LIÈGE université
Gembloux
Agro-Bio Tech

NSABS

UNIVERSITE PELEFORO GON COULIBALY
KORHOGO
UPGC

26th National Symposium for Applied Biological Sciences

Topic

Physicochemical and Thermal properties of Mango (*Mangifera indica L*) Seed Kernel Fats from Various Ivorian Varieties

Alfred Kouakou KOUASSI[1] , C. Blecker[1] , G. Pucaro[2] , S. Moret[4], T. Alabi[3] , S. Danthine[1]

[1]Food Science and Formulation, University of Liege, Gembloux Agro-Bio Tech, Passage des Deportes, 2, B-5030 Gembloux, Belgium.
[2]Laboratory of Analytical Chemistry, University of Liege, Gembloux Agro-Bio Tech, Passage des Deportes, 2, B-5030 Gembloux, Belgium.
[3]Teaching and research unit in Biological Sciences, University Peleforo Gon Coulibaly (UPGC), B-1328 Korhogo, Côte D'Ivoire.
[4]Department of Agri-Food, Environmental and Animal Sciences, University of Udine, 33100, Udine, Italy

8 July 2022

Study background

Mango is the most popular fruits in **Ivory Coast**
Annual production of fruit: 180 000 tons per year

Considerable amounts of mango seeds from manufacturing and consumption are unexploited.

Mango seed kernels contain approximately 3.7 to 15% fat (DM)

Mango kernel fat (MKF) attracted attention because of its similar characteristics to those of cocoa butter

Mango seed discarded as waste (Ivory coast)

Ivoirian mango might be an interesting source of edible fat.

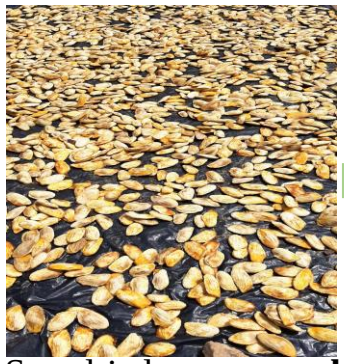
- **The aim of this work was to characterize different Ivoirian mango seeds kernel fat (MSKF) in order to improve knowledge regarding their physicochemical characteristics and to evaluate their potentialities**

Experimental procedure

❑ Sampling-Treatment- Fat extraction (solvent)

➢ **Seven Ivorian mango seed varieties** were collected: ***Amelie*** *(AM)*, ***Kent*** *(KT)*, ***Palmer*** *(PR)*, ***Keitt*** *(KI)*, ***Brooks*** *(BR)*, ***Dadiani*** *(DI)* and ***Djakoumankoun*** *(DN)*

Fresh mango **seeds**



Sun-dried mango **seeds**

Sun-dried mango seed **kernels**

mango seed kernels **powder**

Extracted mango seed **kernel fat** (MSK fat)

❑ Physicochemical and Thermal characterization of the extracted fats

- Physicochemical characteristics

Physicochemical characteristics

Table 1.

Parameter	Mango variety						
	KT	BR	PR	KI	AM	DI	DN
Fat content (% of DM)	7.57 ± 0.06^{d}	9.26 ± 0.03^{b}	8.12 ± 0.02^{c}	7.45 ± 0.02^{d}	4.89 ± 0.05^{e}	9.37 ± 0.02^{b}	9.57 ± 0.01^{a}
Free fatty acid (FFA, %)	1.63 ±0.08^{c}	0.90 ±0.01^{e}	1.83 ±0.05^{b}	2.06 ±0.04^{b}	4.57 ±0.08^{a}	1.18 ±0.08^{de}	1.30 ± 0.07^{d}
Peroxyde value (PV, Meq O_2/kg)	0.11 ±0.01^{b}	0.12 ±0.03^{ab}	0.13 ±0.04^{ab}	0.11 ±0.01^{b}	0.25 ±0.07^{a}	0.11 ±0.01^{b}	0.11 ± 0.01^{b}
Iodine value (IV, gI_2/100 g)	55.26 ±0.22^{a}	47.27 ±0.35^{cd}	55.16 ±0.01^{a}	53.25 ±0.03^{a}	60.38 ±0.58^{a}	49.79 ±0.12^{bc}	42.72 ±0.06^{d}

- Fat content: **4,89 – 9,57%**

- Quality parameters

FFA: 0,9 – 4,57%
PV: 0,11 – 0,25 MeqO_2/kg
(Codex Alimentarius (%FFA≤ 2 ; PV< 15)

- IV : **42.72 - 60.38 g/100g**
(*measure of the degree of unsaturation of fat*)

Semi-solid (room temp): AM, KT, PR, KI, DI, BR
Solid fat (rom temp): DN

AM: Amelie KT: Kent PR: Palmer KI: Keitt BR: Brooks DI: Dadiani DN: Djakoumankoun

Physicochemical characteristics

❑ Fatty acid composition (FAC)

Table 2.

