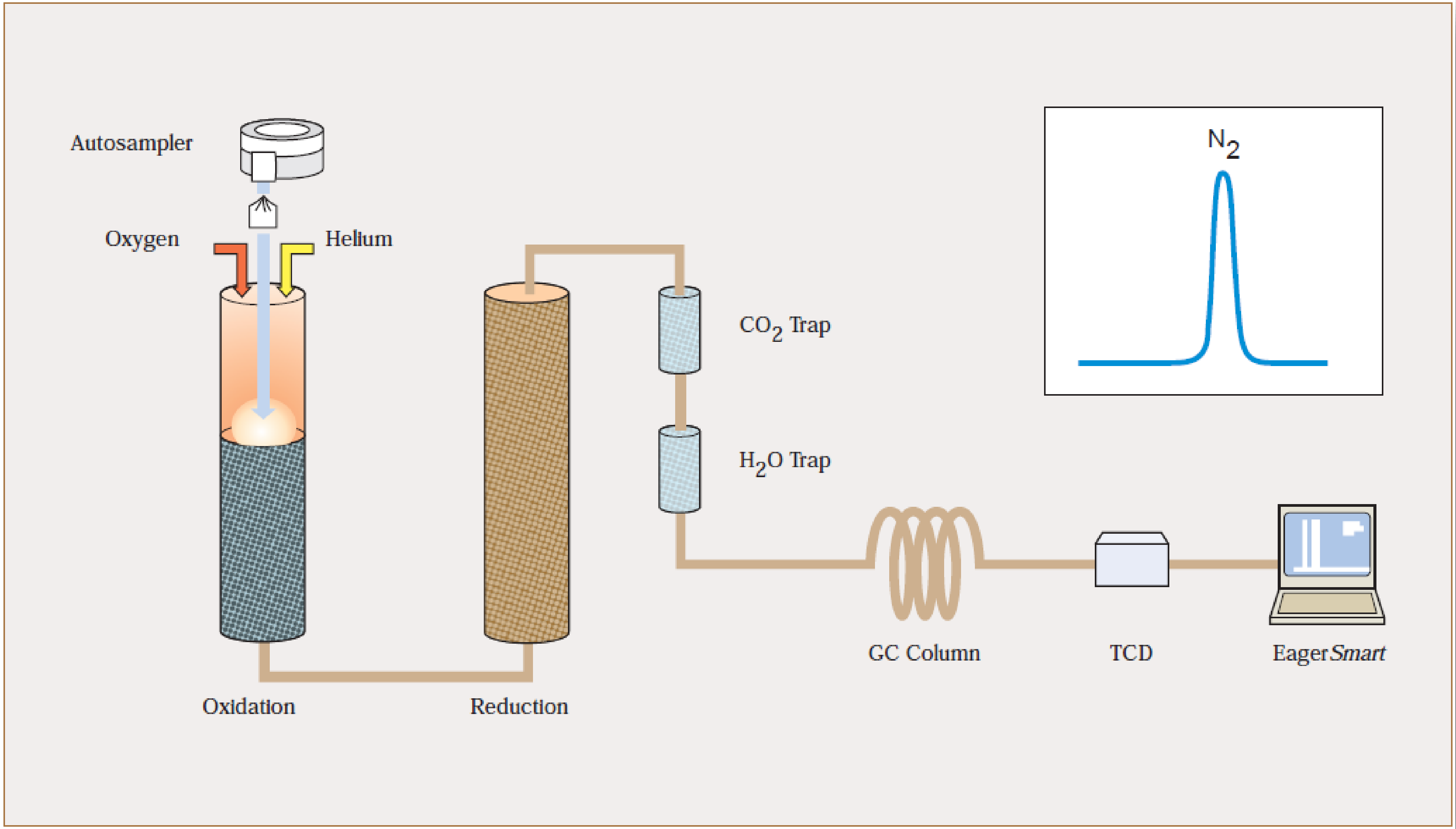
FLASH 2000 Analyzer – Nitrogen / Protein Configuration

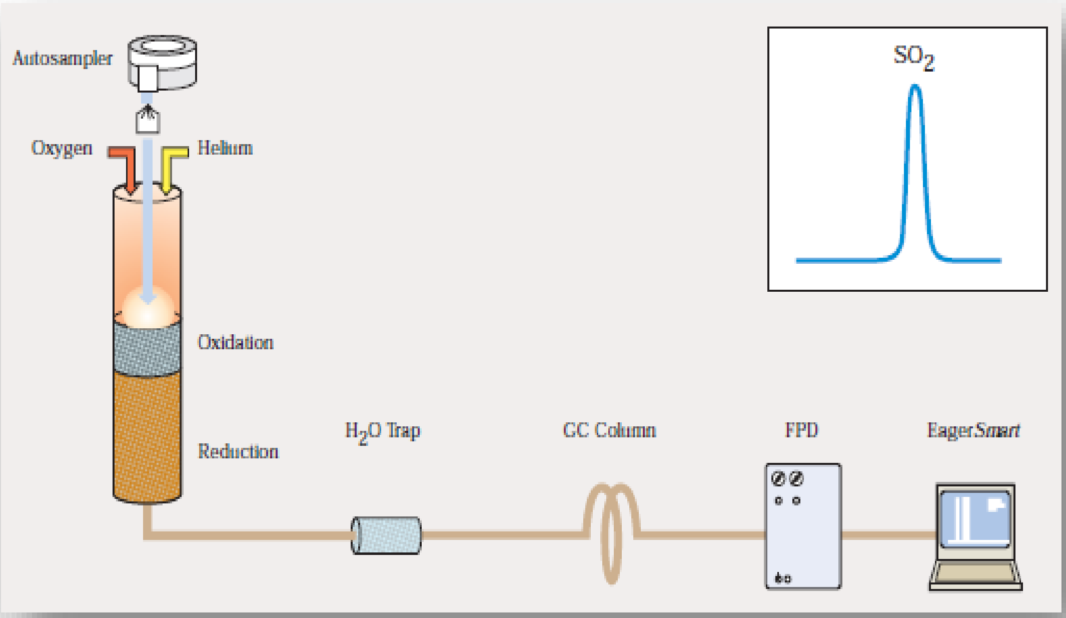


The valuable solution as alternative to Kjeldahl method

- **Conversion from N/Protein to NC configuration**
- **Conversion from N/Protein to CHNS / CHN / NCS configuration**
- **Conversion from N/Protein to Oxygen configuration**
- **Conversion form N/Protein to Sulfur determination by FPD detector**

- **Analysis of solids, liquids and viscous samples**
- **MAS Plus and AI/AS 1310 Liquid Autosampler installed on the same system**

FlashSmart+ FPD Detector: lower S det. 5 – 10 ppm



FPD : Flame Photometric Detector

OEA / FPD key features

- Total Sulfur determination
- For every type of materials
- Wide application range
- High and Low Conc. of S in the same instrument
- Constant FPD conditions with different samples
- OEA / FPD can be coupled to Flash*Smart* and previous OEA models
- Eager*Smart* Data Handling Software
- Sulfur Reference Materials included in the OEA / FPD system

Sulfur analysis by FPD detector

Sample	S %	Av. S%	RDS %
Chocolate	0.3565 0.3648 0.3551 0.3551 0.3589	0.3585	1.14
Maize Starch	0.0065 0.0063 0.0065 0.0064 0.0067	0.0065	2.28
Dried fruit	0.0549 0.0524 0.0548 0.0547 0.0525	0.0538	2.39
Diet food	0.1535 0.1535 0.1491	0.1520	1.67
Spiked diet	0.3449 0.3362 0.3417	0.3409	1.29

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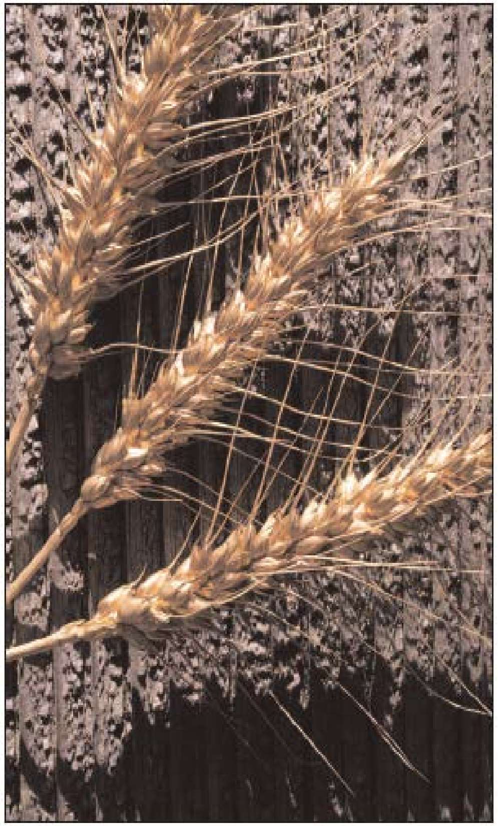
N / Protein determination of Corn Gluten and Soya

Sample	N %	RSD %	Protein %	RSD %
1	10.0489 10.0461 10.0516	0.0274	62.8055 62.7881 62.8222	0.0271
2	9.4731 9.4775 9.4759	0.0235	59.2069 59.2345 59.2241	0.0235
3	10.4201 10.4356 10.4378	0.0925	65.1256 65.2225 65.2362	0.0925
4	10.7510 10.7734 10.7722	0.1170	67.1940 67.3337 67.3265	0.1169
5	10.3815 10.3800 10.3782	0.0159	64.8846 64.8752 64.8637	0.0161



Sample	N %					Protein %				
Soya 50%	7.05	7.06	7.00	6.98	7.04	44.07	48.11	43.74	43.66	44.00
Soya 55%	7.86	7.81	7.83	7.78	7.84	49.14	48.80	48.93	48.64	48.99
Soya CR	5.51	5.61	5.58			34.47	35.07	34.86		
Soya M	5.92	5.85	5.88			36.98	36.57	36.76		

N /Protein determination of Cured Meats

Sample	N %	Protein %	RSD %
Bacon	2.744	17.153	
	2.725	17.032	
	2.710	16.939	
	2.755	17.224	
	2.734	17.090	1.867
	2.834	17.716	
	2.664	16.654	
	2.752	17.199	
	2.814	17.590	
	2.772	17.325	
Salami	4.649	29.057	
	4.512	28.201	
	4.808	30.051	
	4.550	28.439	
	4.530	28.315	2.206
	4.682	29.265	
	4.708	29.424	
	4.677	29.233	
	4.771	29.821	
	4.569	28.556	

Sample	No. of runs	N %	RSD %
Beef sausage	34	2.9972	1.6697
Pepperone salame	36	3.2163	1.7932
Turkey salame	27	5.0592	1.6987
Genoa salame	40	3.3069	1.4353

N / Protein determination in Wurstel Sausage

W (mg)	N %	Prot. %
214.8	2.393	14.956
221.0	2.415	15.092
271.6	2.442	15.263
297.6	2.404	15.026
175.0	2.441	15.259
209.5	2.401	15.007
247.0	2.450	15.310
205.3	2.427	15.166
230.3	2.444	15.274
258.0	2.418	15.115

Statistical Data:

Number of Analyses: 10

Average N%: 2.423
Std. Dev.: 0.020
RSD %: 0.834

Average Protein %: 15.147
Std. Dev.: 0.126
RSD %: 0.834

N / Protein determination in Cheese

Sample	N %	Protein %
"Caprine-"	2.283	14.564
	2.298	14.662
"Mascarpone"	0.642	4.099
	0.629	4.013
Seasoned "Provolone"	4.335	27.657
	4.394	28.031
	4.364	27.843
	4.293	27.391
	4.350	27.756
	4.366	27.852
	4.358	27.806
	4.382	27.960
	4.324	27.589
	4.359	27.811
"Parmesan"	5.190	33.115
	5.164	32.944
	5.172	32.999
	5.181	33.054
	5.261	33.567
	5.267	33.604
	5.229	33.360
	5.260	33.558
	5.170	32.984
	5.230	33.370

N / Protein determination of Chocolate

Sample	N %	Protein %	RSD %
White chocolate	1.018	6.365	
	1.019	6.370	0.190
	1.016	6.347	
Black chocolate	0.969	6.057	
	0.969	6.057	0.114
	0.971	6.069	
Plain chocolate	1.530	9.540	
	1.512	9.442	0.745

N / Protein determination of Starch

Sample	N %	Protein %	RSD %
1	0.0546	0.3409	
	0.0551	0.3445	0.5256
	0.0548	0.3426	
2	0.0371	0.2322	
	0.0366	0.2285	0.8299
	0.0370	0.2312	
3	0.0129	0.0804	
	0.0126	0.0789	2.2977
	0.0123	0.0768	
4	0.0476	0.2975	
	0.0474	0.2962	0.2530
	0.0474	0.2962	

N / Protein determination in Brewery Industry

MALT

N %	Protein %
1.588	9.925
1.580	9.875
1.560	9.750
1.575	9.844
1.553	9.706
1.560	9.750
1.555	9.719
1.530	9.562
1.547	9.669
1.574	9.837
1.563	9.769
1.537	9.606
1.576	9.850
1.562	9.762
1.549	9.681
1.565	9.781
1.562	9.762
1.558	9.737
1.546	9.662
1.575	9.844

Statistical Data:
Number of analysis: 20
Av. N %: 1.561
Av. Protein %: 9.754
RSD %: 0.941

BEER

Day 1 (ppm N)	Day 2 (ppm N)
691	677
679	691
701	698
685	698
689	706
688	696
692	678
693	706
699	698
689	675
708	691
724	710
731	722
701	709
708	699
705	697
724	685
693	698
699	692
704	684

Statistical Data
Number of analysis: 20
Day 1: Av. N: 700 ppm
RSD %: 1.961
Day 2: Av. N: 696
RSD %: 1.7205

WORT

Nitrogen %
0.1232
0.1229
0.1243
0.1235
0.1248
0.1259
0.1247
0.1253
0.1263
0.1245
0.1215
0.1253
0.1222
0.1234
0.1256
0.1246
0.1249

Statistical Data:
Number of analysis: 17
Average N%: 0.1243
RSD %: 1.0701

N / Protein determination in Juice

Sample Name	Nitrogen %	Protein %	RSD %
1	0.3674	2.2964	0.3459
	0.3658	2.2864	
	0.3649	2.2804	
2	0.0534	0.3340	1.0884
	0.0536	0.3347	
	0.0545	0.3407	

Nitrogen Determination in Soy Sauce

Sample	N %	Protein %	RSD %
1	0.6135	3.8346	
	0.6134	3.8339	0.384
	0.6176	3.8598	
2	0.8181	5.1132	
	0.8207	5.1293	
	0.8186	5.1161	0.144
	0.8190	5.1188	
	0.8206	5.1287	

Food Supplements – NC Determination

Sample	N %	RSD %	C %	RSD %
1	5.7388 5.7468 5.7443	0.0713	14.5980 14.6226 14.6122	0.0845
2	11.3650 11.3911 11.3692	0.1232	45.6246 45.3035 45.3432	0.3854
3	5.8447 5.8313 5.8626	0.2686	17.1273 17.1149 17.1605	0.1376
4	3.6302 3.6131 3.6343	0.3101	37.0935 36.9753 36.9562	0.2010

CHNS determination of Food Related Products

Sample	N %	RSD %	C %	RSD %	H %	RSD %	S %	RSD %
Fish gelatine	16.249 16.212 16.189	0.185	43.023 43.099 43.051	0.089	6.902 6.608 6.586	2.632	0.394 0.408 0.408	2.004
Bovine gelatine	15.796 15.835 15.838	0.148	44.615 44.647 44.624	0.037	6.623 6.658 6.622	0.309	0.531 0.536 0.537	0.601
Porcine gelatine	16.088 16.016 16.043	0.226	44.460 44.397 44.379	0.096	6.631 6.659 6.582	0.585	0.531 0.536 0.537	0.970
Starch	2.530 2.516 2.537 2.520 2.528	0.329	31.008 30.850 31.000 30.956 30.967	0.204	5.396 5.456 5.415 5.373 5.310	1.004	0.399 0.396 0.391 0.392 0.398	0.902
Food supplement A	13.168 13.160 13.194	0.137	52.179 52.084 52.178	0.104	6.665 6.626 6.626	0.311		
Food supplement B	0.071 0.071 0.073	1.109	8.0197 8.0251 8.0241	0.036	2.207 2.199 2.209	0.254		
Food supplement C	0.330 0.332 0.329	0.533	40.615 40.396 40.630	0.323	6.274 6.331 6.323	0.488	0.366 0.368 0.357	1.581

