

Supplementary material

Title of the paper:

Comparison between cocoa and chocolate.
Characterization and fatty acids content.

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Summary: The connection between chocolate and cocoa is studied. As cocoa is produced in different countries, samples coming from the same area are analyzed. Analyses are focused to the characterization of the considered samples for different quality and to individuate the original production also connected with a nutritional aspect. For this purpose, qualitative and quantitative traditional analysis and fatty acids determination are performed.

The obtained experimental data show interesting correlations. The percentages of fatty acids allow a distinction among cocoa and chocolate samples. Furthermore, a relation among the data obtained for primary matters and final products corresponding to countries situated on the same parallel even if present in different continents can be assumed.

Supplementary material: Tables

Table S1. Percentages of protein nitrogen in cocoa and chocolate.

Cocoa	% Protein N	Chocolate	% Protein N
Nigeria	23.32 ±0.53	Ghana	8.77 ±0.04
Ivory Coast	20.86 ±0.42	Ghana 2	8.94 ±0.13
		Tanzania	8.56 ±0.17
		Africa	12.67 ±0.24
Dominican Rep.	21.08 ±0.36		
		Cuba	7.85±0.12
		Cuba 2	8.18±0.17
		Santo Domingo	8.93±0.13
		Santo Domingo 2	8.25±0.11
		Grenada	9.38±0.16
		Costa Rica	8.53±0.04

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		Venezuela	9.33 ±0.09
		Venezuela 2	12.61 ±0.19
		Ecuador	9.44±0.50
		Ecuador 2	9.45±0.25
		Ecuador 3	9.12±0.38
		Ecuador 4	8.16±0.03
		Ecuador 5	8.96±0.21
Peru	21.36 ±0.35	Peru	6.79 ±0.03
Bolivia	22.86 ±0.30	Bolivia	7.93 ±0.01
Sample A	20.01 ±0.41	Sample 1	9.00 ±0.10
Sample B	21.48 ±0.27	Sample 2	10.63 ±0.22
		Sample 3	14.64±0.10
		Sample 4	14.05±0.12

Table S2 Ashes percentages obtained by analyzing samples of cocoa and chocolate.

Cocoa	% Ashes	Chocolate	% Ashes
Nigeria	12.51 ±0.01	Ghana	2.02 ±0.01
Ivory Coast	10.07 ±0.01	Ghana 2	2.01 ±0.01
		Tanzania	2.39 ±0.01
		Africa	3.58 ±0.01
Dominican Rep	8.26 ±0.02		
		Ecuador	2.63±0.01
		Ecuador 2	2.34±0.01
		Ecuador 3	2.51±0.01
		Ecuador 4	2.17±0.01
Peru	8.47 ±0.02	Peru	1.79 ±0.01
		Bolivia	2.05 ±0.01
		Venezuela	2.46 ±0.01

		Venezuela 2	2.75 ±0.01
Sample A	9.84 ±0.01	Sample 1	2.14 ±0.01
Sample B	7.12 ±0.01	Sample 2	3.06 ±0.01
		Sample 3	3.36±0.01
		Sample 4	3.73±0.01

Table S3. Total fat percentage in samples of cocoa and chocolate.

Cocoa	% Total fat	Chocolate	% Total fat
Nigeria	11,45 ±0.18	Ghana	40.26 ±0.33
Ivory Coast	19.92 ±0.09	Ghana 2	43.93 ±0.91
		Tanzania	47.64 ±1.03
		Africa	54.47 ±0.27
Dominican Rep.	15.73 ±0.40		
		Ecuador	41.53±0.20
Peru	21.69 ±0.21	Peru	40.54 ±0.18
		Bolivia	42.64 ±1.41
		Venezuela	48.31±0.21
		Venezuela 2	51.37 ±0.50
Sample A	22.36 ±0.82	Sample 1	42.26 ±0.84
Sample B	22.35 ±0.58	Sample 2	42.80 ±0.30
		Sample 3	82.00±0.05
		Sample 4	82.23±0.05

Table S4. Percentages of fatty acids. In table 4 the following symbols are used: Cocoa = Ca and Chocolate = Cho, and Palmitic = PAL, Linoleic = LIN, Oleic =OLE and Stearic = STE.

	Ca %PAL	Ca %LIN	Ca %OLE	Ca %STE	Cho %PAL	Cho %LIN	Cho %OLE	Cho %STE
Peru	10.31	1.56	13.60	13.88	23.55	0.49	32.21	32.50
Nigeria	12.34	1.82	16.41	17.44				
Bolivia					9.13	1.47	12.14	11.67
Tanzania					15.39	1.34	20.46	20.62
Ghana					9.08	1.47	12.03	12.20
Africa					7.15	1.09	9.70	10.22
Sample A	10.76	11.48	14.47	14.95				
Sample B	9.62	3.07	12.45	13.12				

Table S5. General comparison between cocoa and chocolate results for some samples.

	Protein N	Ashes	Fat	Total
Peru				
Cocoa	21.36	8.47	21.69	56.61
Chocolate*	9.70	2.56	40.54	55.04
Samples A and 1				
Cocoa	20.01	9.84	22.36	56.59
Chocolate*	9.00	2.14	42.26	55.87
Samples B e 2				
Cocoa	21.48	7.12	22.35	55.04
Chocolate*	10.63	3.06	42.80	59.39

Chocolate* data of sample declared at 70 % are normalized to 100 %.