Fatty acid	This study							Kassi et al,2019		Muchiri et al,2012	Lieb et al,2019	
	Sample (maceration extraction)							maceration		Soxhlet	Soxhlet	
	KT	BR	PR	KI	AM	DI	DN	KT	BS	KT	KI	PR
C16:0 (P)	9.39 ±0.04	8.69 ±0.4	9.39 ±0.16	10.64 ±0.03	13.44 ±0.9	9.50 ±0.2	8.28 ±0.12	9.7	8.33	10.57	8.4	6.5
C18:0 (S)	35.07 ±0.01	42.54 ±0.57	34.25 ±1.79	35.61 ±1.02	30.26 ±2.27	40.62 ±0.08	48.33 ±0.02	31.06	41.66	30.74	35.1	35.6
C20:0 (A)	1.82 ±0.08	2.15 ±0.21	1.67 ±0.15	1.74 ±0.13	1.67 ±0.23	1.72 ±0.05	2.29 ±0.02	1.00	0.85	1.64	2.5	2
SFA	**46.28 ±0.13**	**53.38 ±0.76**	**45.30 ±2.09**	**48.00 ±0.92**	**45.37 ±1.61**	**51.85 ±0.06**	**58.89 ±0.09**	41.76	50.84	42.68	47.8	45.5
C18:1n9 (O)	47.00 ±0.03	41.23 ±0.66	47.86 ±1.62	45.51 ±0.52	43.93 ±0.66	41.44 ±0.01	35.92 ±0.09	58.24	49.16	46.37	45.1	47.8
C18:2n6 (L)	6.23 ±0.23	5.22 ±0.06	6.33 ±0.37	6.08 ±0.12	9.58 ±1.91	6.39 ±0.02	4.88 ±0.02	0	0	10.4	6	5.7
C18:3n3(Ln)	0.49 ±0.07	0.17 ±0.05	0.50 ±0.11	0.42 ±0.02	1.11 ±0.36	0.32 ±0.02	0.31 ±0.02	nd	nd	0.60	0.6	0.6
PUFA	6.72±0.09	5.39±0.10	6.83±0.47	6.50±0.10	10.70±2.27	6.71±0.04	5.19±0.01	nd	nd	11	6.6	6.2
UFA	**53.72 ±0.13**	**46.62 ±0.76**	**54.70 ±2.09**	**52.01 ±0.92**	**54.63 ±1.67**	**48.15 ±0.06**	**41.11 ±0.09**	58.24	49.16	57.37	52.2	54.4

- Six main fatty acids
- Oleic and stearic acids are the major FA (74,20 - 84,25%)
- DN had the highest SAFA content (58,89%) and AM lowest(45,37%), inversely for PUFA
- Variety-dependent FA profile
- KT and PR had similar FA profiles
- Intra and inter-regional variability were observed

✓ IV seems to be correlated with FA profile of all sample studied

- FA: fatty acid PUFA: polyunsaturated FA SAFA: saturated fatty acid

AM: Amelie KT: Kent PR: Palmer KI: Keitt BR: Brooks DI: Dadiani DN: Djakoumankoun

Physicochemical characteristics

❑ Triacylglycerol composition (TAG)