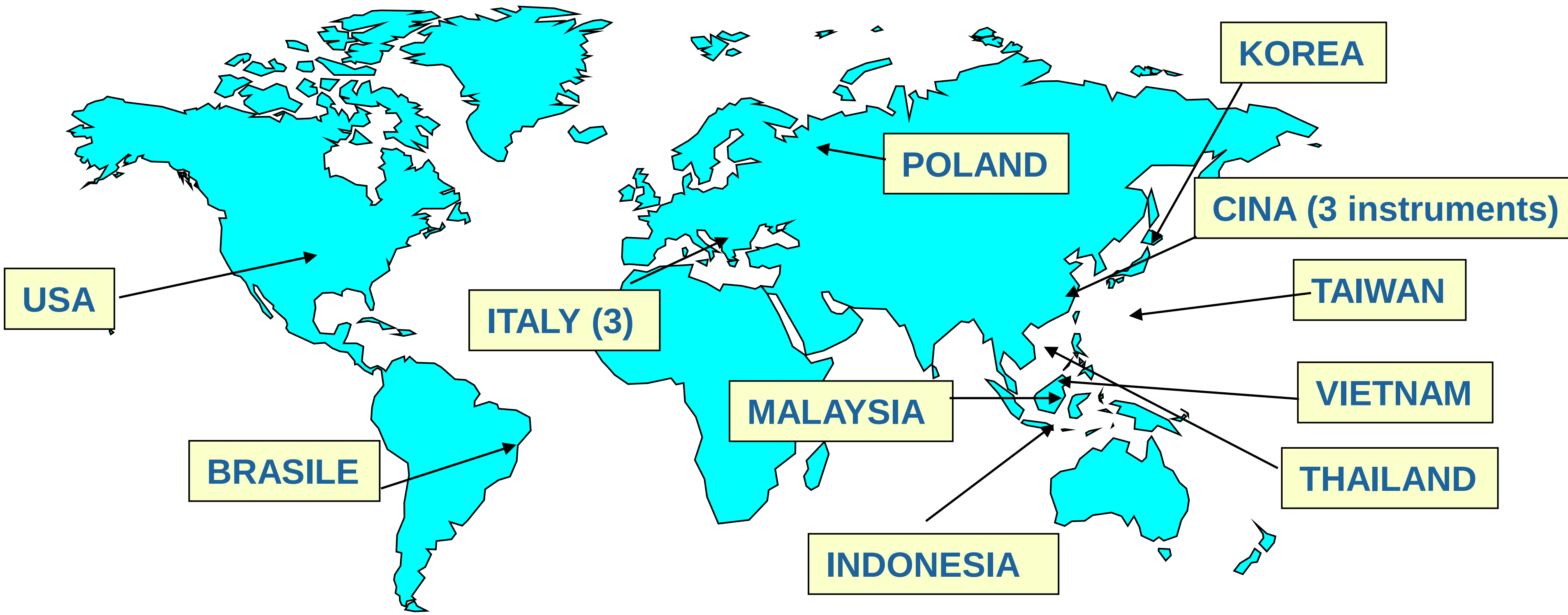
N / Protein determination of Dietary Fiber (celite)

Sample 1	N %	RSD %	Protein %	RSD %
1	0.123		0.771	
	0.125	0.9337	0.782	0.8198
	0.123		0.771	
2	0.175		1.094	
	0.174	0.3305	1.089	0.2423
	0.175		1.093	
3	0.358		2.240	
	0.352	0.9786	2.200	1.0061
	0.352		2.203	
4	0.281		1.755	
	0.285	0.9316	1.782	1.0328
	0.286		1.790	

N / Protein determination in Animal Feed

Cargill produces and distributes crop nutrients and feed ingredients to farmers, beef, dairy, pork and poultry producers and animal feeders. They originate and process grain, oilseeds and other agricultural commodities for distribution to makers of food, feed and other products.

Cargill also collaborates with food manufacturers, food service, distributors and retailers with a focus on customer and consumer benefits. Cargill offers insights in food and beverage ingredients, meat and poultry products, and food applications that help customers succeed.



N / Protein determination in Animal Feed

Sample	N %	Protein%
Petfood	4.65	29.07
	4.61	28.81
	4.70	29.40
	4.69	29.32
	4.69	29.34
Av. %	4.67	29.19
RSD %	0.81	0.84
Fishfood	7.89	49.32
	7.94	49.64
	8.02	50.11
	7.84	49.01
	8.09	50.57
Av. %	7.96	49.73
RSD %	1.24	1.24

N/Protein determination in fish meals

Day	Day 1		Day 2		Day 3	
Data	N %	Prot %	N %	Prot %	N %	Prot %
	11.20	69.99	11.19	69.92	11.20	69.99
	11.21	70.07	11.19	69.91	11.18	69.90
	11.21	70.04	11.19	69.92	11.19	69.97
	11.19	69.95	11,20	70.02		
	11.17	69.84	11.21	70.07		
	11.15	69.71	11.20	70.00		
	11.13	69.57	11.14	69.60		
	11.17	69.84	11.25	70.33		
	11.14	69.59	11.19	69.93		
	11.21	70.09	11.19	69.93		
Average %	11.18	69.87	11.19	69.96	11.19	69.95
RSD %	0.27	0.27	0.26	0.26	0.07	0.07

N / Protein determination in Animal Feed

Sample	N %	RSD %
Fish Meal	10.29	1.221
Gluten Meal	10.52	0.854
Maize	7.95	0.784
Starch	0.046	2.031
Chicken Feed	3.01	1.546
Straw	0.45	0.623
Green Grass	3.28	0.954
Meat and Bone Mix	8.20	1.422

Samples analyzed in triplicate

Flash*Smart* vs. Kjeldahl Method – Technical Comparison

Information	Kjeldahl Method	FLASH 2000 Analyzer (Dumas Method)
Range of sample weight	500 – 1000 mg (2000 mg)	100 - 1000 mg (solid, viscous and liquid)
Procedure steps	Sample preparation-weighing-digestion-distillation-titration-calculations-results.	Sample preparation-weighing-analysis-results
Timing		
Warming up	10 - 45 minutes (once a day)	30 minutes (from stand-by condition). Warming up is not needed using the Wake-up automatic function.
Preparation of the sample (Homogenization)	5 – 20 minutes	5 - 20 minutes This can be done when the system is analyzing samples (not possible with Kjeldhal)
Preparation of reagents	Manual preparation: 10 - 20 minutes	Filling of two reactors and two traps: 20 minutes
Digestion	2 – 6 hours	No
Cool Down	20 mins – 2 hours	No
Nitrogen analysis time	10 minutes	4 – 6 minutes
Other steps	5 – 10 minutes (distillation/tritation, washing of distillation system)	No
Total time for one N determination (excluding warming up)	3 – 10 hours	4 - 6 minutes/sample (samples can be weighed during a sequence of analyses)
Safety	High cost Concentrated acids at boiling temperature Toxic catalyst and chemicals Glass tubes Consumables: H_2SO_4 96-98%, NaOH 40 %, H_3BO_3 3%, HCl 0.1N, $CuSO_4.5H_2O$, $ZnSO_4$ KSO4, H_2SO_4 0.1N, NaOH 0.1N, Acetanilide 10N NaOH in a 25 litre vessel	Low cost No fumes, acids and toxic reagents No atmospheric pollution Special stainless steel tubes Consumables: EDTA, CuO-Pt on alumina, copper, soda lime, molecular sieve, silicagel, quartz wool The separation column is **not** a consumable.
Waste disposal	Alkali waste High cost Large amount Note: destruction of 1 batch of 20 tubes takes almost 3 hours	Ashes in the crucible (the amount of ashes depends of the sample nature). Exhausted catalyst, copper and soda lime (CO_2 adsorber)
Equipment		
Lifetime of instrument	Moderate lifetime due to acidic environment Frequent servicing every 3-4 months	Long lifetime of instrument
Leakage Problems	Often rubber tubing breaks, leading to leaking	None. Automatic Leak Test (Eager Xperience software function) is performed after maintenance
Damage to safety cabinet	Slight damage due to accident spillage of corrosive chemicals	No
Laboratory requirements	Cluttered workplace	Clean workplace
Anti acid table	Yes	No
Need of chimney	Yes	No
Gases	No	Yes, helium and oxygen, optional argon (as an alternative to helium)
User knowledge	High Basic laboratory and chemistry knowledge. Knowledge of tritrimetric methods Lab technician, analytical training needed Labor intensive	Low Basic laboratory and chemistry knowledge Basic knowledge in gas chromatography Lab technician, analytical training needed, instrument operation and maintenance training needed.

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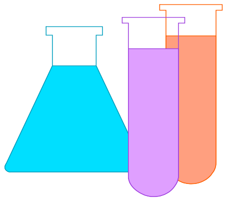
Flash*Smart* vs. Kjeldahl Method

Technical Comparison

Information	Kjeldahl Method	FLASH 2000 Analyzer (Dumas Method)
Maintenance	High Regular maintenance of seals, reagent pumps, glass parts of the system. Distillated system, washing of tubes and filters every 3 months. Frequent replacement of rubber tubing and modules (hot block digestion). Manual cleaning of glass tubes Daily care of instrument	Low Lifetime: Catalyst ≥1000 runs, copper ≥500 runs, traps about 120 runs. Ash removal: 80 – 120 runs. Maintenance is scheduled in the Eager Xperience software, automatic signal when needed. Large number of runs with same reactors Easy to maintain: special stainless reactors and crucible for faster ash removal.
Capacity (number of analyses in continuous cycle)	6 – 20 per day The capacity is limited by the digestion time	1 drum for 32 samples With 3 extra drums, capacity is up to 125 samples
Automation and unattended analysis (number of analyses)	Not automated There is no automation in digestion/distillation No automatic sample loading	Automatic MAS 200R autosampler Truly unattended operation Ability to add extra samples during the analyses
Quantitative recovery of N	Matrix problems Incomplete N recovery from some samples even after hours of digestion	Total conversion of organic and inorganic material to elemental gases. Results unbaised by sample matrix due to the flash combustion method.
Manual and/or automatic protein calculation	Manual (Excel file) In house spreadsheet for keying in data and final protein calculation	Dedicated Eager Xperience Software, automatically calculates the protein content. It is possible to use different protein factors according to sample nature.
Software	No dedicated software	Eager Xperience dedicated software with the following features: Stand-by, Wake-up and Auto-Start automatic functions Maintenance program OxyTune option automatically calculates the amount of oxygen necessary for complete combustion of the sample Ability to insert the humidity of the sample for proper protein calculation Automatic transfer of the weight from the balance Standard and personal reports Automatic Leak Test CFR 21 part 11 compliance
Validation	–	Ability to validate/qualify the FLASH 2000 OEA
Modularity	No	FLASH 2000 N/Protein analyzer can be easily modified to NC, CHN, CHNS, NCS, Oxygen determination without changing hardware and software The FLASH 2000 OEA can be upgraded with a dedicated liquid autosampler AI/AS 1310. The Eager Xperience software is able to control the liquid autosampler without any updated version and without extra cost.

Kjeldahl method AOAC 981.10 - Crude protein in meat



Method:

- Weigh approx. 2 g of sample
- Add catalyst: 7 g K_2SO_4, 0.25 g HgO
- Add 15 ml H_2SO_4
- Add 3 ml H_2O_2
- Digestion at 410 ° C for 45 min
- Cool for 10 min
- Add NaOH/ Na_2SO_3 solution
- Steam distillation
- Collect in H_3BO_3
- Titrate with HCl

Kjeldahl user's nightmares !!

SAFETY

Concentrated acids at boiling temp

Toxic catalyst and chemicals

WASTE DISPOSAL

TIME CONSUMPTION

RELIABILITY OF RESULTS

Flash*Smart* vs. Kjeldahl Method – Analytical Comparison

Analysis of BIPEA (Bureau InterProfessionnel d'Etrudes Analytiques, France) Reference Material.

The first table shows the average and range indicated in the relative Reference Materials Certificates.

The second table shows the N/ Protein data of the BIPEA samples analyzed in duplicate by the Flash*Smart* using a sample weight of about 200 – 300 mg.

BIPEA sample information available

Sample	Moisture	Fat	Carbohydrate	Kjeldahl Protein		Combustion Protein	
	%	%	%	Av.%	Tolerance	Av.%	Tolerance
Bipea - Feed for Sow	9.8	2.8	48.7	16.0	0.6	16.2	0.6
Bipea - Dehydrated Alfalfa	7.7		29.3	14.8	0.6	15.1	0.6
Bipea - Hyperproteic Powder		0.8		85.4	3.4	86.4	3.5

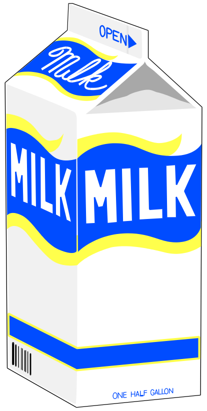
Reproducibility of Nitrogen / Protein determination in BIPEA Reference Materials

Sample	Bipea - Feed for Sow		Bipea - Dehydrated Alfalfa		Bipea - Hyperproteic Powder	
%	N %	Protein %	N %	Protein %	N %	Protein %
	2.60	16.25	2.45	15.31	13.65	85.31
	2.58	16.12	2.44	15.25	13.63	85.19
Average %	**2.59**	**16.185**	**2.445**	**15.28**	**13.64**	**85.25**
RSD %	**0.546**	**0.568**	**0.289**	**0.278**	**0.104**	**0.099**

Nitrogen / Protein determination in Milk Reference Material

Reference Material from Cetre d'Étude et de Controle des Analyses en Industrie Laitiére, France

Kjeldahl Method - Mean from the results of 5 laboratories: 0.5284 % N



Flash*Smart* data

N %	Average N %	RSD %	Protein %	Average Protein %	RSD %
0.5312	0.5298	0.5604	3.3891	3.3800	0.5605
0.5286			3.3722		
0.5321			3.3948		
0.5339			3.4065		
0.5306			3.3854		
0.5251			3.3504		
0.5335			3.4035		
0.5264			3.3584		
0.5288			3.3735		
0.5276			3.3659		

Nitrogen / Protein determination in Fish Meal

Fish meal sample	FlashSmart - Protein %	Kjeldahl Method - Protein %	Difference
1	63.7	63.5	0.2
2	65.4	65.4	0.0
3	65.5	65.2	0.3
4	69.7	70.2	-0.5
5	69.8	70.0	-0.2
6	71.6	72.0	-0.4
7	69.7	69.5	0.2
8	67.9	68.5	-0.6
9	69.6	69.4	0.2
10	70.4	70.0	0.4
11	69.9	69.6	0.3
12	67.5	67.3	0.2
13	67.8	67.5	0.3
14	65.3	64.8	0.5
15	69.7	69.7	0.0
16	65.4	65.3	0.1
17	70.5	70.0	0.5
18	70.7	70.2	0.5
19	71.9	71.9	0.0
20	69.1	69.5	-0.4
21	69.9	70.0	-0.1
22	65.4	65.6	-0.2
23	67.3	67.6	-0.2
24	65.2	64.8	0.4

Nitrogen / Protein determination in Brewery industry

Sample Name	Kjeldahl Method		FlashSmart		
	N %	Protein %	N %	Protein %	RSD %
Malt 1	1.66	10.38	1.67	10.44	0.25
Malt 2	1.75	10.94	1.78	11.12	0.67
Malt 3	1.54	9.62	1.53	9.56	0.51
Malt 4	1.43	8.94	1.40	8.75	0.66
Barley 1	1.39	8.69	1.42	8.88	0.46
Barley 2	1.35	8.44	1.34	8.38	0.87
Barley 3	1.56	9.75	1.57	9.81	0.56
Barley 4	1.47	9.19	1.45	9.06	1.01

