

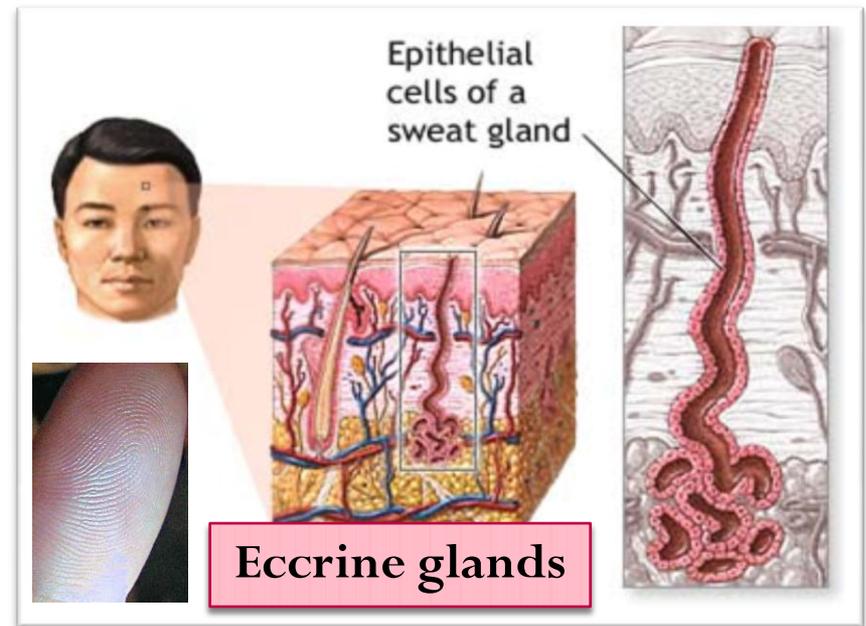
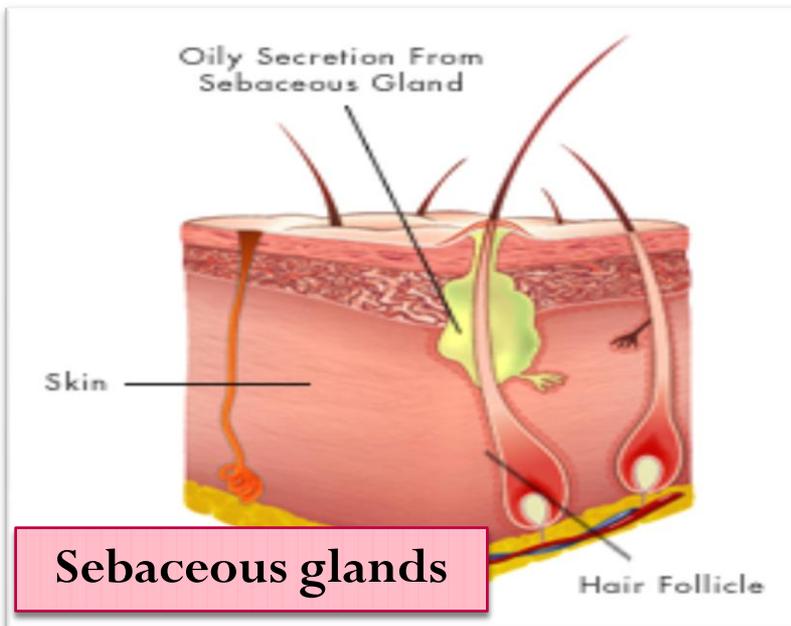
Variation in amino acid and lipid composition of latent fingerprints

Croxton, R. S., Baron, M. G., Butler, D., Kent, T. and Sears, V. G. Variation in amino acid and lipid composition of latent fingerprints. *Forensic Science International*, 199, 93-102.