TAG	AM	BR	DI	DN	KI	KT	PR
LLL	0.29	0.08	0.08	0.03	0.07	0.15	0.12
OLLn	0.18	0.05	0.03	0.01	0.02	0.09	0.09
PLLn	0.31	0.10	0.09	0.12	0.08	0.14	0.11
OLL	1.92	0.88	0.96	0.63	1.10	1.27	0.90
PLL	0.43	0.11	0.11	0.05	0.14	0.21	0.17
POLn	0.53	0.31	0.34	0.21	0.47	0.42	0.34
PLnP	0.06	0.02	0.03	0.03	0.02	0.02	0.01
OOL	3.14	1.58	1.76	0.86	2.06	2.47	2.16
SLL+POL	3.52	1.75	1.98	1.33	2.15	2.26	1.89
PLP	0.95	0.34	0.39	0.41	0.42	0.46	0.33
OOO	7.76	4.78	4.81	2.45	7.25	8.39	7.93
SLO+OOP	10.86	7.46	8.71	5.21	9.31	10.14	8.88
SLP+POP	4.84	3.20	3.56	3.59	3.70	3.48	3.10
SOO	20.80	20.71	22.88	15.54	22.64	25.77	25.47
SLS+SOP	15.36	16.22	17.12	17.93	15.59	14.04	13.72
AOO	2.48	1.95	1.73	1.52	2.21	2.17	2,26
SOS	23.94	36.98	32.87	45.83	29.38	26.29	29.68
AOS	2.63	3.46	2.55	4.25	3.39	2.23	2.83
Monounsaturated TAGs (StUS)	53.21	63.96	60.89	74.65	57.15	51.58	54.11
Diunsaturated TAGs (StUU)	33.49	28.67	31.48	21.37	32.34	36.05	34.69
Triunsaturated TAGs (UUU)	13.29	7.37	7.63	3.98	10.50	12.37	11.21
Trisaturated TAGs (StStSt)	0	0	0	0	0	0	0

- 22 TAGs were identified in all the fat samples StUSt (9), StUU (8) and UUU (5)
- No StStSt TAGs were observed.
- Major TAGs found : SOS (23,94 – 45,83%), SOO (15,54 – 25,77%), OOO (2,45 – 8,39%).
- Variety-dependent TAG composition. KT and PR have similar TAG profile
- Among the 7 varieties, AM and DN stand out with their very distinct profile.