Sample Name	Kjeldahl Method	FlashSmart	
	N %	N %	RSD %
Beer 1	0.0587 – 0.0592	0.0594	1.133
Beer 2	0.0641 – 0.0644	0.0647	1.023
Beer 3	0.0650 – 0.0666	0.0659	0.956
Beer 4	0.0614 – 0.0619	0.0618	1.011
Beer 5	0.0628 – 0.0630	0.0630	0.892
Beer 6	0.0640 – 0.0645	0.0637	0.912
Wort 1	0.0885 – 0.0890	0.0892	1.232
Wort 2	0.1140 – 0.1150	0.1170	0.874
Wort 3	0.1300 – 0.1310	0.1320	0.912
Wort 4	0.0995 – 0.0993	0.0993	1.112
Wort 5	0.0825 – 0.0827	0.0821	1.098
Wort 6	0.0889 – 0.0893	0.0899	1.210

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Flash*Smart* vs. Kjeldahl Method – Analytical Comparison

Sample	Flash*Smart*		Kjeldahl Method	
	N %	Protein %	N %	Protein %
Soya	6.27	39.20	6.27	39.18
Lentils	4.35	27.17	4.35	27.19
Rice	1.13	7.08	1.12	7.00
Wheat	1.75	10.91	1.74	10.89
Beans	3.74	23.35	3.74	23.38
UHT milk 1	0.53	3.38	0.53	3.37
UHT milk 2	0.50	3.19	0.49	3.17
Crude milk 1	0.57	3.65	0.57	3.66
Crude milk 2	0.47	3.03	0.47	3.02
Crude milk 3	0.41	2.65	0.42	2.66
Pasteurized milk 1	0.50	3.21	0.50	3.19
Pasteurized milk 2	0.46	2.96	0.47	2.99
Milk powder 1	4.32	27.56	4.30	27.43
Milk powder 2	4.18	26.64	4.19	26.73
Milk powder 3	5.46	34.83	5.43	34.64
Yoghurt	0.080	0.51	0.078	0.50
Mascarpone cheese	0.635	4.05	0.638	4.07
Grapes	0.52	3.25	0.51	3.19
Bacon (low fat)	2.73	17.06	2.70	16.86
Meat loaf	2.01	12.57	1.97	12.31
Ham	2.56	16.00	2.54	15.87
Biscuits 1	1.40	8.80	1.39	8.72
Biscuits 2	1.36	8.51	1.34	8.37
Flour	1.34	8.40	1.32	8.24

Official Methods

AACC (American Association of Cereal Chemists)

Crude Protein in Cereals 46-30, 1999

AOAC (Association of Official Analytical Chemists)

Protein (crude) in Animal Feed, official Method 990.03, 4.2.08
Crude Protein in Meat and Meat Products including Pet Foods, Official Method 992.15, 39.1.16
Crude Protein in Cereal, Grains and Oilseeds, Official Method 992.23, 32.2.02
Nitrogen (Total) in Fertilizers, Official Method 993.13, 2.4.02

AOCS (American Oil Chemists Society)

Combustion Method for determination of Crude Protein Official Method Ba 4e-93 (revised 1995)

ASBC (American Society of Brewing Chemists)

Nitrogen determination in Barley, official Method, 1996

ASBC (American Society of Brewing Chemists)

Total Nitrogen in Wort and Beer by combustion method. Report of subcommittee, 1994

IDF (International Dairy Federation)

Nitrogen determination in Dairy Products by combustion method, 14891 – FIL 185

IFFO (International Fishmeal and Fish Oil organization Ltd.)

Nitrogen determination in Fish Meal by combustion method

ISO (International Organization for Standarization)

Food Products – Determination of the Total Nitrogen content by combustion according to the Dumas principle and calculation of the crude protein content. Part 1: Oil seeds and Animal Feeding Stuffs, 16634-1, 2008

Office International de la Vigne et du Vin

Quantification of Total Nitrogen by Dumas method (Musts and Wines)

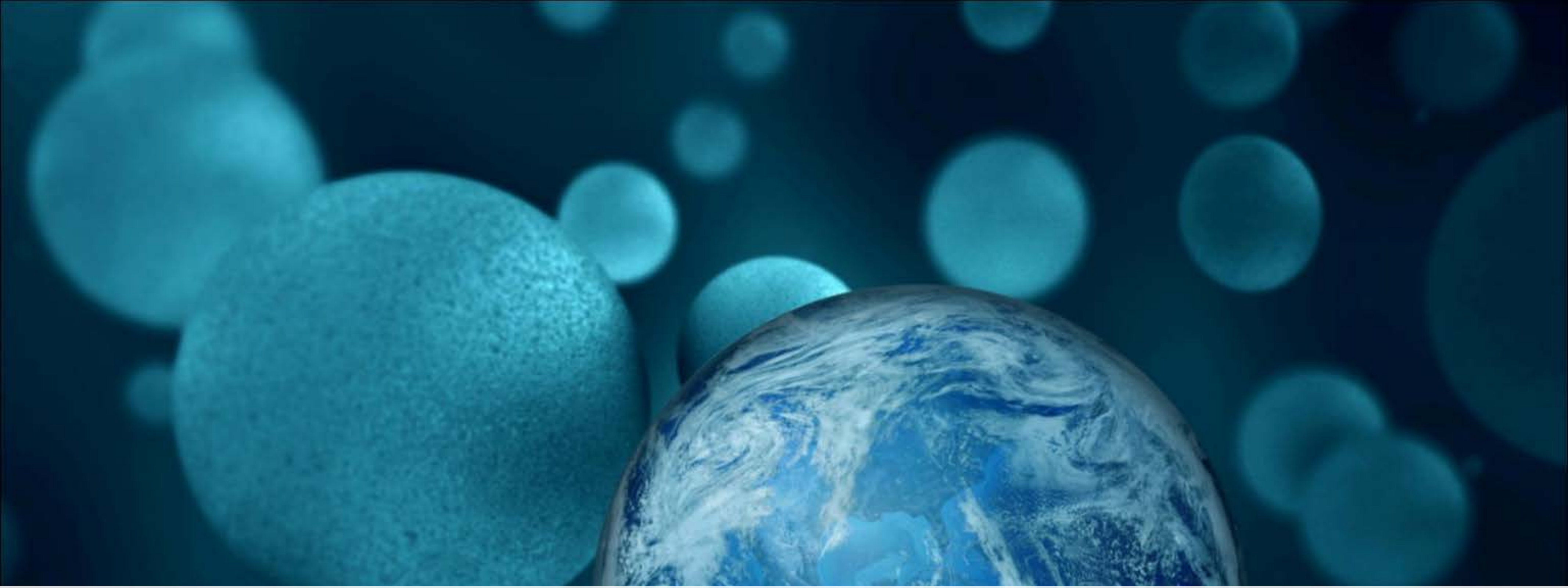
AOAC 990.03 Official Method

Requirements:

- The analysis of Nicotinic acid, Lysine chloride and a mixture of corn grain and soybean according to the **AOAC 990.03** Performance Requirements (Association of Official Analytical Chemists) in which is indicated that the system must meet or exceed following minimum performance specification:
- System must be capable of measuring Nitrogen in feed materials containing **0.2 – 20 % Nitrogen.**
- Accuracy of system is demonstrated by making 10 successive determinations of Nitrogen in Nicotinic acid and Lysine chloride. **Means** of determinations must be **within ± 0.15 of the respective theoretical values, with standard deviation ≤ 0.15**.
- Suitable fineness of grind is that which gives **relative standard deviation (RSD) ≤ 2.0 %** for 10 successive determinations of Nitrogen in mixture of corn grain and soybean (2+1) that has been ground for analysis. RSD % = (SD / mean %N) x 100. Fineness (ca. 0.5 mm) required to achieve this precision must be used for all mixed feeds and other nonhomogeneous materials.

Flash*Smart* Nitrogen determination according to AOAC 990.03

Sample	Nicotinic acid	Lysine chloride	Mixture of corn grain and soybean	
%	Nitrogen %	Nitrogen %	Nitrogen %	Protein %
Data	11.30	15.31	3.27	20.44
	11.30	15.23	3.25	20.29
	11.35	15.16	3.26	20.38
	11.29	15.22	3.24	20.28
	11.37	15.27	3.28	20.52
	11.42	15.11	3.27	20.42
	11.42	15.22	3.25	20.36
	11.44	15.19	3.26	20.39
	11.48	15.19	3.26	20.37
	11.39	15.25	3.28	20.49
Average %	**11.38**	**15.21**	**3.26**	**20.39**
RSD %	**0.576**	**0.372**	**0.404**	**0.379**



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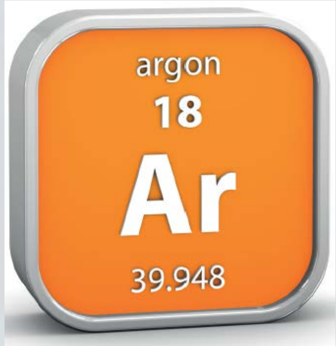
FLASH 2000 Analyzer Argon Gas Option for N and NC analysis



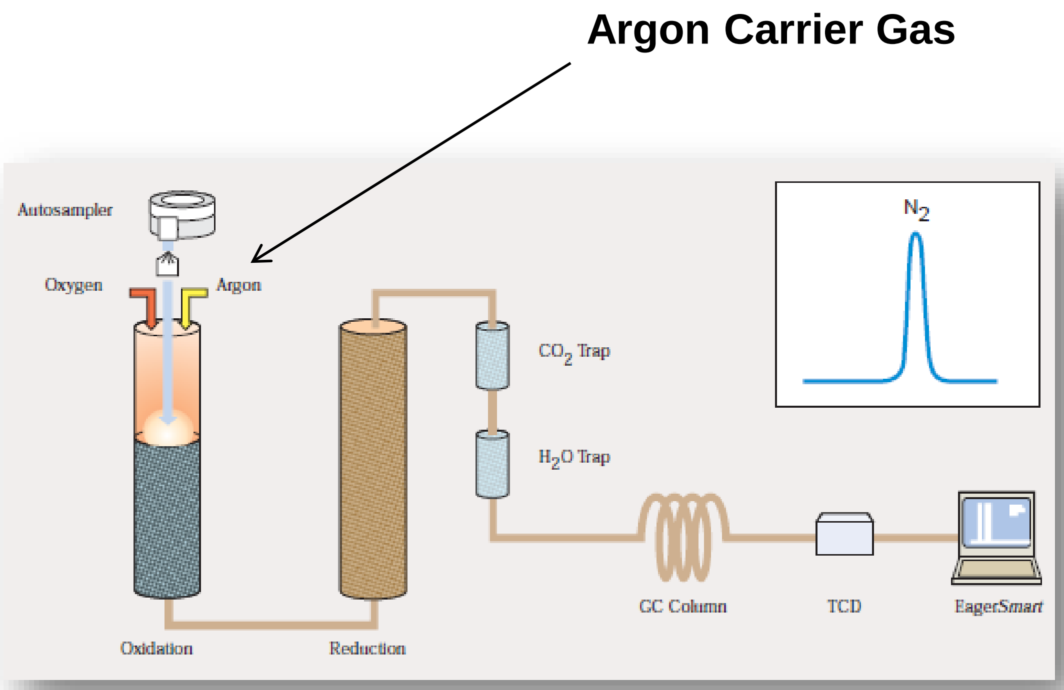
Flash*Smart* Analyzer Argon Gas Option for N and NC analysis

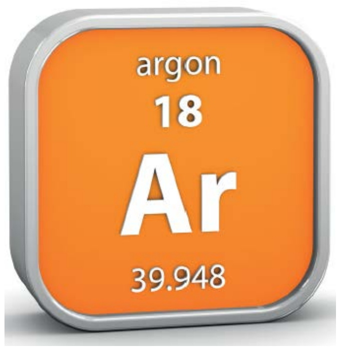
Eliminate the Risk → Switch from Helium to Argon

- Argon is already available
- Comparable results with He carrier gas
- Up to 50% lower cost than Helium

ThermoFisher SCIENTIFIC

FlashSmart Nitrogen Configuration





Analytical conditions	
Combustion Furnace Temperature:	950 °C
Reduction Furnace Temperature:	840 °C
Oven Temperature:	50 °C (GC column inside the oven)
Argon Carrier Flow:	60 ml/min
Argon reference Flow:	60 ml/min
Oxygen Flow:	300 ml/min
Sample Delay:	10 sec
Run time:	10 mins

N/Prot determination in Animal Feed (Argon Carrier Gas)

BIPEA Reference Materials

Sample	Moisture	Fat	Carbohydrate	Kjeldahl Protein		Combustion Protein	
	%	%	%	Av. %	Tolerance	Av. %	Tolerance
Bipea - Feed for Sow 3/2009	9.8	2.8	48.7	16.0	0.6	16.2	0.6
Bipea - Dehydrated Alfalfa 3/2009	7.7	---	29.3	14.8	0.6	15.1	0.6
Bipea - Hyperproteic Powder 1/2008	---	0.8	---	85.4	3.4	86.4	3.5

Data obtained with Flash*Smart* using Argon as carrier gas

Sample	Bipea – Feed for Sow		Bipea – Dehydrated Alfalfa		Bipea - Hyperproteic Powder	
%	N %	Protein %	N %	Protein %	N %	Protein %
	2.67	16.71	2.47	15.46	13.53	84.59
	2.67	16.67	2.49	15.57	13.56	84.74
	2.66	16.63	2.45	15.34	13.67	85.42
	2.60	16.22	2.41	15.04	13.62	85.10
	2.63	16.41	2.47	15.41	13.69	85.57
	2.67	16.72	2.48	15.49	13.66	85.36
	2.67	16.66	2.37	14.81	13.60	85.02
	2.67	16.71	2.44	15.27	13.63	85.21
	2.61	16.32	2.38	14.87	13.71	85.72
	2.65	16.55	2.37	14.79	13.67	85.43
Average %	2.65	16.56	2.43	15.21	13.63	85.22
RSD %	1.02	1.09	1.93	1.97	0.42	0.42