Table S6. Comparison between FAME composition of cocoa and chocolate both coming from Peru. Data are expressed in mg in the first row and in % in the second row. Symbols are the same of table 4.

Chocolate	PAL	LIN	OLE	STE	Total
mg	260.95	5.47	356.89	360.19	983.5
%	23.55	0.49	32.21	32.5	88.75

As it was above determined (vide table 5) that the total percentage of fatty acids is 40.54 % in chocolate, it can be calculated that the total percentage of fatty acids found (with the above table) is 35.98 %.

Cocoa	PAL	LIN	OLE	STE	Total
mg	72.1	10.88	95.15	97.12	275.2
%	10.31	1.56	13.6	13.88	39.35

As it was above determined that the total percentage of fatty acids is 21.69 % (table 5) in cocoa, it can be calculated (with the above table) that the total percentage of FAME found is 8.54 %.

Supplementary material: Figures

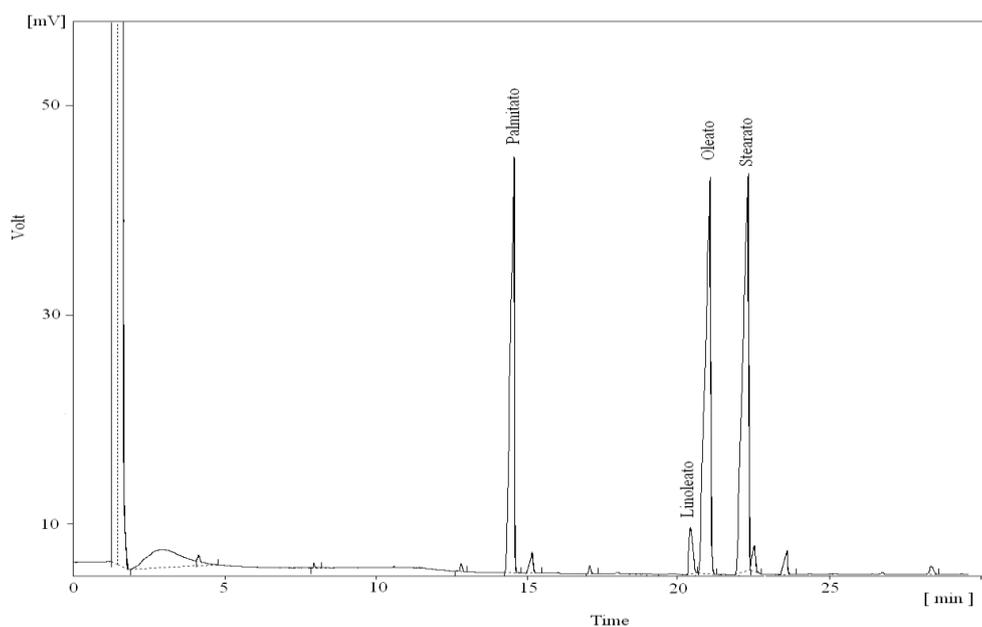


Fig. S1. An example of chromatogram obtained for cocoa fat.

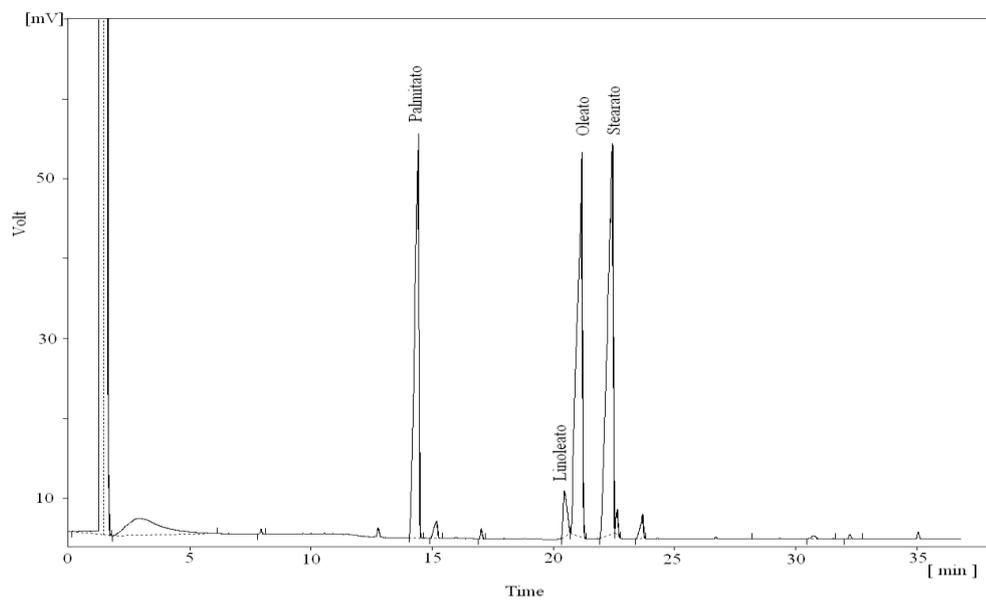


Fig. S2. An example of chromatogram obtained for chocolate fat.