St: saturated acid
U: unsaturated acid
S: stearin acid
O: oleic acid

Physicochemical characteristics

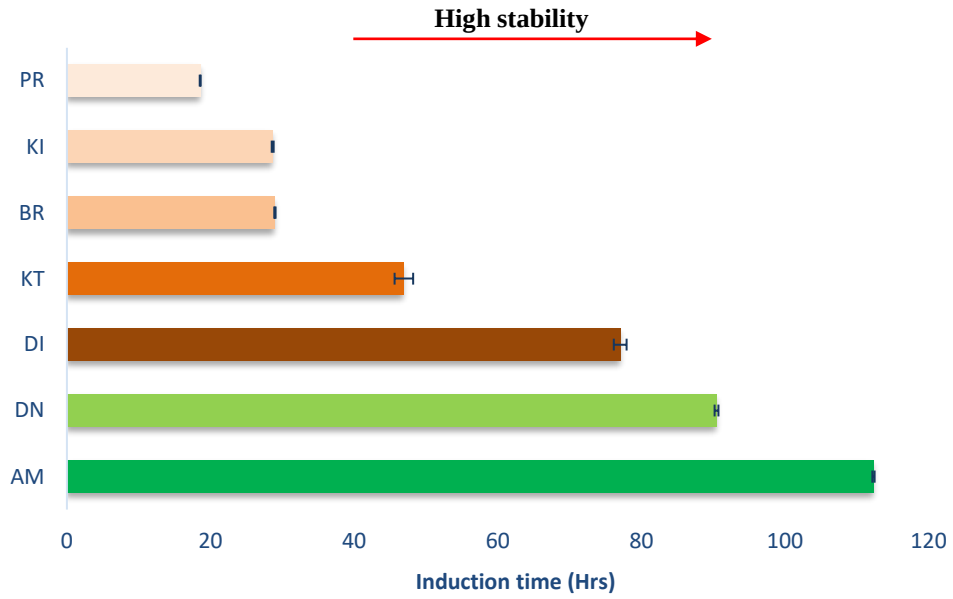
❑ Sterol composition

Sterol composition (mg/Kg)	Mango variety						
	AM	KT	PR	KI	BR	DI	DN
Campesterol	535.44 ±0.01[a]	300.15 ±0.02[b]	2.48.33 ±0.01[c]	682.92 ±0.01[d]	323.18 ±0.02[e]	383.23 ±0.01	299.04 ±0.02
Stigmasterol	1190.82 ±0.01[a]	549.82 ±0.01[b]	402.67± 0.01[c]	948.35 ±0.02[d]	516.48 ±0.08[e]	485.77 ±0.01[f]	639.55 ±0.02[g]
ß-sitosterol	4854.98 ±0.1[a]	3120.51 ±0.01[b]	2079.80 ±0.02[c]	5355.91 ±0.02[d]	2672.97 ±0.01[e]	2762.94 ±0.1[f]	2204.52 ±0.01[g]
D5-avenasterol	0	68.29 ±0.01[a]	53.88 ±0.02[b]	136.59 ±0.01[c]	35.83 ±0.03[d]	105.435 ±0.01[e]	58.03 ±0.02[f]
24-methylenecholesterol	0	0	1.16 ±0.01[d]	9.46 ±0.01[a]	6.90 ±0.07[b]	4.34 ±0.01[c]	0
Total sterol	6881.24 ±0.03[a]	4038.74 ±0.06[b]	2785.83 ±0.06[c]	7133.22 ±0.05[d]	3555.34 ±0.15[e]	3741.70 ±0.04[f]	3201.14 ±0.06[g]

KI had the higher sterol content (7133,22 mg/kg) and DN had the lower one (3201,14 mg/kg)

ß-sitosterol was the most abundant sterol in the 7 MSK fats

❑ Oxidative stability index (OSI,110°C)



- OSI value ranged from 18,59 to 112,35 hrs
- AM had the higher OSI value (112,35 hrs), despite its higher PUFA level (10,70%)

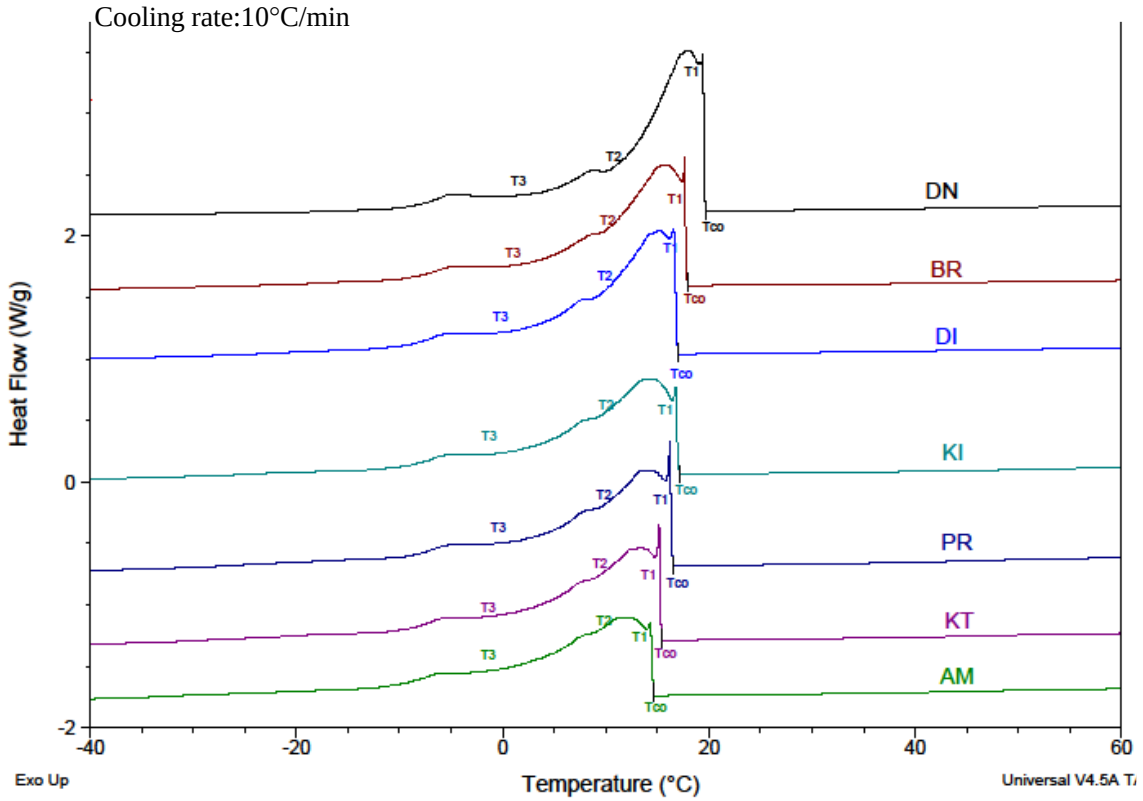
- Oxidative stability of MKF might be affected by sterol species and concentration, besides the FA composition.