N/protein Data Comparison – Argon vs Helium

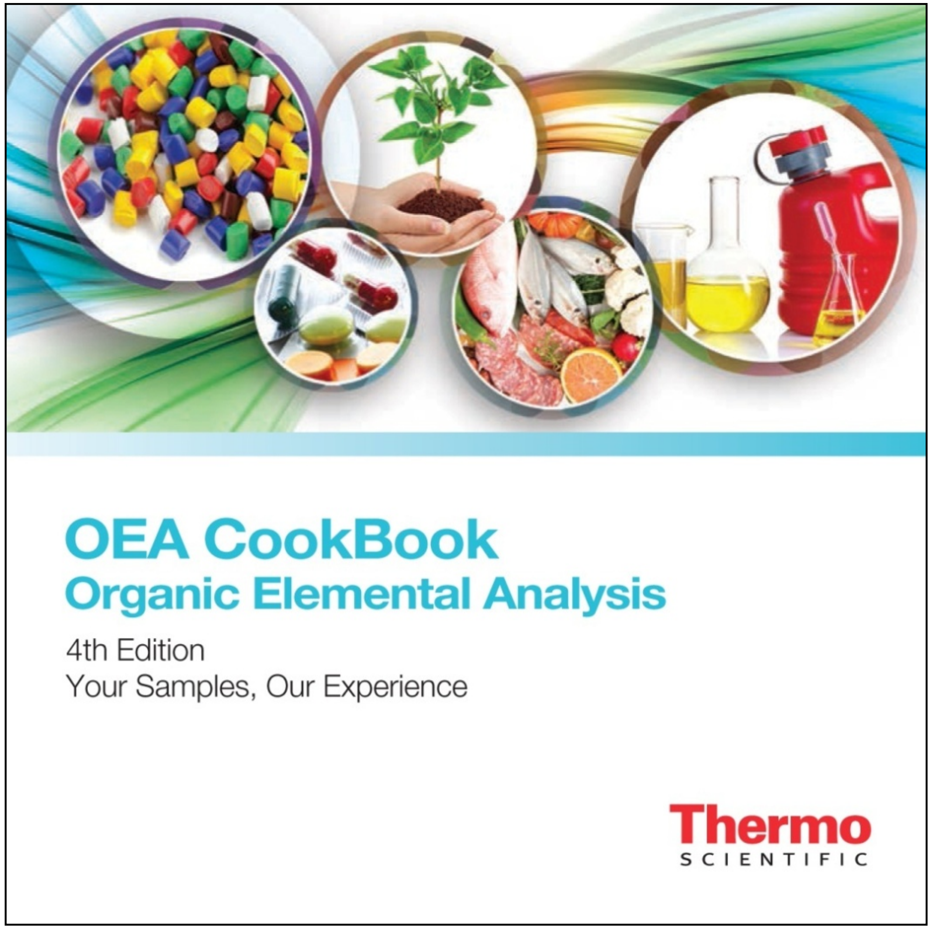
Animal Feed

	Argon Gas					Helium Gas				
Name	Weight (mg)	N %	RSD %	Protein %	RSD %	Weight (mg)	N %	RSD %	Protein %	RSD %
Wheat flour	130 - 140	1.91 1.93 1.94	0.79	11.93 12.05 12.14	0.87	160 - 200	1.92 1.93 1.90	0.79	11.98 12.06 11.88	0.75
Maize 1	130 - 140	1.25 1.25 1.26	0.46	7.84 7.83 7.87	0.27	150 - 200	1.26 1.26 1.27	0.46	7.88 7.93 7.91	0.32
Maize 2	130 - 140	1.48 1.49 1.49	0.39	9.24 9.29 9.29	0.31	150 - 200	1.50 1.50 1.49	0.38	9.41 9.39 9.34	0.38
DDGS	120 - 130	4.79 4.78 4.83	0.55	29.92 29.85 30.21	0.64	150 - 160	4.79 4.80 4.77	0.31	29.92 30.03 29.80	0.38
Sunflower 1	100 - 120	6.02 6.08 6.09	0.62	37.62 38.01 38.08	0.65	170 - 200	6.10 6.07 6.09	0.25	38.15 37.91 38.07	0.31
Sunflower 2	130 - 140	5.69 5.75 5.71	0.53	35.54 35.95 35.68	0.58	170 - 200	5.65 5.61 5.64	0.37	35.31 35.05 35.22	0.37
Soya	130 - 150	8.11 8.08 8.00	0.71	50.66 50.51 49.99	0.70	170 - 180	7.98 8.03 8.01	0.31	49.87 50.21 50.06	0.34
Gluten 1	130 - 140	9.31 9.27 9.28	0.22	58.20 57.92 58.02	0.24	170 - 180	9.34 9.33 9.31	0.16	58.36 58.33 58.21	0.14
Gluten 2	130 - 140	9.31 9.35 9.28	0.38	58.18 58.44 57.98	0.40	170 - 180	9.32 9.37 9.36	0.28	58.28 58.55 58.50	0.25
Poultry feed 1	120 - 140	2.91 2.98 2.96	1.22	18.18 18.62 18.48	1.22	150 - 160	2.95 2.96 2.90	1.09	18.43 18.53 18.13	1.13
Poultry feed 2	130 - 140	4.31 4.39 4.30	1.14	26.96 27.43 26.87	1.11	150 - 160	4.37 4.35 4.42	0.82	27.30 27.17 27.65	0.91

Application Notes available

- AN 42157 Thermo Scientific FLASH 2000 Protein Analyzer for Cereals and Beans
- AN 42159 Reproducibility of Nitrogen / Protein determination with the Thermo Scientific FLASH 2000 Protein Analyzer
- AN 42186 Sulfur determination in Food by the Thermo Scientific FLASH 2000 Elemental Analyzer coupled with FPD detector
- AN 42196 Characterization of Food and Animal Feed Related Products by the Thermo Scientific FLASH 2000 Elemental Analyzer
- TN 42214 Analytical Comparison of the Thermo Scientific FLASH 2000 Nitrogen / Protein Analyzer with the traditional Kjeldahl Method
- TN 42215 Technical Comparison of the Thermo Scientific FLASH 2000 Nitrogen / Protein Analyzer with the traditional Kjeldahl Method
- AN 42200 Nitrogen / Protein determination in Animal Feed by the Thermo Scientific FLASH 2000 Analyzer using Argon as Carrier Gas
- AN 42201 Nitrogen / Protein determination in Flours by the Thermo Scientific FLASH 2000 Analyzer using Argon as Carrier Gas
- AN 42203 Thermo Scientific FLASH 2000 Nitrogen / protein Analyzer using Argon as Carrier Gas: Stability, Linearity, Repeatability and Accuracy
- AN 42262 Nitrogen/Protein Determination in Food and Animal Feed by Combustion Method (Dumas) using the Thermo Scientific Flash*Smart* Elemental Analyzer

OEA CookBook



The OEA CookBook includes a chapter on **OEA-IRMS applications**

N/Protein determination 1 2

BARLEY • BEANS • BRAN • CORN • LENTILS • MILK • MILK POWDER • PEAS • RICE • SOYA • WHEAT (continued)

Sample	N %	Protein %	RSD %
Corn	1.137	7.104	0.736
Soya	6.207	38.796	0.549
Corn-soya (2:1)	2.545	15.907	0.659
Barley	1.590	9.939	1.356
Bran	2.271	14.192	0.807
Wheat	1.742	10.889	0.305
Oats-wheat mix	2.871	16.361	0.705
Rice	1.101	6.270	0.831
Seeds of cartam	2.375	14.845	1.531
Lentils	3.840	23.993	0.553
Beans	3.544	22.150	0.695
Peas	3.873	24.204	0.532
Milk	0.510	3.254	0.768
Milk powder	1.840	11.741	0.460

Sample information

Standard:	Aspartic acid	10.52 %N
Standard weight:		50 - 100 mg
N/Protein factor:	Milk products	6.38
	Others	6.25
Sample weight:		200 - 300 mg
OxyTune Category:	B cat, A cat. for milk powder	

Notes

Each value is the average of 10 runs.
Crops and beans have been treated in a rotary mill, 1 mm granulometry.

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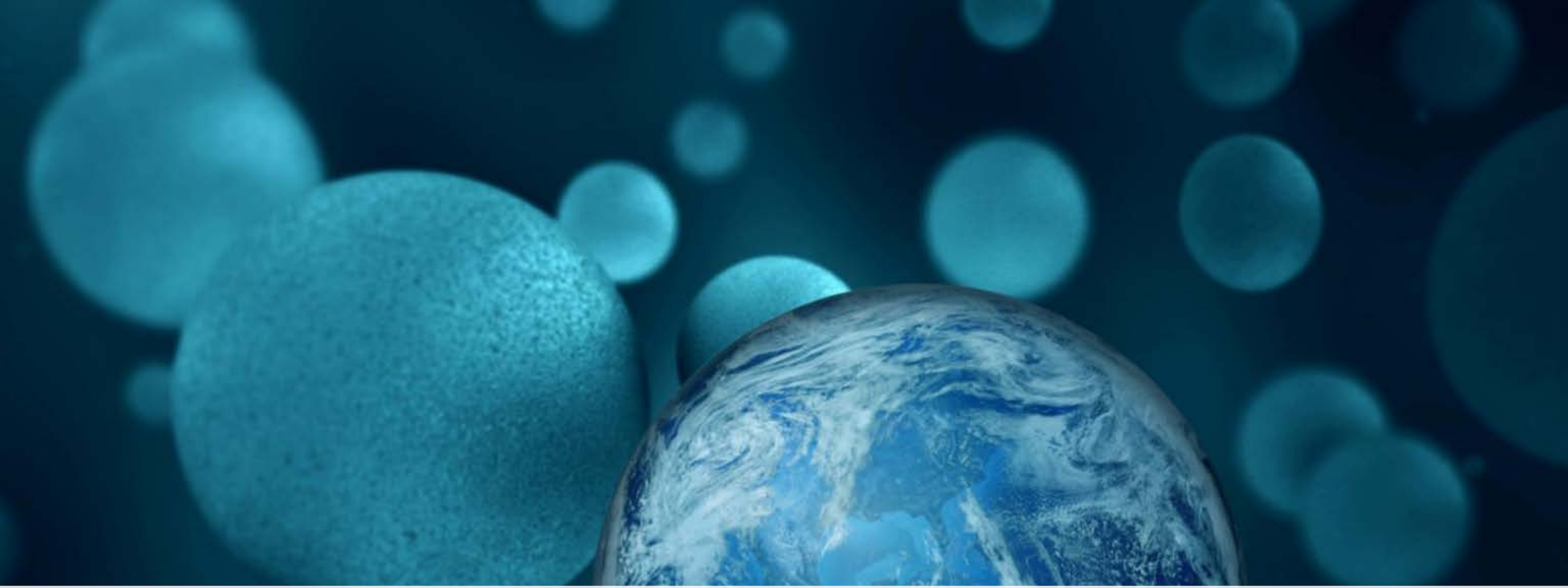


Thermo Fisher SCIENTIFIC

Food Origin & Authenticity: Revealing the Truth using Isotope Fingerprints

Drs. Christopher Brodie, Lionnel Mounier & Lin-Tang GOH*

*Factory Product Manager (Germany) for IRMS, *Regional Senior Manager (SEA) for Mass Spectrometry*

Isotope Fingerprint for Food Authenticity and Food Integrity

- Food and beverage products have a fingerprint, a unique chemical signature that allows the product to be identified.

- To visualize this fingerprint, Isotope Ratio Mass Spectrometry (IRMS) can be used, identifying the isotope fingerprint of the product.

- The isotope fingerprint is region or process specific (Table 1), which means that products can be **differentiated based on geographical region** (cheese, coffee, sugar, fish and animal feeding areas), **botanical processes** (beans, seeds, olive oil, vanilla), **soil and fertilization processes** (fruits and vegetables) **and fraudulent practices** (sugar addition to honey, watering of wines and spirits).

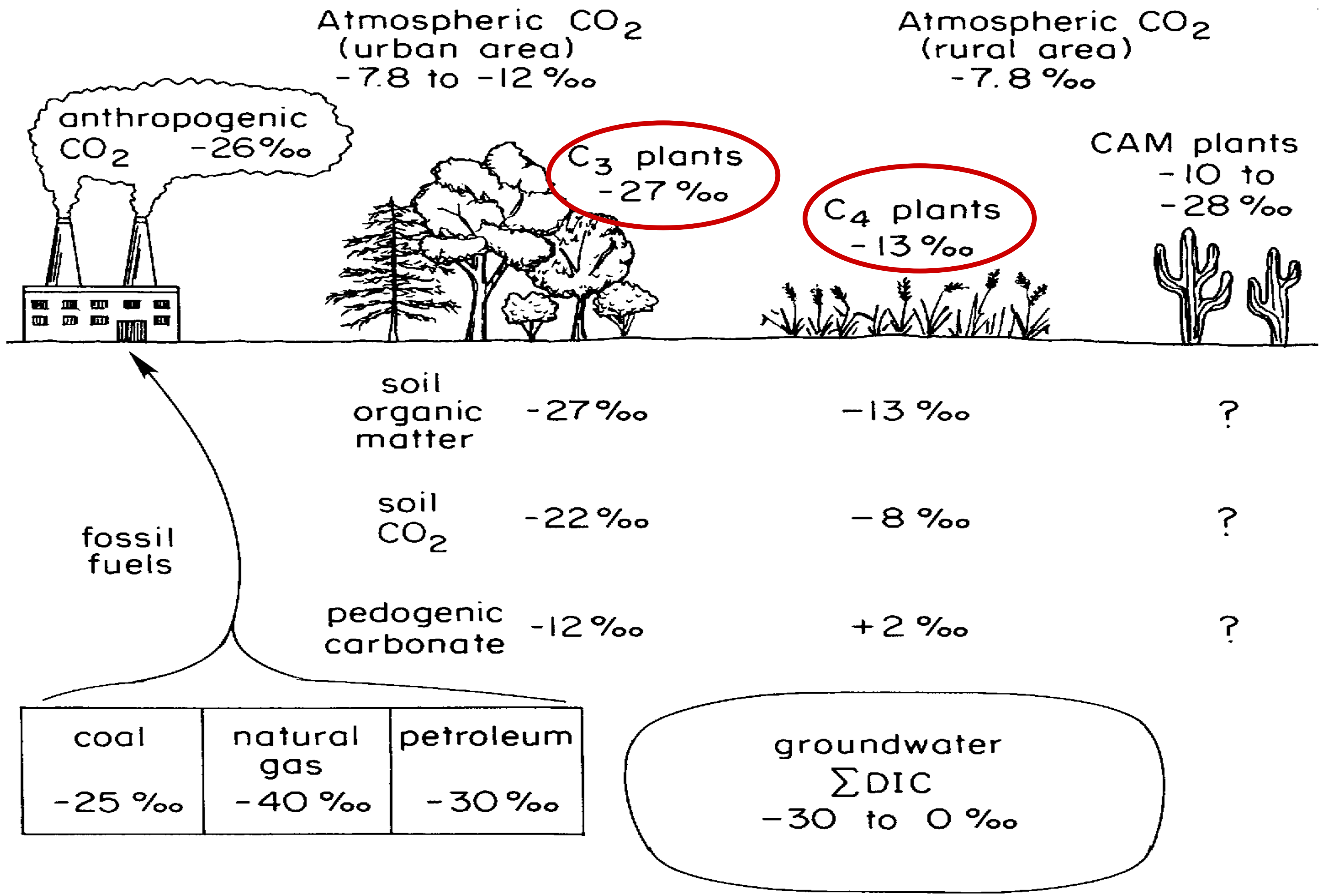
Some Examples of Food Fraud

Food and Beverages:	Potential Fraud:
Fruit juices	Watering, sweetening
Wine	Watering, chaptalization, label declaration
Vinegar	Origin identification (maize, cider, grape, …)
Beers	Origin identification (grains other than malt)
Alcoholic beverages	Mislabeling, origin identification
Honey	Addition of inverted and cane sugars
Olive oils	Addition of cheaper oils
Tea, Coffee	Mislabeling and origin
Dairy products	Addition of undeclared milk, Mislabeling
Meat	Mislabeling (origin) and feeding diet
Fish	Mislabeling (wild ↔ farmed)
Fruit and vegetables	Mislabeling (organic versus inorganic)

