



**WAGENINGEN EVALUATING PROGRAMS
FOR ANALYTICAL LABORATORIES**

Certificate of Analysis



International Plant-Analytical Exchange

REFERENCE MATERIAL

IPE sample 249



General Information

In this report an overview is given of analytical data for this sample collected in our proficiency testing program. The consensus values are calculated using a robust statistical model. With this NDA model mean and standard deviation are calculated using all reported data when at least 8 results are left after removal of reported 'lower than' (<) and 0 (= zero) values. No outliers are removed.

This report is divided into three sections: Consensus Values, Indicative Values and Values for Information. The division is made on the reliability of the data. Consensus Values are based on at least 16 results while the coefficient of variation is smaller than 25 %. Indicative Values are based on at least 8 and less than 16 results or a coefficient of variation between 25 % and 50 %. Other values, based on more than 2 and less than 8 results or a coefficient of variation higher than 50 %, are given for information only.

In the sections with Consensus Values and Indicative Values the following parameters are given: mean, standard deviation, coefficient of variation, number of results, median and MAD (Median of Absolute Deviation) and the uncertainty in the consensus values. The confidence limits (at 95 % probability) are calculated for these determinands.

In the section with Information Values the following parameters are given: median, MAD and number of results. For determinands which have at least 5 results reported as smaller than (<) the median of these 'smaller than results' is calculated. In some cases this median of '<' values is much smaller than median and mean of the indicative values. This may be caused by a too optimistic (too low) value for the detection limit reported by a (small) majority of participating laboratories who report '<' -values.

All values, expressed on a weight basis (kg or %), are reported in oven dry (105 °C) material. Moisture is reported in the material as received.

Sample information

WEPAL reference materials are from natural sources only. There is no spiking, mixing or other alterations of the samples. For sample preparation the IPE samples are dried at 70 °C and milled to pass a 0.5 mm sieve.

This IPE sample 249 of Cocoa (bean) / Theobroma cacao from Ecuador is prepared for the WEPAL proficiency programs. The sample is used in 2 periods (or rounds). The results on which the values in this report are based were taken from the periods given in the following table.

Year	Round	Number
2022	3	2
2019	4	4



Consensus Values IPE 249



Method: Inorganic Chemical Composition

Element	Unit	Mean	Std.Dev.	CV %	N	Median	MAD	Uncertainty	95 % confidence limits		
As	µg/kg	56.9	8.62	15.1	24	57.8	5.95	2.20	53.3	-	60.6
B	mg/kg	17.4	1.63	9.4	144	17.4	1.15	0.17	17.09	-	17.62
Ca	g/kg	1.32	0.122	9.2	188	1.31	0.085	0.011	1.31	-	1.34
Cd	µg/kg	1000	118	11.8	51	990	84	21	971	-	1037
Co	µg/kg	741	72.0	9.7	41	725	47.8	14.1	718	-	763
Cu	mg/kg	22.5	1.72	7.6	190	22.6	1.17	0.16	22.30	-	22.80
Fe	mg/kg	119	19.8	16.7	178	120	13.5	1.9	115.6	-	121.5
K	g/kg	11.9	0.65	5.5	199	11.9	0.44	0.06	11.80	-	11.99
Mg	g/kg	3.45	0.227	6.6	193	3.44	0.159	0.020	3.42	-	3.48
Mn	mg/kg	20.8	1.64	7.9	180	20.8	1.14	0.15	20.58	-	21.06
Mo	µg/kg	397	43.0	10.8	45	400	30.0	8.0	384	-	410
N - Kjeldahl (as N)	g/kg	22.6	1.06	4.7	121	22.7	0.74	0.12	22.45	-	22.83
Ni	µg/kg	4570	471	10.3	35	4520	345	100	4410	-	4734
P (as P)	g/kg	4.73	0.290	6.1	198	4.70	0.200	0.026	4.69	-	4.77
S (as S)	g/kg	1.50	0.114	7.6	111	1.50	0.080	0.014	1.48	-	1.52
Se	µg/kg	264	41.7	15.8	21	250	29.0	11.4	245	-	283
Zn	mg/kg	55.2	4.32	7.8	186	55.1	2.96	0.40	54.5	-	55.8

Method: Real totals

Element	Unit	Mean	Std.Dev.	CV %	N	Median	MAD	Uncertainty	95 % confidence limits		
C - elementary	g/kg	608	9.5	1.6	59	608	6.4	1.5	605.2	-	610.1
N - elementary	g/kg	23.2	0.70	3.0	96	23.2	0.50	0.09	23.08	-	23.36

Method: Nutritional values

Element	Unit	Mean	Std.Dev.	CV %	N	Median	MAD	Uncertainty	95 % confidence limits		
Total ash	g/kg	40.3	2.52	6.3	27	41.0	1.81	0.61	39.3	-	41.3



Indicative Values IPE 249



Method: Inorganic Chemical Composition

Element	Unit	Mean	Std.Dev.	CV %	N	Median	MAD	Uncertainty	95 % confidence limits		
Ba	mg/kg	8.60	0.711	8.3	13	8.69	0.501	0.247	8.18	-	9.03
Cr	µg/kg	662	248.7	37.6	31	652	164.0	55.8	571	-	753
Hg	µg/kg	4.56	1.720	37.7	17	4.96	1.270	0.521	3.68	-	5.44
Pb	µg/kg	132	43.2	32.8	35	138	30.5	9.1	117	-	147
Sr	mg/kg	14.5	1.35	9.3	10	14.4	0.93	0.53	13.6	-	15.5
V	µg/kg	237	54.9	23.2	10	250	34.3	21.7	198	-	275

Method: Real totals

Element	Unit	Mean	Std.Dev.	CV %	N	Median	MAD	Uncertainty	95 % confidence limits		
Al	mg/kg	102	39.2	38.3	18	107	27.1	11.5	82.8	-	122

Method: Acid extractable (So-called totals)

Element	Unit	Mean	Std.Dev.	CV %	N	Median	MAD	Uncertainty	95 % confidence limits		
Al	mg/kg	85.7	23.56	27.5	42	81.9	15.97	4.54	78.4	-	93.1

Method: Nutritional values

Element	Unit	Mean	Std.Dev.	CV %	N	Median	MAD	Uncertainty	95 % confidence limits		
Crude fibre	g/kg	248	39.1	15.7	13	240	26.6	13.5	225	-	272
Total fat	g/kg	466	26.0	5.6	11	460	18.9	9.8	449	-	484



Informative Values IPE 249

Method: Inorganic Chemical Composition

Element	Unit	Median	MAD	N
Cl (as Cl)	g/kg	0.364	0.1550	20
I	µg/kg	34.0	10.00	4
Li	µg/kg	44.4	18.56	5
N - NO3 (as N)	mg/kg	19.0	5.61	4
Na	mg/kg	36.9	14.93	87
Rb	µg/kg	29800	3670	5
Sb	µg/kg	11.9	4.99	4
Sn	µg/kg	17.1	12.79	4
Ti	mg/kg	4.29	0.780	4

Results smaller than (<)

Median of <	N
0.500	5
50.0	26
50.0	5

Method: Acid extractable (So-called totals)

Element	Unit	Median	MAD	N
Si	mg/kg	136	1.0	3

Method: Other determinations

Element	Unit	Median	MAD	N
delta 13C	‰ V-PDB	-29.0	0.14	6
delta 15N	‰ Air	4.55	0.140	6

Method: Nutritional values

Element	Unit	Median	MAD	N
ADF-ash-free	g/kg	310	30.5	7
NDF-ash-free	g/kg	371	30.0	7