AM: Amelie KT: Kent PR: Palmer KI: Keitt BR: Brooks DI: Dadiani DN: Djakoumankoun

Thermal behaviour of MSK fats

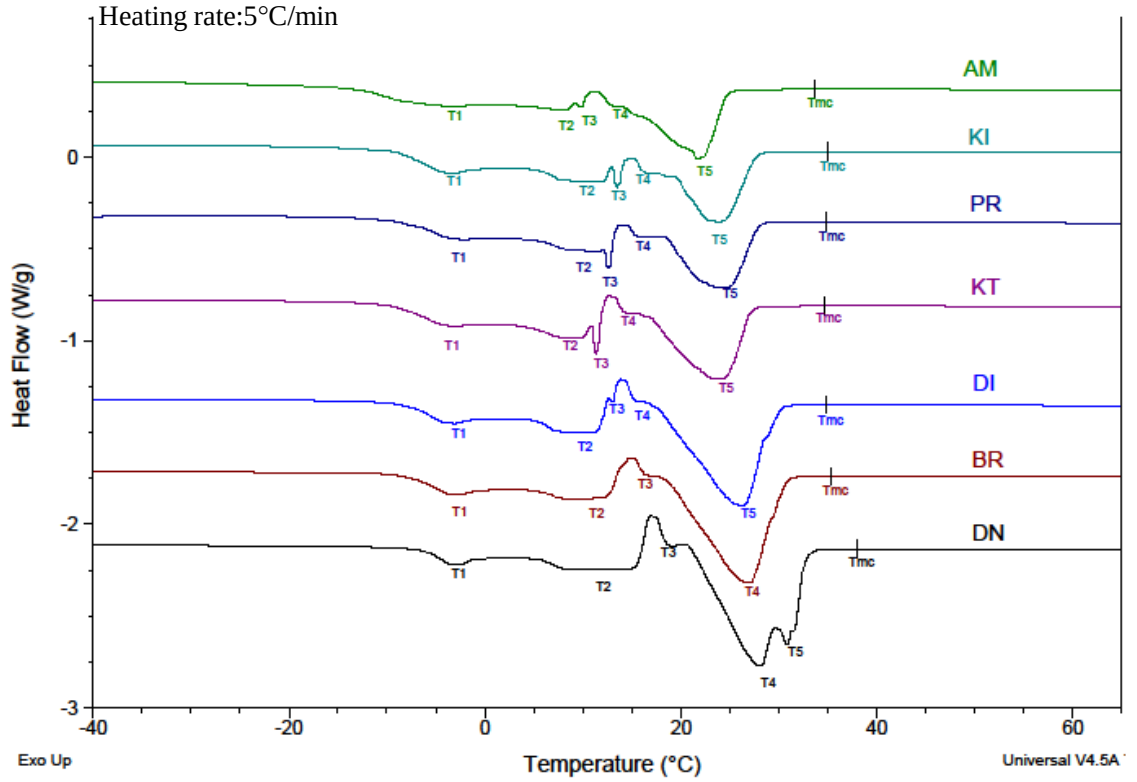
Thermo-physical properties

❑ DSC Crystallization profile



- 3 major exothermic regions (TAG groups)
- DN displayed the higher crystallization onset temp (Tco =19,63°C) and AM exhibited the lower (14,72°C)
- Tco are related to high StUSt TAG content