Summary of isotope fingerprints in Food Fraud

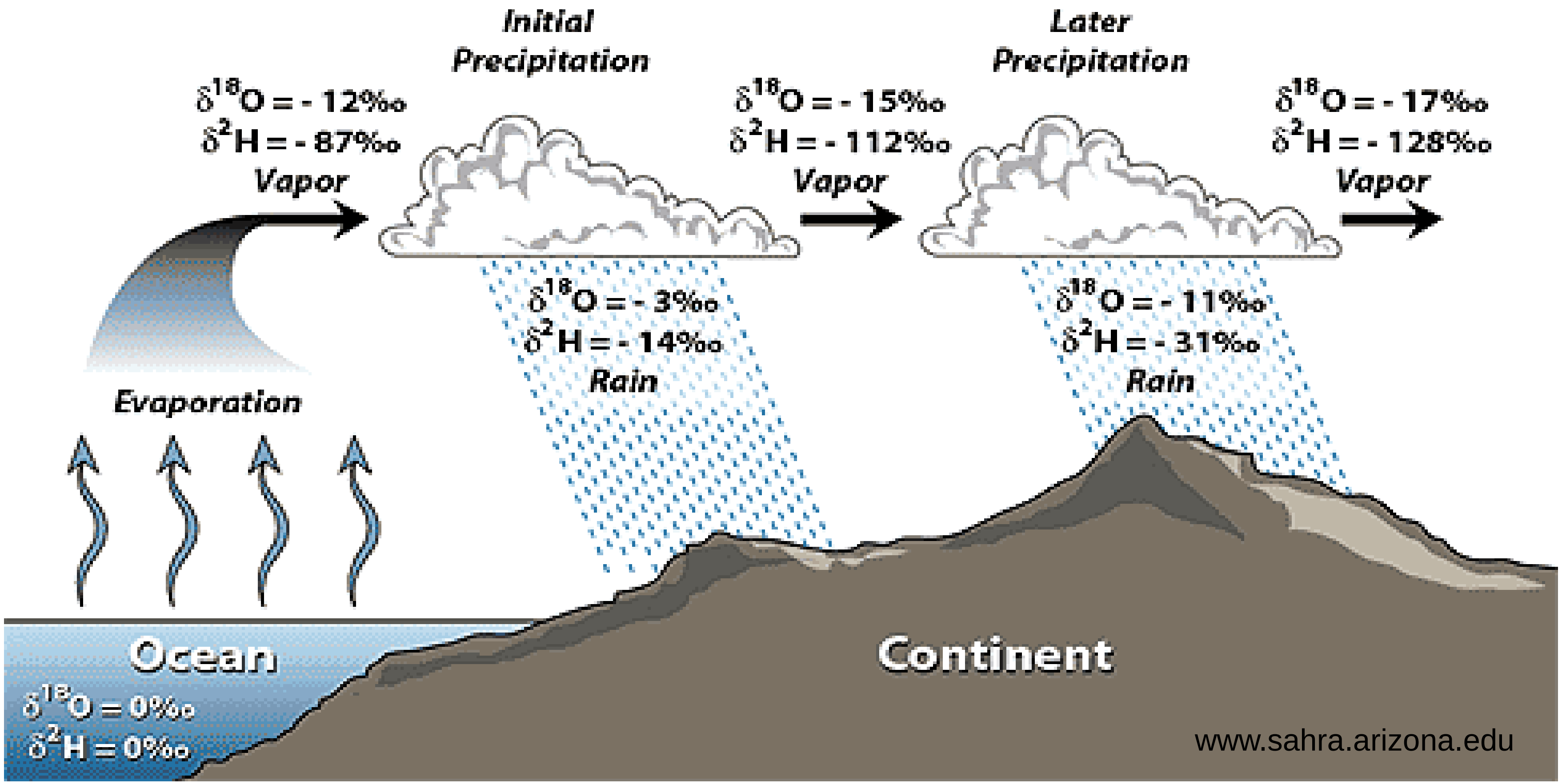
Stable Isotope	What is the biogeochemical interpretation?	What is an example of food fraud interpretation?	What products can be affected?
Carbon	Photosynthesis (C3, C4 and CAM pathways)	Adulteration (e.g. sweetening with cheap sugar)	Honey; Liquor; Wine; Oliver oil; Butter
Nitrogen	Fertilizer assimilation by plants	Mislabeling (Differentiate organic and non-organic)	Vegetables; Animal meat
Sulfur	Local soil conditions; Proximity to shoreline	Origin of product	Vegetables; Animal meat; Honey
Oxygen	Local-regional rainfall; geographical area	Watering of beverages; Origin	Coffee; Wine; Liquor; Water; Sugar; Meat
Hydrogen	Local-regional rainfall; geographical area	Watering of beverages; Origin	Coffee; Wine; Liquor; Water; Sugar; Meat

What can δ13C tell us?



- $\delta^{13}C$ values change due to fractionation induced by photosynthesis
  - For example, this can differentiate between products derived from C3 and C4 plants

What can δ^2H and $\delta^{18}O$ tell us?



- Hydrogen and oxygen isotopes are fractionated in the water cycle through evaporation, transpiration, sublimation, condensation and precipitation processes across the latitudes, giving rise to unique local – regional signatures, which transfer to biological material during their growth period

What can $\delta^{15}N$ and $\delta^{34}S$ tell you?

- Nitrogen Isotopes in food and beverages can provide information on:
  - Nitrogen sources for plants (e.g. fertilization)
  - Sources for animal feed stuffs

- Sulfur Isotopes in food and beverages can provide information on:
  - Sulfur sources for plants (e.g. fertilization), complimenting Nitrogen
  - Coastal versus inland geography (sea-spray)
  - Sources for animal feed stuffs

Thermo Scientific™ isotope ratio solutions for Food Integrity:

EA IsoLink IRMS System

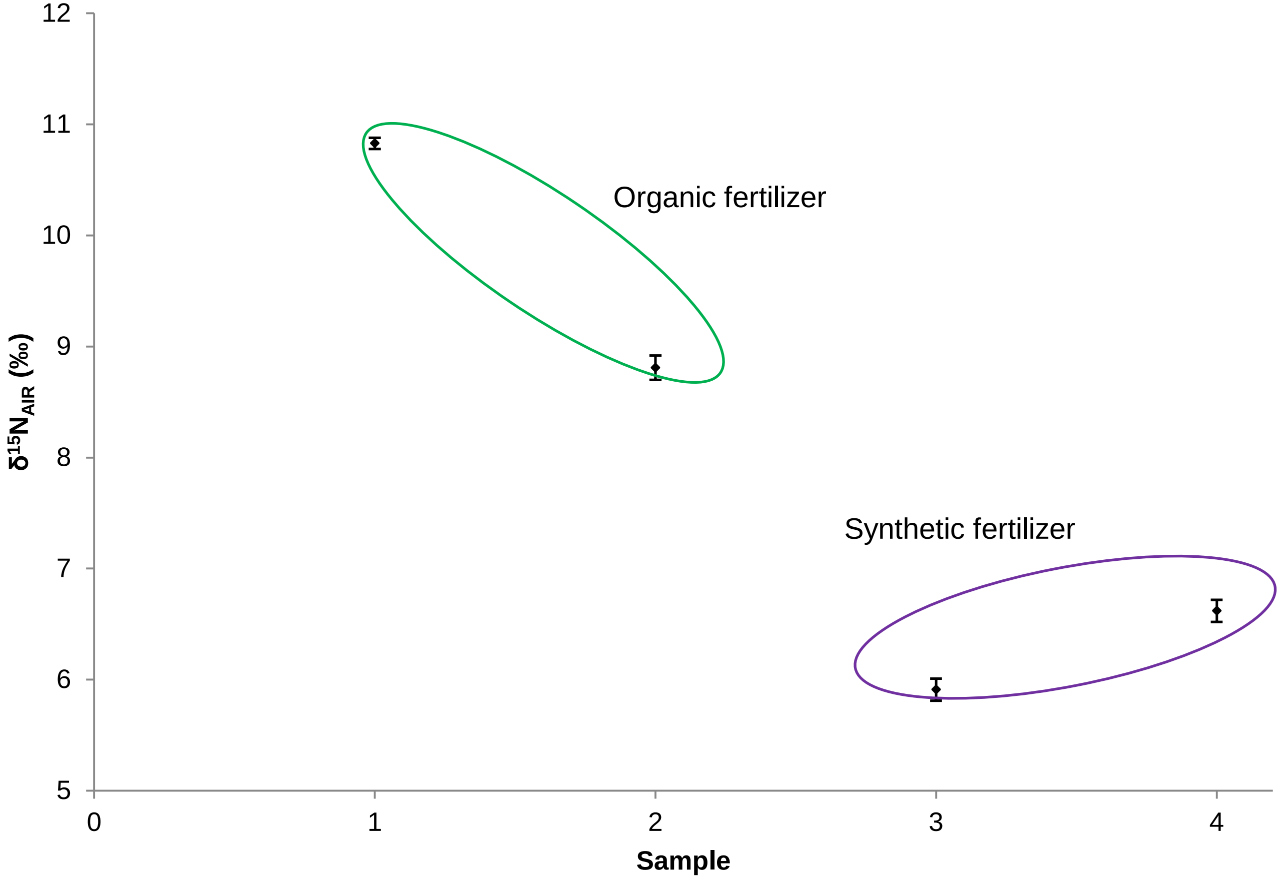
GC IsoLink II

LC IsoLink

GasBench II

EA-IRMS: δ15N in tomatoes (organic vs. non-organic)

Mineral fertilizer show low N values while organic fertilization by compost reults in higher N values.



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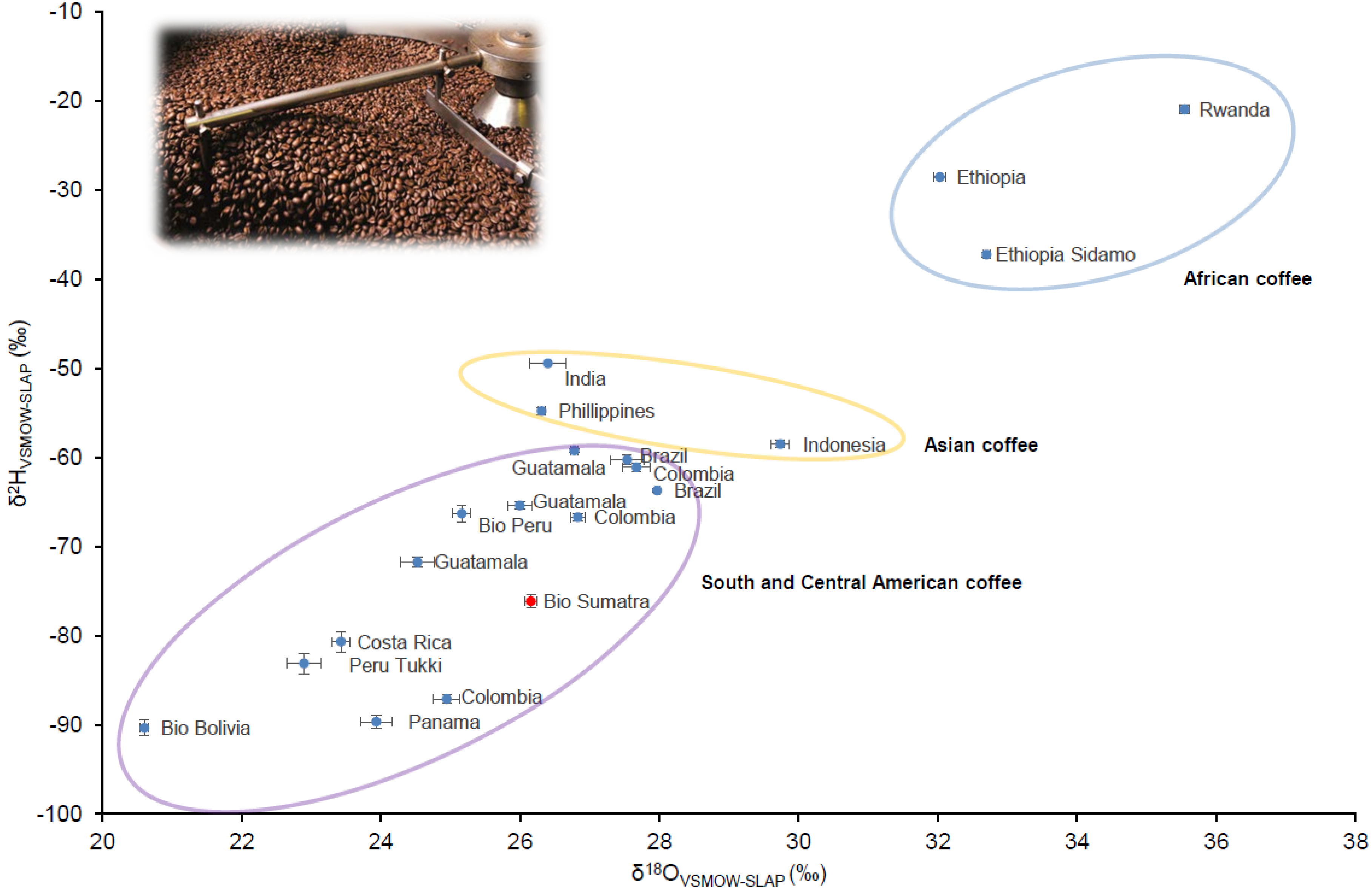
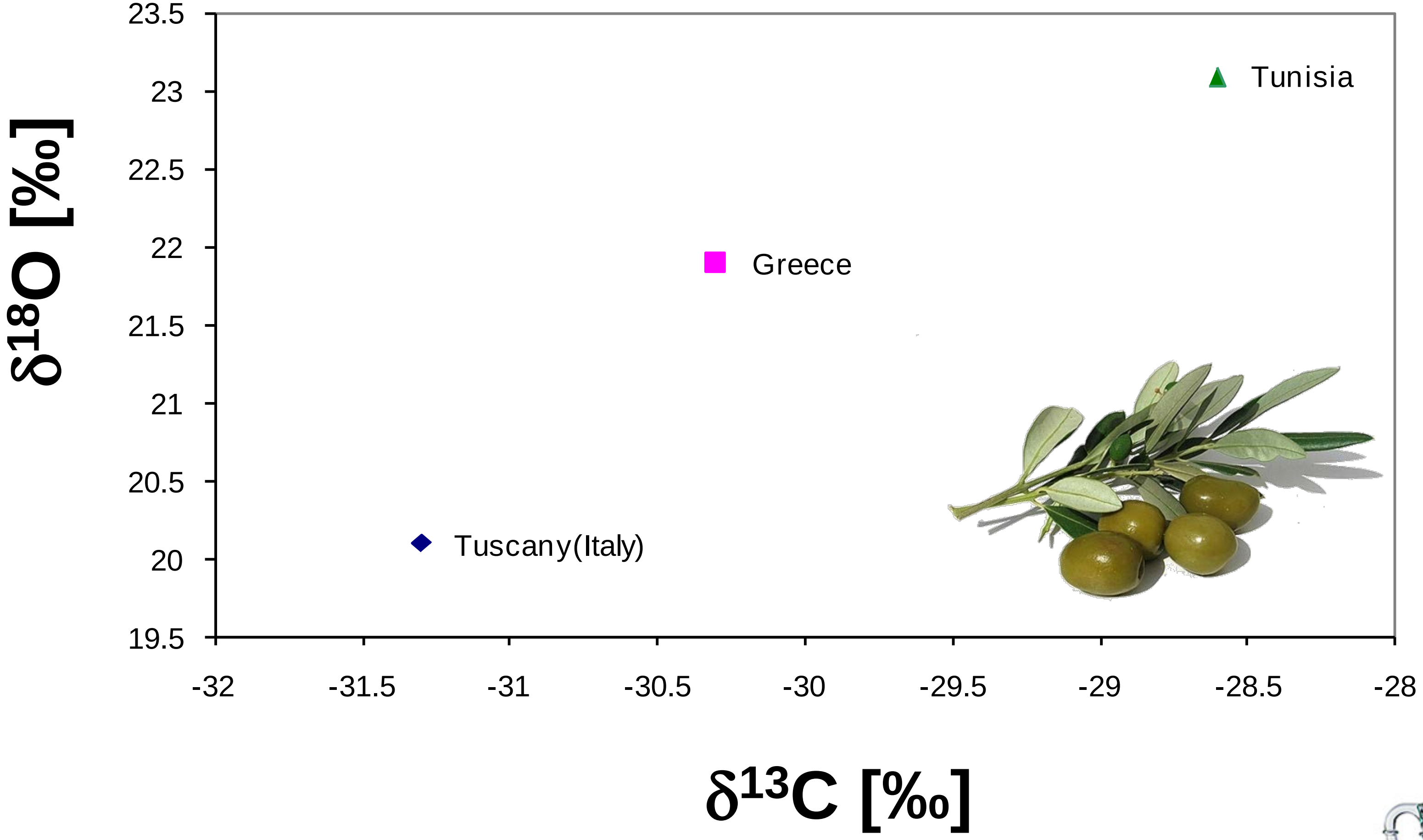
EA-IRMS: δ^2H and $\delta^{18}O$ in Roasted Coffee Beans