Saowapark Beerzine
52312345

Latent fingerprints

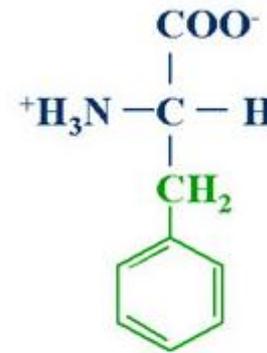
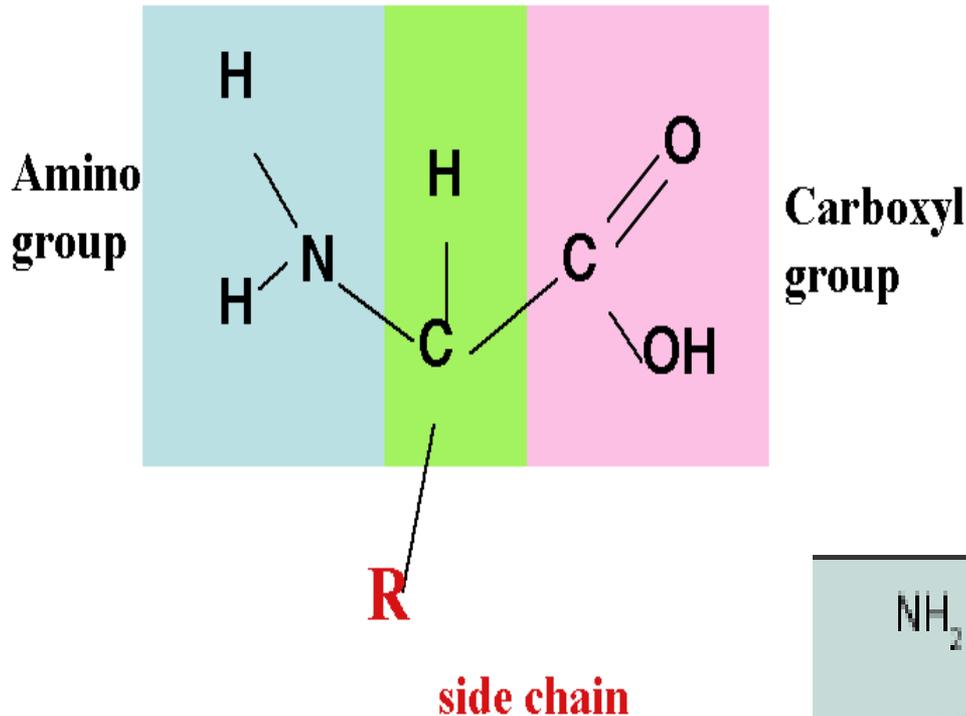
- Latent fingermark is a complex mixture of natural secretions and contaminations from the environment.
- Three types of glands responsible for the natural secretions of the skin are the *eccrine* glands, *apocrine* glands and the *sebaceous* glands.



The major chemical constituents of the glandular secretions

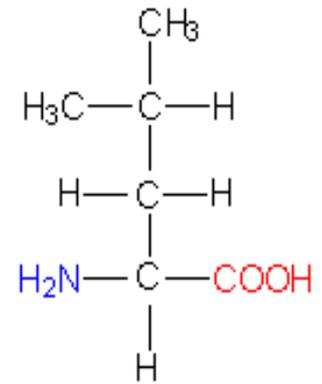
SOURCE	CONSTITUENTS	
	INORGANIC	ORGANIC
eccrine glands	chlorides metal ions sulfates phosphates ammonia water (>98%)	amino acids urea uric acid lactic acid sugars creatinine choline
apocrine glands	iron water	proteins carbohydrates sterols
sebaceous glands		fatty acids glycerides hydrocarbons alcohols