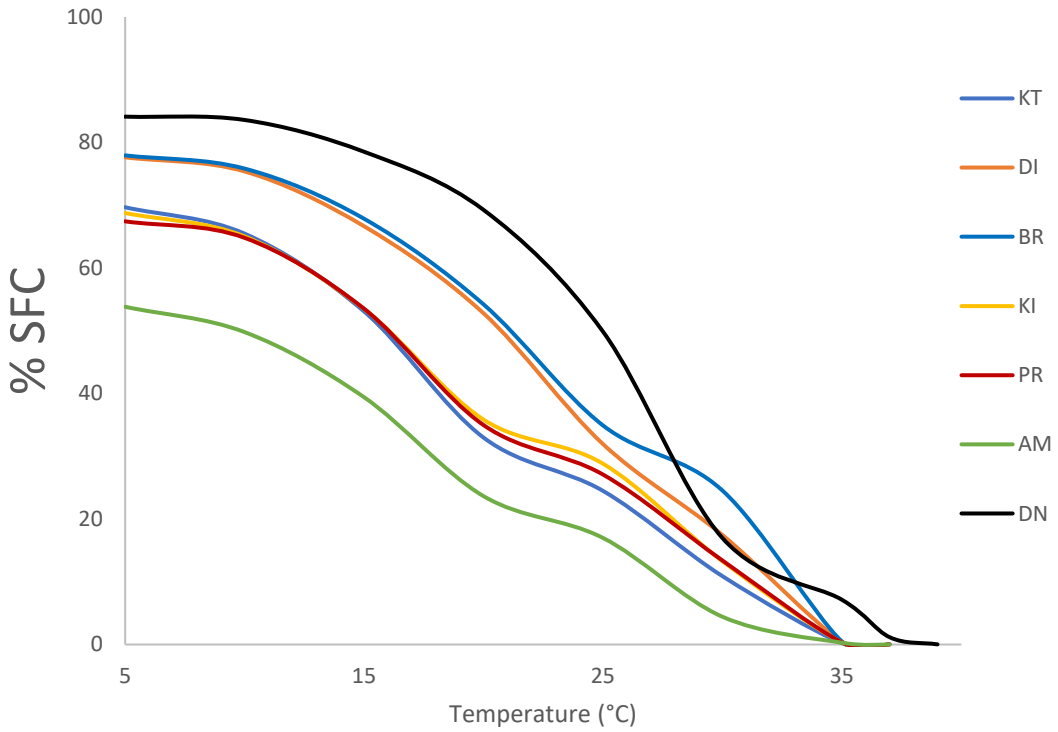
❑ DSC Melting profile



- Complex melting profiles ⇔ diversity of TAGs
- 3 melting point regions: very low (-20 -2°C), low (4 -16°C) and high (17-40°C)
- VLMP (UUU TAGs), LMP (SUU TAGs), HMP (StUSt TAGs)
- Complete melting temperature around 35°C, except DN (38°C)

Thermo-physical properties

❑ Melting profile by pNMR



- **Solid Fat Content** (*SFC*)
- Quantity of TAGs at a particular temperature.
- DN presents the higher SFC value and AM the lower.
- SFC profiles linked to the FAC and TAG profiles
- Complete melting temperature for all samples around 35°C, except for DN (38°C).
- KT and PR showed similar melting profile ⇔ similar TAGs composition
- Results are in agreement with those of the DSC analysis.

Fat composition	DN	BR	DI	KI	KT	PR	AM
SAFA	58.89	53.38	51.85	48.00	46.28	45.30	45.37
PUFA	5.19	6.83	6.71	6.50	6.72	6.83	10.70
SUS TAG	74.65	63.96	60.89	57.15	51.58	54.11	53.21
UUU TAG	3.98	7.37	7.63	10.50	12.37	11.37	13.29