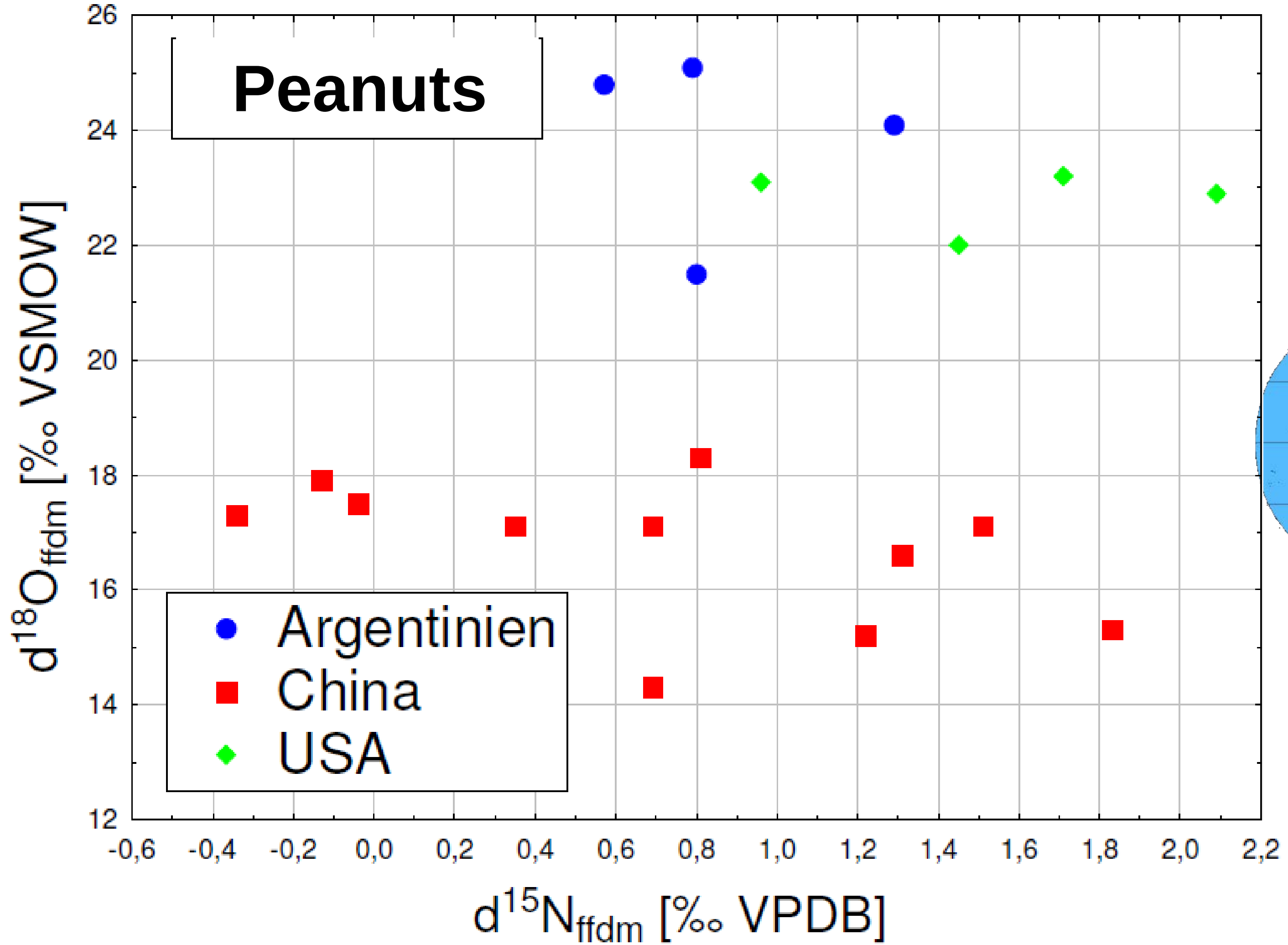
EA-IRMS: $\delta^{13}C$ and $\delta^{18}O$ in Olive Oil

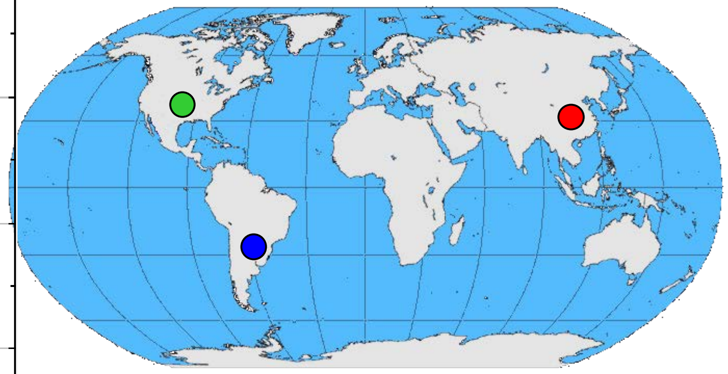
Where does your olive oil come from?



Data taken from: Giovanni Fronza, et al.
Rapid Commun. Mass Spectrom. 2001; 15: 763-766

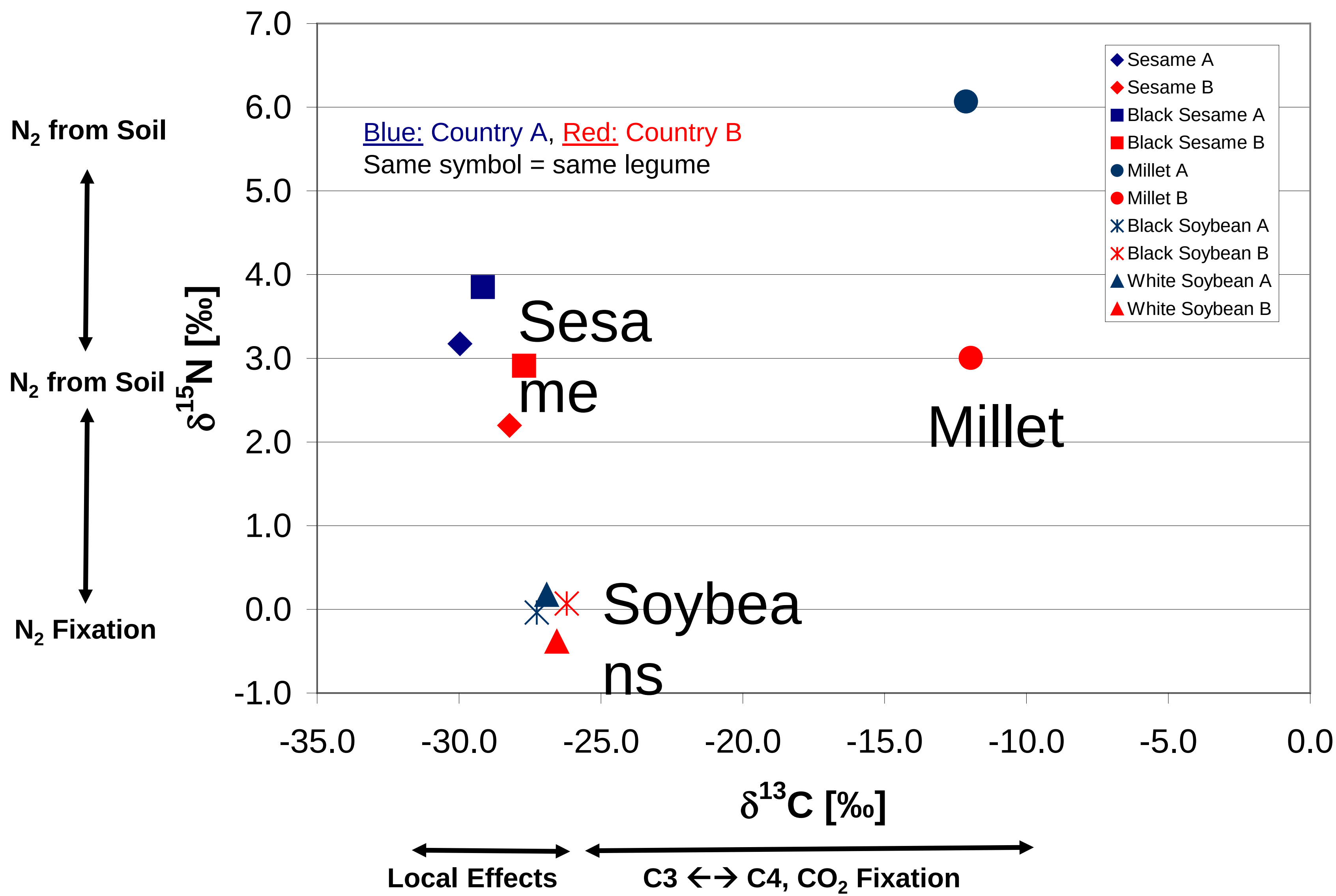
$\delta^{18}O$ as indicator for origin
$\delta\ ^{15}N$ often related to fertilizers





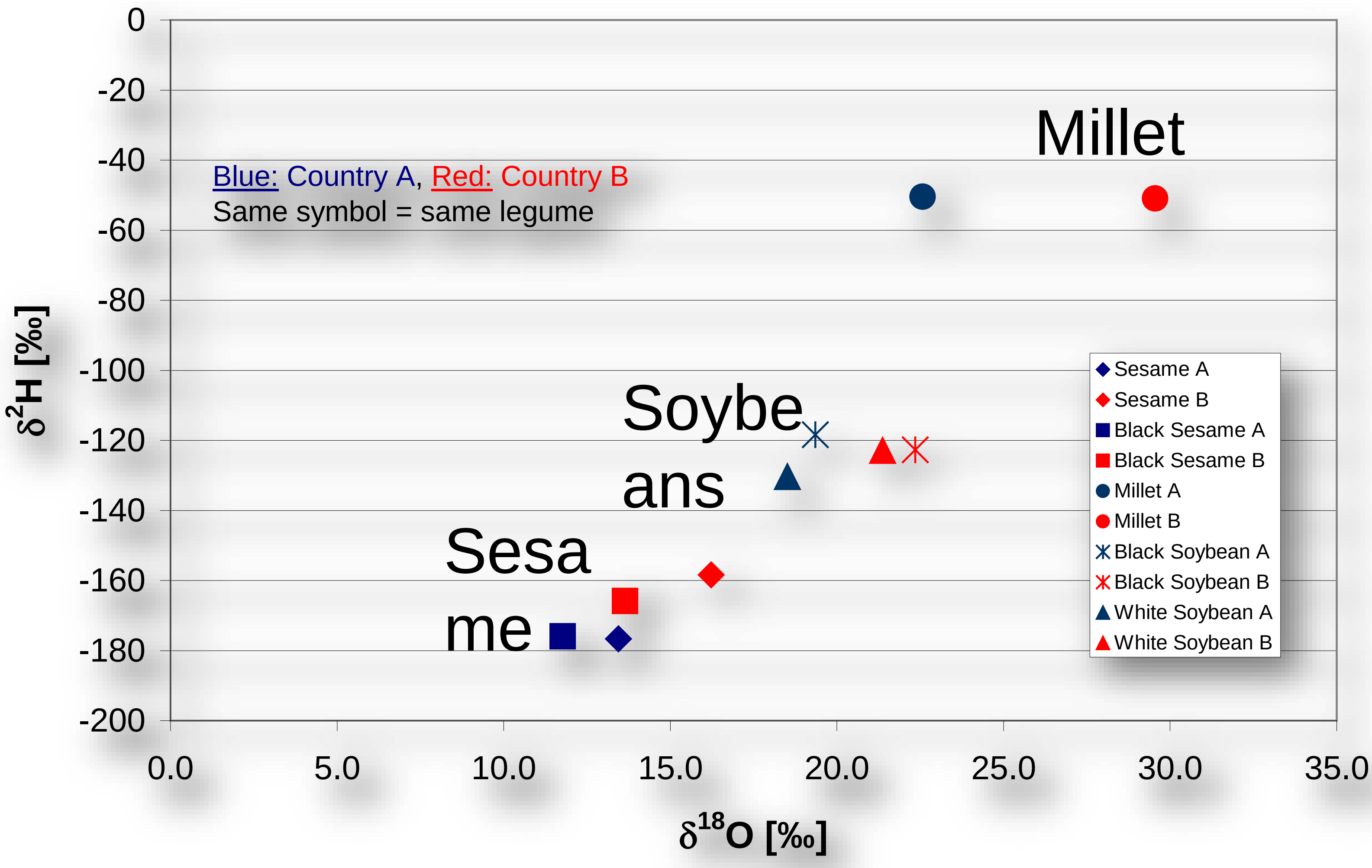
EA-IRMS: Origin of seeds, millet and soybean

Agricultural products from Korea (Blue) and China (Red)



EA-IRMS: Origin of seeds, millet and soybean

Agricultural products from Korea (Blue) and China (Red)



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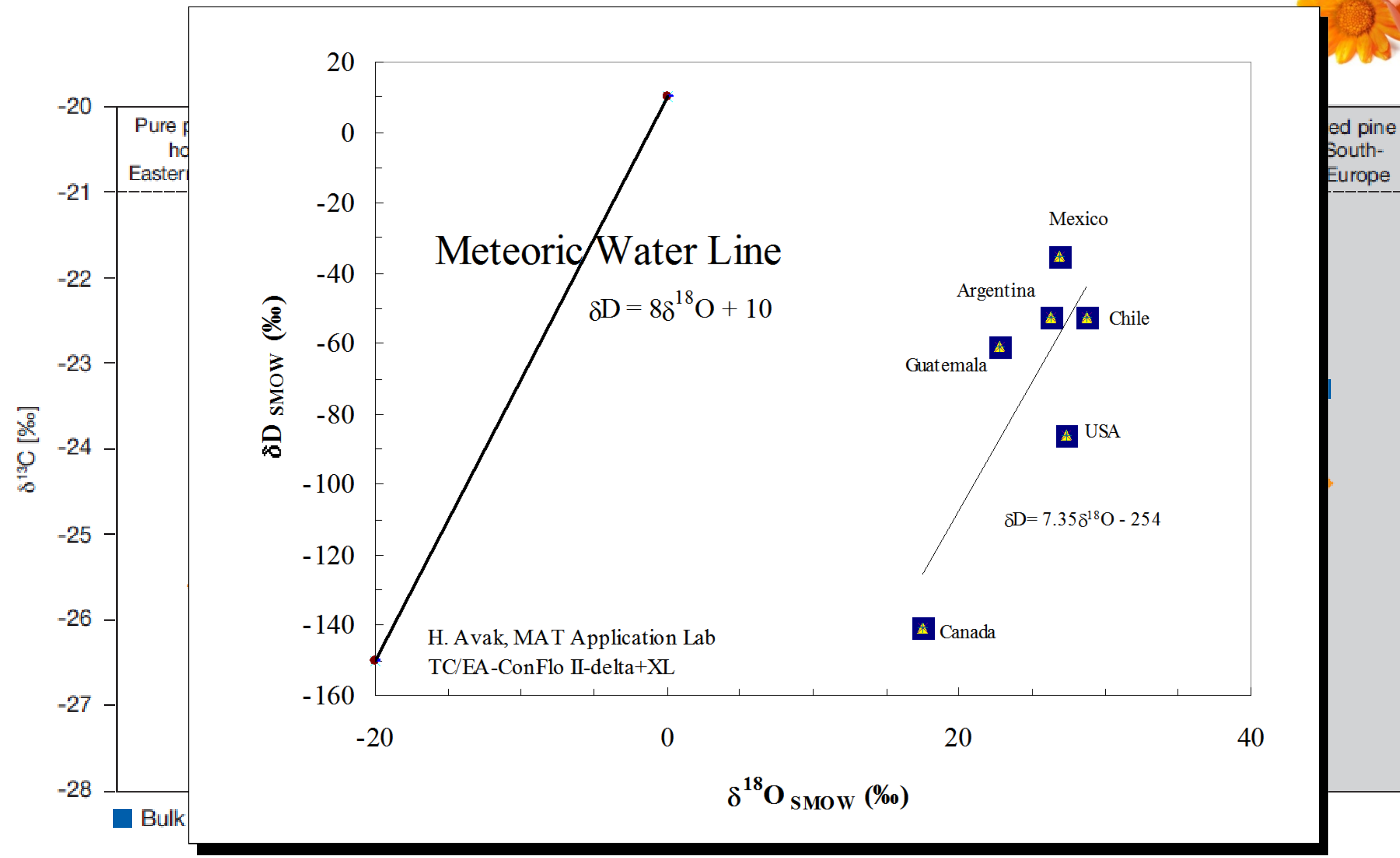
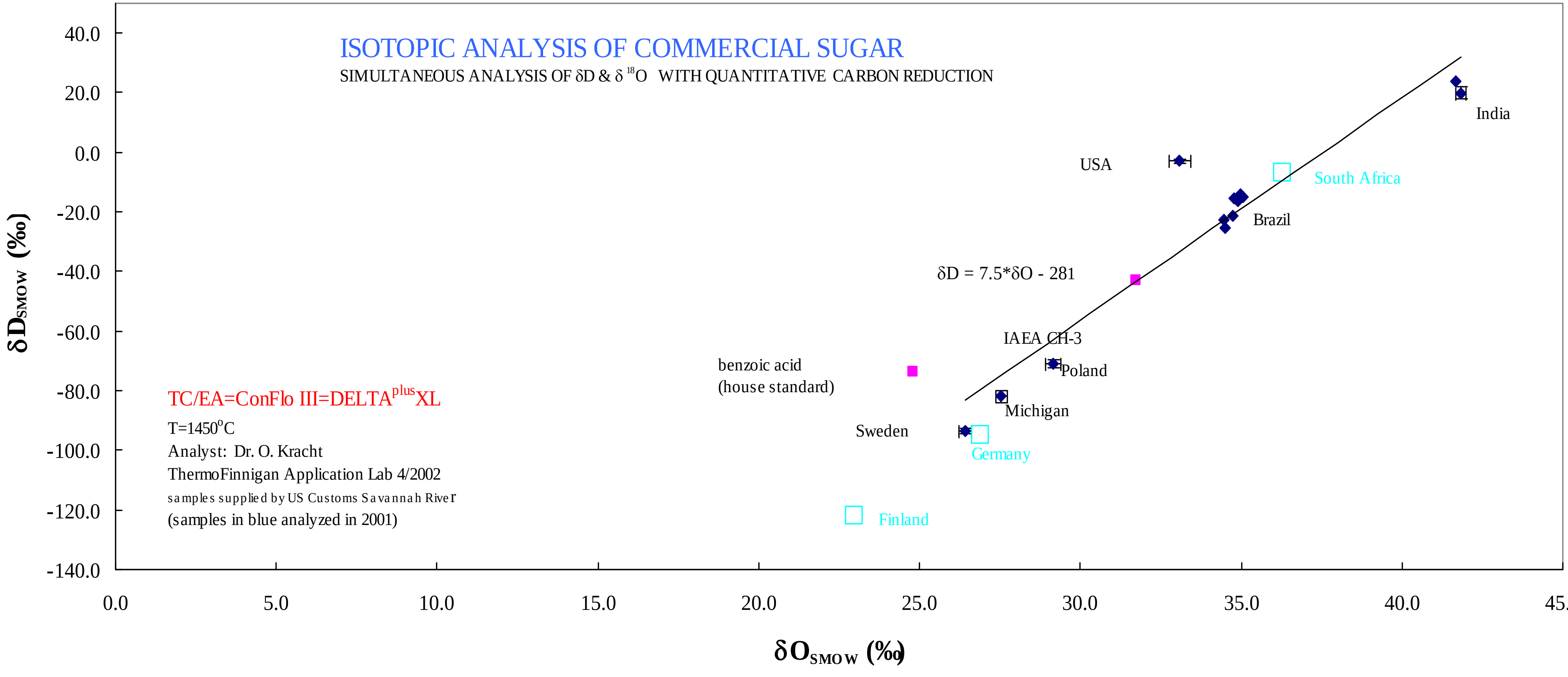
The Isotope fingerprint of honey can define where it comes from