Amino acid

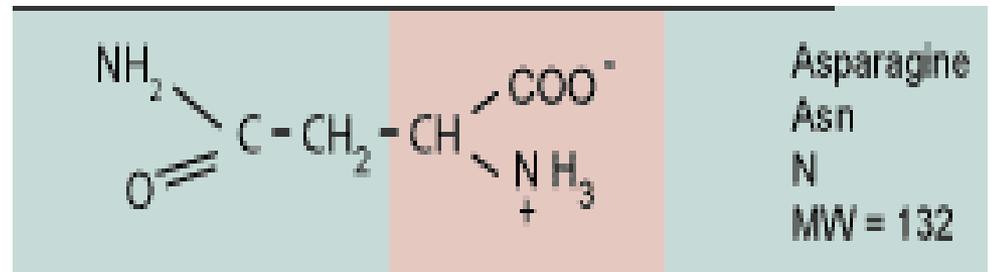


Phenylalanine

Non-polar amino acid



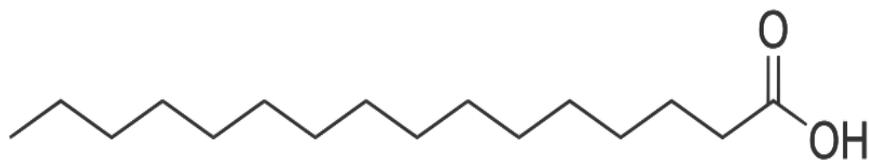
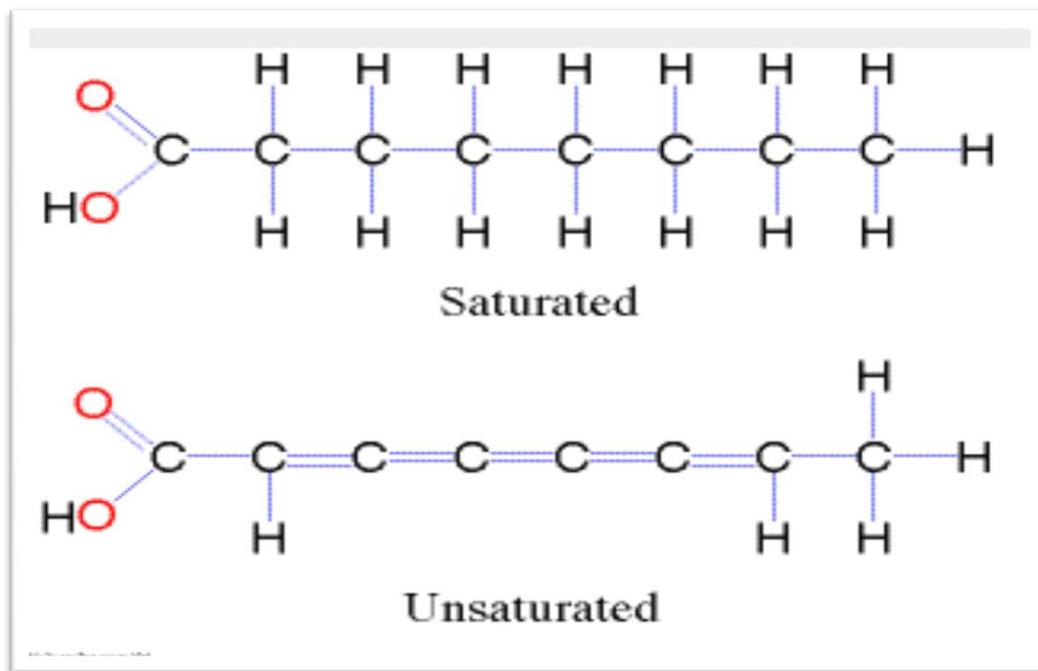
leucine - Leu; L