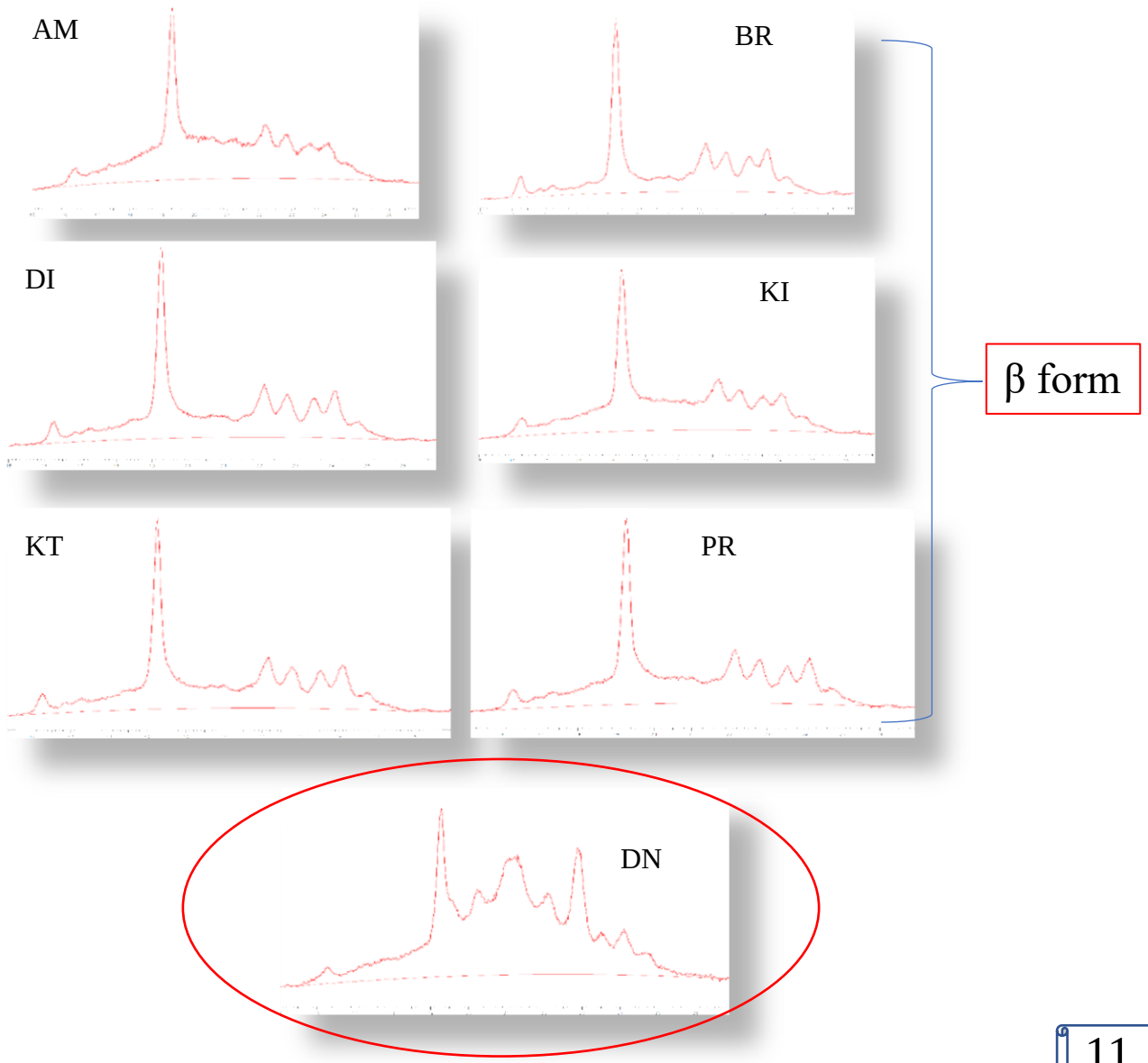
Thermo-physical properties

❑ Study of polymorphic behaviour by XRD

Six main peaks, one with very high intensity around 4.60 Å (β structure): in all samples except for DN

DN showed a different polymorphic behavior: blend of the β' and β structure

β-form appears to be the most prevailing and stable polymorph for the all mango seed kernel fats studied



CONCLUSION

❑ Hierarchical top-down classification

Class	Sample	SAFA (%)	StUSt TAG (%)	UUU TAG (%)	IV, wijs ($gI_2/100g$)	state
1	**DN**	58.89	74.65	3.98	42.72	**Hard (solid)**
2	**BR**	53.38	63.96	7.37	47.27	**Intermediate (semi-solid)**
	DI	51.85	60.89	7.63	49.79	
3	**PR**	45.30	54.11	11.21	55.16	**Soft (semi-solid)**
	KT	46.28	51.58	12.37	55.26	
	KI	48.00	57.15	10.50	53.25	
4	**AM**	45.37	53.21	13.29	60.38	**Very soft (semi-solid)**

All fats studied were extracted from Ivorian mango varieties

⬇

Different physicochemical characteristics

Different thermal behaviour

✓ The seven Ivorian mango varieties might offer numerous applications in the food, pharmaceutical and cosmetics industries.

AM: Amelie KT: Kent PR: Palmer KI: Keitt BR: Brooks DI: Dadiani DN: Djakoumankoun

THANK YOU FOR YOUR ATTENTION !!!

LIÈGE université
Gembloux
Agro-Bio Tech

Science des Aliments et Formulation

RÉPUBLIQUE DE CÔTE D'IVOIRE

DOB