EA-IRMS: H and O Isotope fingerprints for sugar origin

The origin of Sugar as defined by Hydrogen and Oxygen isotopes



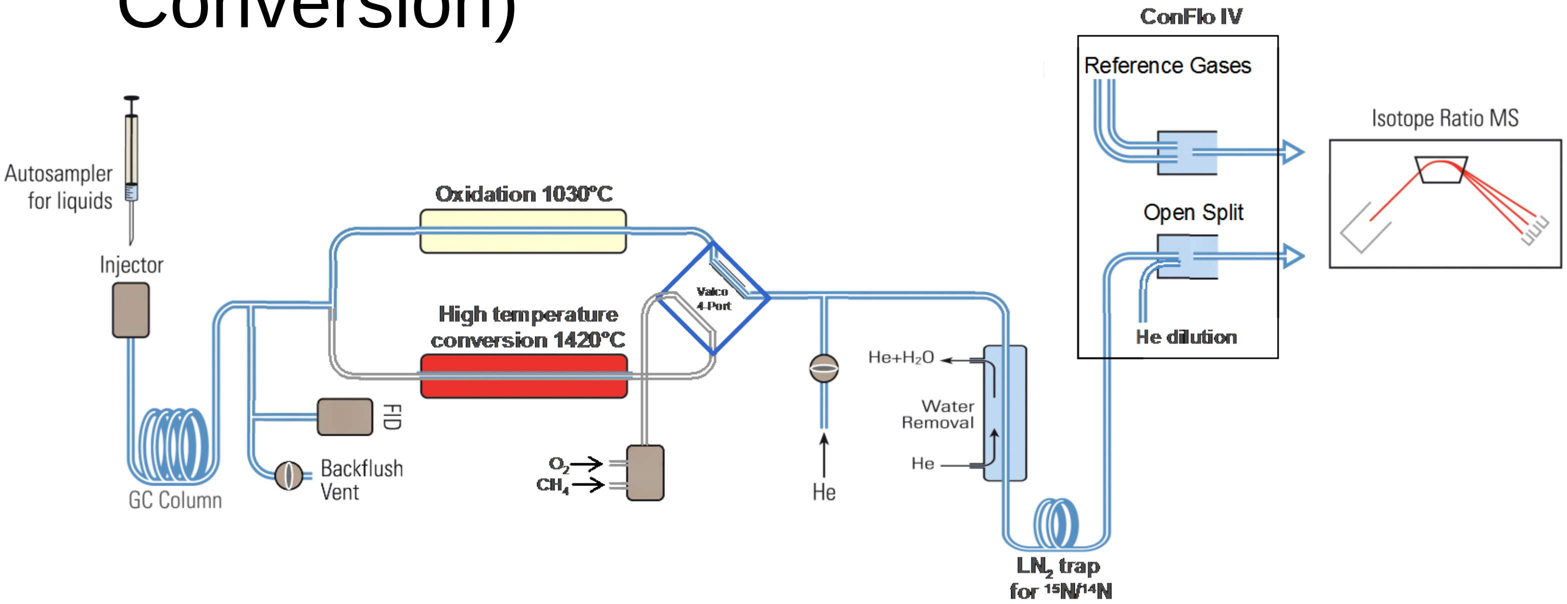
EA-IRMS: C Isotope fingerprints for sugar authenticity

Carbon isotope fingerprints can determine if label claims are correct:

Is your sugar really beet sugar?

Sample	$\delta^{13}C_{VPDB}$ (mean ± 1σ)	Label Claim	Do the $\delta^{13}C$ fingerprints agree?
China	-12.61± 0.15	Corn sugar	Corn sugar
France	-12.14±0.12	Cane sugar	Cane sugar
Hawaii (Brown)	-12.41±0.13	Cane sugar	Cane sugar
Italy (Brown)	-12.22±0.05	Cane sugar	Cane sugar
Ivory Coast	-12.24±0.19	Cane sugar	Cane sugar
Philippines	-12.95±0.09	Cane sugar	Cane sugar
San Francisco	-12.89±0.04	Cane sugar	Cane sugar
Senegal	-12.42±0.25	Cane sugar	Cane sugar
United Kingdom	-12.75±0.04	Cane sugar	Cane sugar
Dubai	-25.02±0.02	Not stated	Beet sugar
Germany	-26.69±0.08	Not stated	Beet sugar

Compound Specific Isotope Analysis for $^{13}C/^{12}C$ Isotope Ratios and $^{15}N/^{14}N$ Isotope Ratio (GC-Combustion) and $^{2}H/^{1}H$ Isotope Ratios and $^{18}O/^{16}O$ Isotope Ratio (GC-High Temperature Conversion)



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GC-IRMS: Isotopes can tell if Tequila is real or not

Plant

This liquor is made exclusively in Mexico from the agaves,

***Agave tequilana weber*.**

Harvest: after 6-10 years

Origin of Tequila

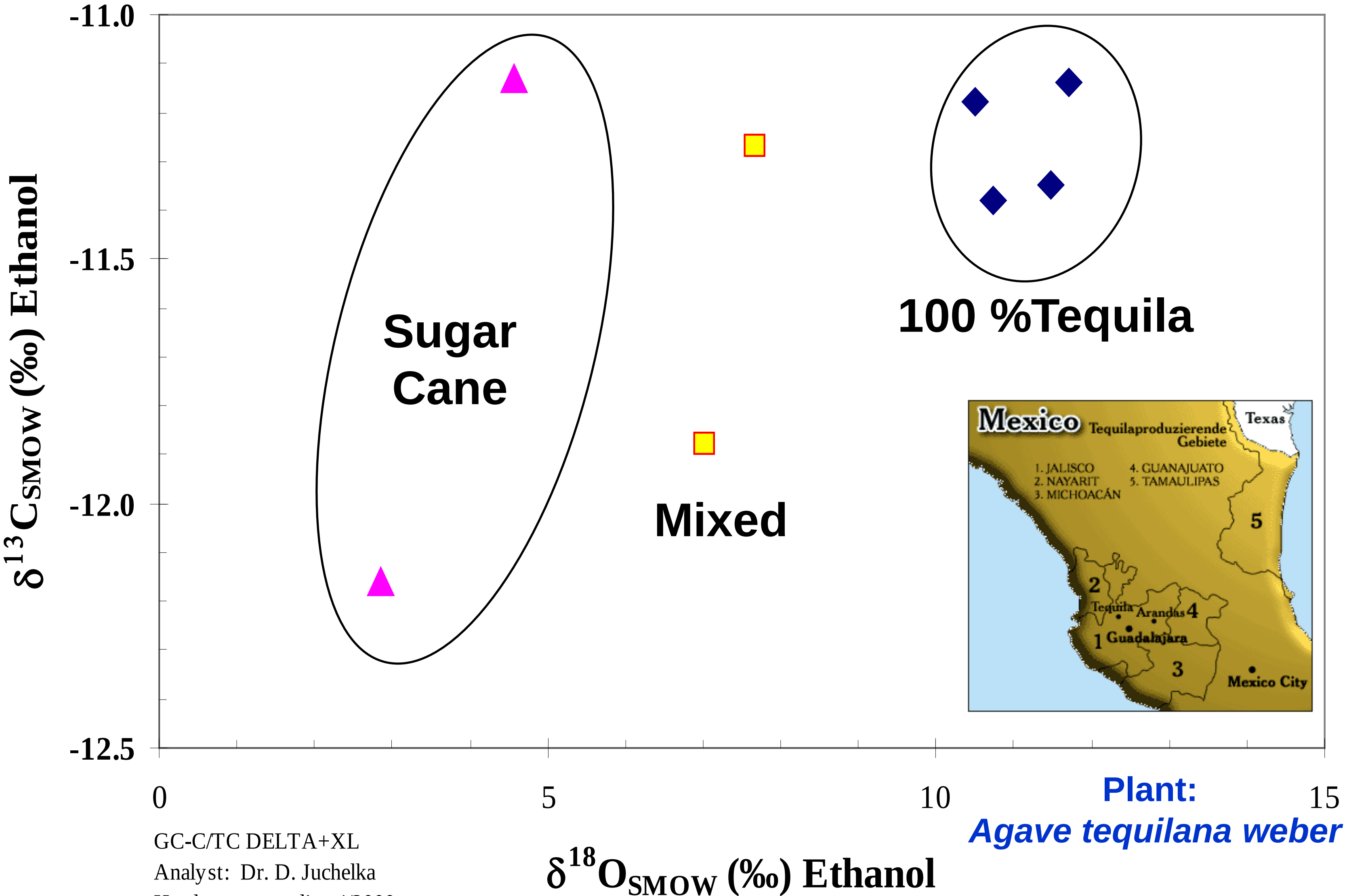
Tequila is produced *exclusively* in 5 regions of Mexico:

- **Jalisco,**
- **Nayarit,**
- **Michoacán,**
- **Guanajuato,**
- **Tamaulipas**

GC-IRMS: Isotopes can tell if Tequila is real or not

δ^{13}C:
Enzymatic Fractionation of Isotope Ratios

δ^{18}O:
Physical Fractionation of Isotope Ratios



GC-C/TC DELTA+XL
Analyst: Dr. D. Juchelka
Headspace sampling 4/2000

Plant:
Agave tequilana weber

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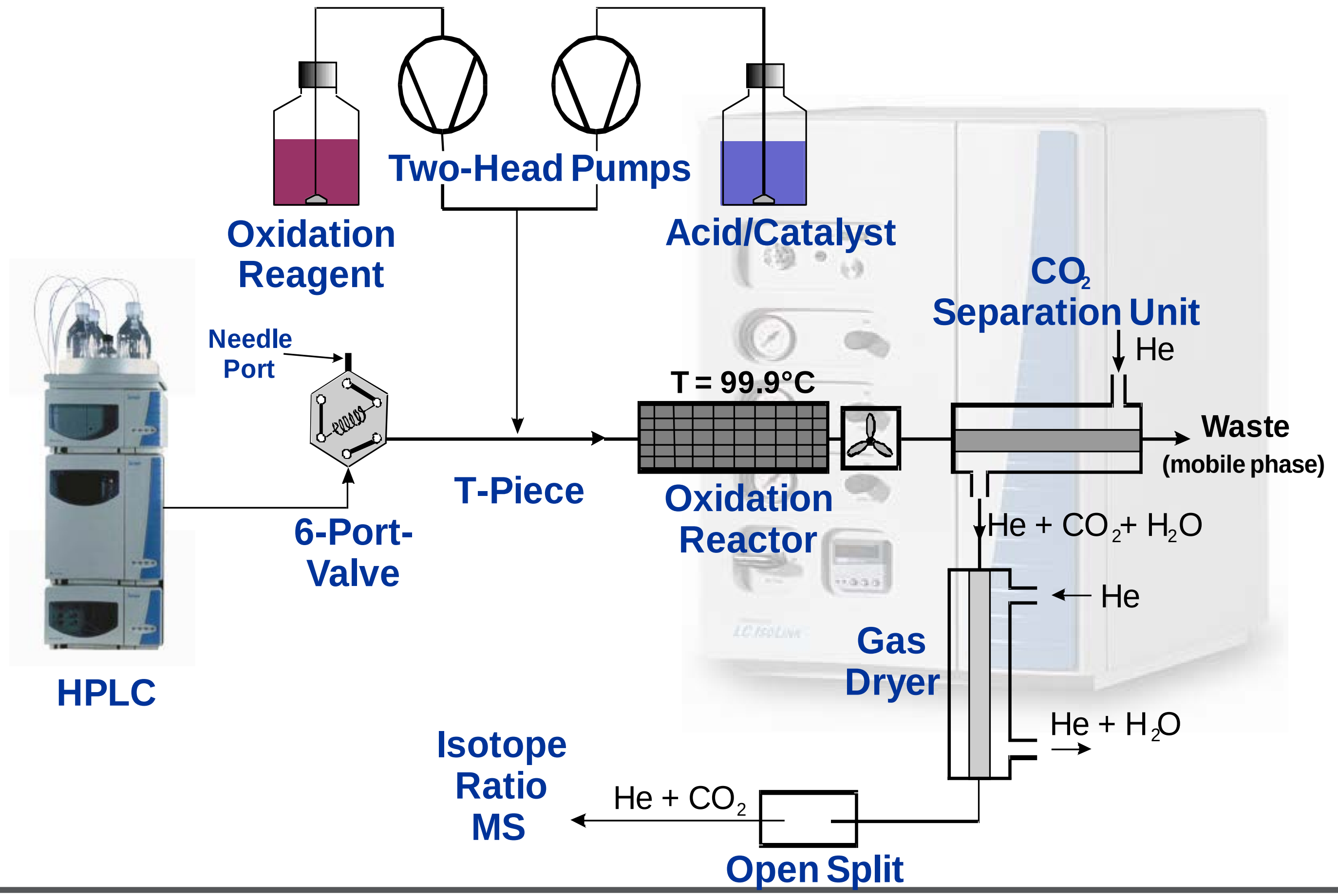
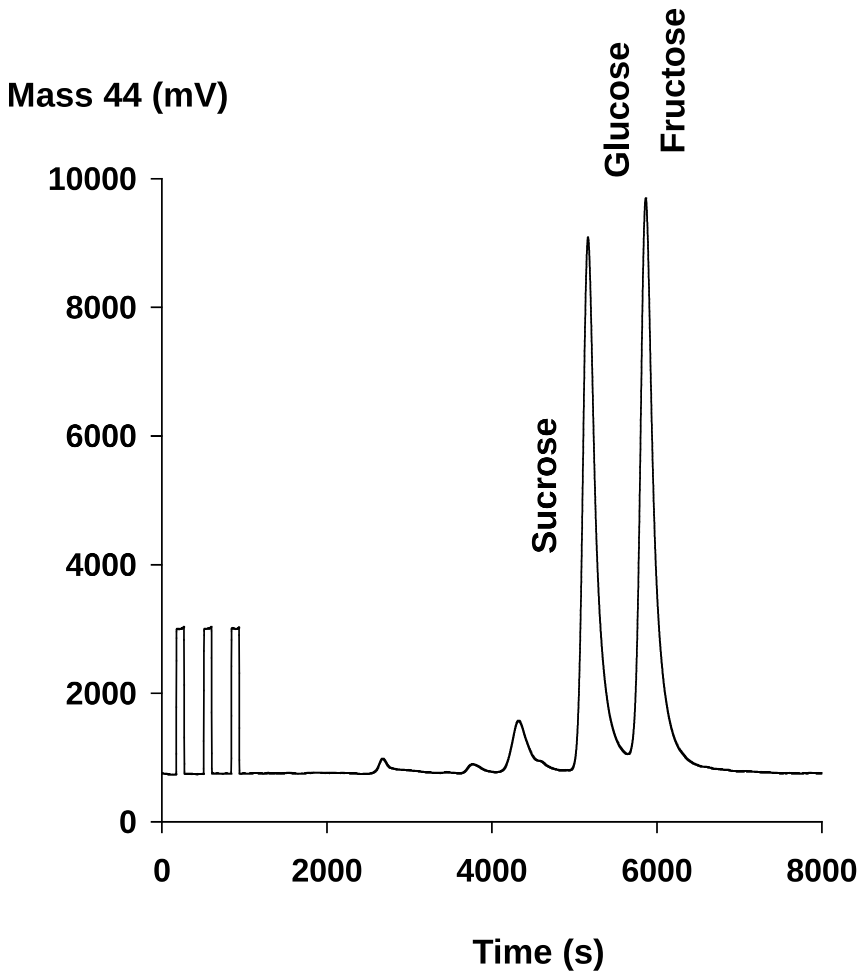
Thermo Scientific LC IsoLink



LC-IRMS: Identification of honey adulteration through sweetening

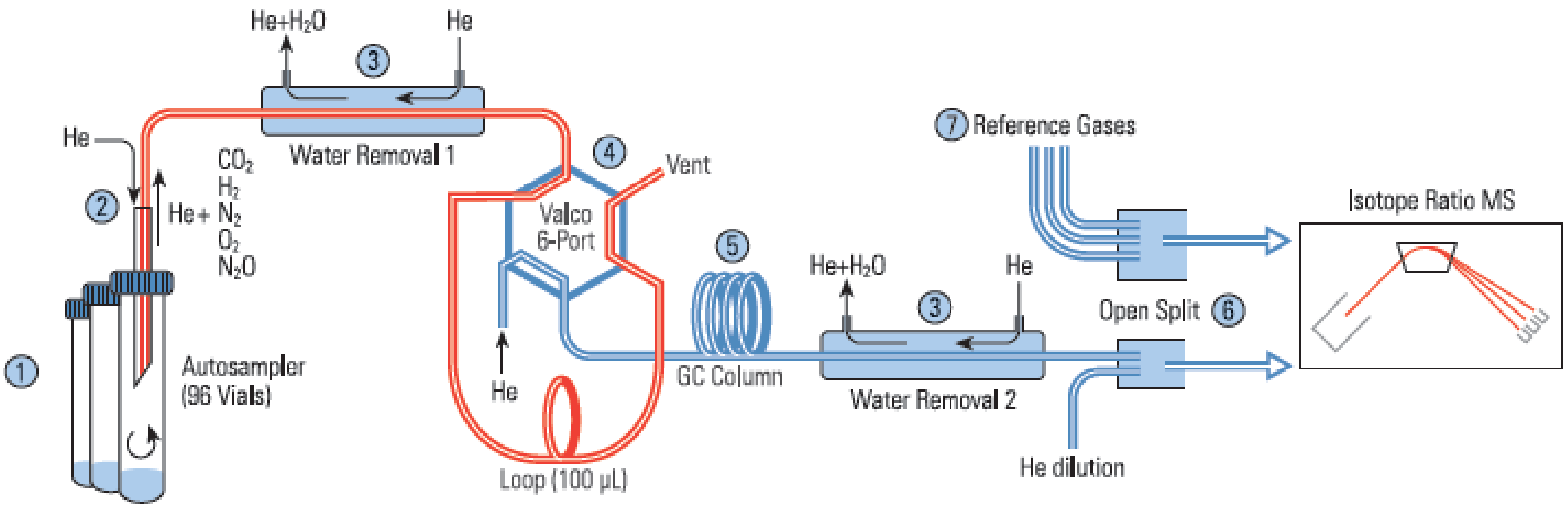
The carbon isotope value of fructose additives can identify adulterated honey



Honey	Glucose $\delta^{13}C$‰	Fructose $\delta^{13}C$‰	Area Fru/Glu	
A	-27.9	-27.8	1.13	pure
B	-25.1	**-26.4**	2.17	**adulterated**
C	-26.5	-26.5	1.35	pure
D	-26.1	-26.0	**4.53**	**adulterated**
E	-11.2	**-13.9**	0.65	**adulterated**

- Absolute $\delta^{13}C$ value
- $\delta^{13}C$ difference, Glu – Fru
- Ratio of area, Fru / Glu

Thermo Scientific GasBench II



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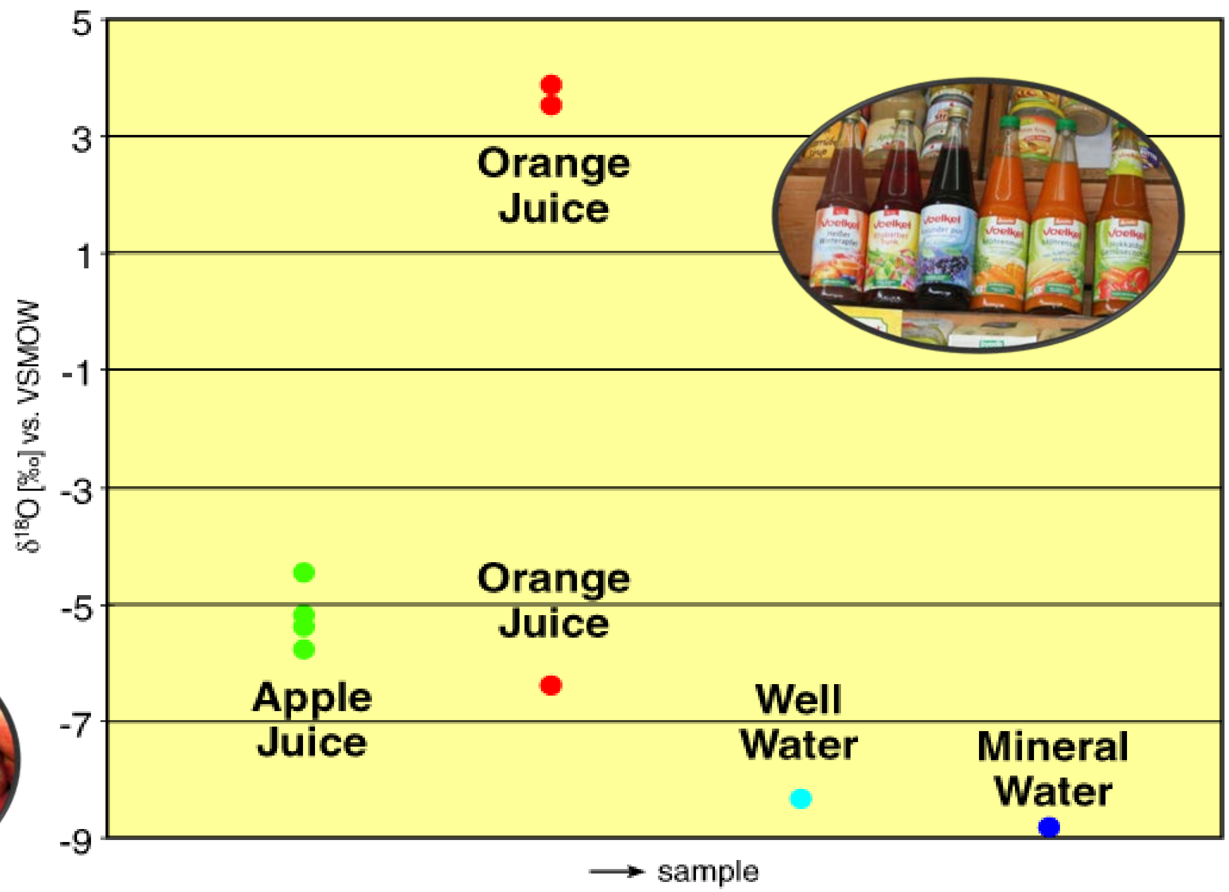
Analysis of fruit juices with the GasBench II



^{18}O equilibration of water in wine from China, Australia & Europe

	x	σ1	n
Hoo-Roo_Austrialia	7.39	0.11	3
QYTB1	-0.92	0.01	3
HeBiNuo1999_ZhangYe-1	5.27	0.06	3
QYTB	-8.13	0.09	3
GreatWall2002_T-1	5.60	0.07	3
COTES DE CASTILION_France-1	1.63	0.03	3
GreatWall1995_ChangLi-2	2.13	0.07	3
QYTB2	-20	0.07	3
Dragon Seal-ShaCheng-9	-0.04	0.10	3
GreatWall_S-2	4.96	0.15	3
Dynasty_TianJin-6	2.33	0.10	2
Dynasty_TianJin-2	2.32	0.24	3
Dynasty_TianJin-1	5.28	0.08	3
GreatWall_S-1	5.02	0.13	2
GreatWall_S-4	3.69	0.09	3
MouTai_ChangLI-3	-0.70	0.10	3
GreatWall_S-3	4.25	0.07	2
Gynasty_TianJin-4	0.40	0.13	3
Gynasty_TianJin-3	5.37	0.12	2
MoGao_WuWei-2	4.69	0.04	3
Grand Dragon_YanTai-1	-0.52	0.21	3
GreatWall_ShaCheng-3	3.96	0.04	3
Virtopia_YunNan-1	1.66	0.05	3
ChangYu_YanTai-4	1.00	0.08	3
GreatWall Longxi99_HuaiZhuo-1	2.28	0.11	3
YunnanHong_YunNan-5	-7.42	0.02	3
Baroncini_Italy	2.96	0.23	3
YunnanHong_YunNan-4	-3.47	0.06	3
Ice Wine_TongHua	-7.41	0.11	3
Grand Dragon_YanTai-2	1.31	0.09	3
GreatWall1995_ShaCheng-2	4.13	0.04	3
Dragon Seal_ShaCheng-10	0.15	0.05	3

QYTB1	assigned for SMOW
QYTB2	assigned for SLAP
QYTB	Chinese QC (-8.14 permil $\delta^{18}O$)

- **QYTB (QC) =** (-8.13 permil $\delta^{18}O$)
- **Average σ1 is 0.09 (n=31)**
- **Measurements showed perfect agreement what is expected for a normal pure water measurement**

- **Total n = 31 of which 27 are triplicates and 4 are duplets**
- **Delta V Advantage**

GasBench II and Flash HT data with Delta V

Accuracy between Devices & organic rich matrices

- milk and coffee cream

$^{18}O/^{16}O$ by GB-IRMS and Flash HT

analyte	IAEA accepted value *$\delta^{18}O/^{16}O$ VSMOW [‰]*	Flash HT *$\delta^{18}O/^{16}O$ VSMOW [‰]*	*1 σ*	GB *$\delta^{18}O/^{16}O$ VSMOW [‰]*	*1 σ*	*comment*
V-SMOW 06	0	0.00	0.05	0.01	0.02	measured as sample
V-SMOW 03	0	n.d.	n.d.	0.03	0.23	measured as sample
SLAP	-55.50	n.d.	n.d.	-55.50	0.04	measured as sample
GISP	-24.50	-24.80	0.06	-24.76	0.06	measured as sample
GISP 98		n.d.	n.d.	-24.25	0.08	measured as sample
GISP 06		n.d.	n.d.	-24.81	0.08	measured as sample
orange juice		n.d.	n.d.	-7.04	0.04	measured as sample
coffee cream		n.d.	n.d.	1.40	0.001	measured as sample
HBW-1		n.d.	n.d.	-8.05	0.000	measured as sample
HBW-3		-7.91	0.04	-7.86	0.01	measured as sample
Ethanol		24.26	0.08	n.d.	n.d.	measured as sample
Flt PTSW				4.13	0.58	wine as sample

analyzed by Thermo Electron (Bremen) IRMS Applications Laboratory, June 2006

all ratios and σ1 resultant from SMOW/SLAP correction

Flash HT with AS 3000

GB used with 4ml, 12ml vials and 100 µl, 200 µl sample, respectively

Official methods and Isotope Fingerprints

Product	Official method	Isotope fingerprint	Sample	What does it address?	Analytical solution
Wine					
	OIV-MA-AS2-12	$\delta^{18}O$	Water	Adulteration, Geographical origin, Year of vintage	Thermo Scientific™ GasBench II System, Thermo Scientific™ Dual Inlet
	OIV-MA-AS312-06	$\delta^{13}C$	Ethanol, Wine must, Grape sugar	Adulteration, origin	Thermo Scientific™ EA IsoLink™ IRMS System, Thermo Scientific™ GC IsoLink II™ Interface for GC-IRMS
	OIV-AS312-07	$\delta^{13}C$	Glycerol in wines	Adulteration by addition of glycerol from C4 maize or Fossil sources	GC IsoLink II Interface for GC-IRMS, Thermo Scientific™ LC IsoLink™ Interface for IRM-LC/MS
	OIV-OENO 510-2013	$\delta^{13}C$	Acetic acid in wine, vinegar		GC IsoLink II Interface for GC-IRMS, EA IsoLink IRMS System
	OIV-OENO 510-2013	$\delta^{18}O$	Water in wine, vinegar	Adulteration, Geographical Origin, Year of Vintage	Thermo Scientific™ GasBench II System, Dual Inlet
Sparkling wine					
	OIV-MA-AS314-03	$\delta^{13}C$	CO_2 in sparkling wine	Origin and authenticity of sparkling wine	GasBench II System, EA IsoLink IRMS System, GC IsoLink, Dual Inlet
Spirits					
	OIV-AS312-07	$\delta^{13}C$	Glycerol in spirits	Adulteration by addition of glycerol from C4 maize or Fossil sources	GC IsoLink II Interface for GC-IRMS, LC IsoLink Interface for IRM-LC/MS
Fruit Juice					
	EU – CEN 1995	$\delta^{13}C$	Sugars	Adulteration	GasBench II System, LC IsoLink Interface for IRM-LC/MS, GC IsoLink II Interface
	USA – AOAC 1981	$\delta^{13}C$	Sugars	Adulteration	GasBench II System, LC IsoLink Interface for IRM-LC/MS, GC IsoLink II Interface
	EU – CEN 1998	$\delta^{13}C$	Sugars and pulp	Adulteration	GasBench II System, LC IsoLink Interface for IRM-LC/MS, GC IsoLink II Interface
	EU – CEN 1995	$\delta^{2}H$ and $\delta^{18}O$	Water	Adulteration	GasBench II System, LC IsoLink Interface for IRM-LC/MS, GC IsoLink II Interface
	AOAC method 2004.01	$\delta^{13}C$	Ethanol (From Fermentation)	Adulteration	GasBench II System, LC IsoLink Interface for IRM-LC/MS, GC IsoLink II Interface
Fruit Juice (Concentrate)					
	AOAC 1992	$\delta^{18}O$	Water	Adulteration	GasBench II System, LC IsoLink Interface for IRM-LC/MS, EA IsoLink IRMS System
Honey					
	AOAC method 991.41	$\delta^{13}C$	C-4 plant sugars at concentration >7%	Adulteration of honey	EA IsoLink IRMS System
	AOAC method 998.12	$\delta^{13}C$	C-4 plant sugars at concentration >7%	Adulteration of honey	EA IsoLink IRMS System
Cheese					
	EU Reg 548/2011	$\delta^{13}C$	PDO	PDO Grana Padano	EA IsoLink IRMS System

Thank You!

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