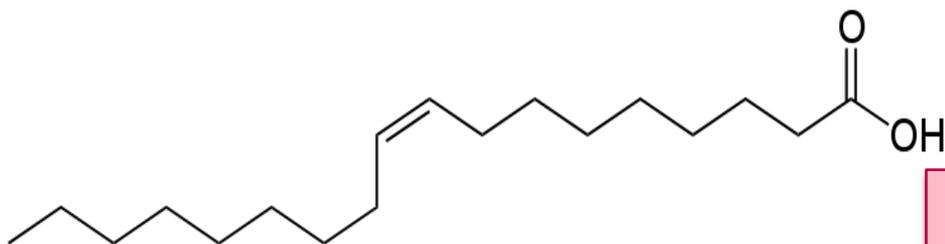
Asparagine
Asn
N
MW = 132

Polar amino acid

Fatty acid

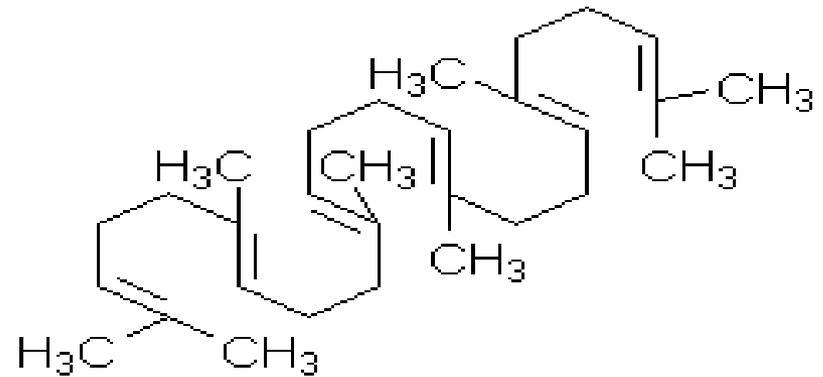
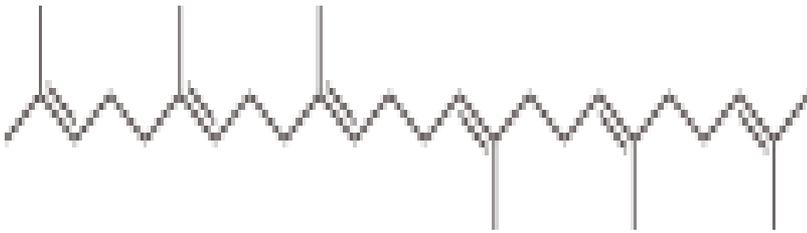


C16 Hexadecanoic acid (palmitic)



C18:1 Octadecenoic acid (oleic)

Squalene



- all plants and animals produce squalene, including humans
- part of the synthesis of cholesterol, steroid hormones, and vitamin D in the human body
- used in cosmetics

Sample

Summary of donor information.

Sex	n	Age	Ethnicity	Smoker	Medication	Cosmetics/ cream	Diet						
Male	9	18-29	13	Caucasian	18	Yes	4	Yes	7	Yes	11	Omnivore	14
Female	9	30-60	5	No	14	No	11	No	7	No	7	Vegetarian	4

Samples

- Natural samples
- Groomed samples

Natural samples

- rubbed their hands together



10cm x 2cm Mylar
Polyester film

LM LR RM RR

30 min



LM LR RM RR

8 μL l-p-chlorophenylalanine in
methanol ($0.3125 \mu\text{mol mL}^{-1}$) + 8 μL
nonadecanoic acid in hexane (1.875
 $\mu\text{mol mL}^{-1}$)

LM ; left middle finger
LR ; left ring finger
RM ; right middle finger
RR ; right ring finger

Chemical Analysis

Chemical Analysis

- Extraction of samples
- GC-MS

Extraction of samples



fingerprints

Cut smaller
into 5 cm x 5 cm



Glass Petri dish



Add 1 mL of 1%(w/v)
NaOH : EtOH : Pyridine
= 75:40:10 (v/v/v)

Shaker @ 200 cycles
 min^{-1} for 1 h



Add 200 μL of ECF
(iso-octane 1:3(v/v))

Vortex 30 s and
Left for 1 min



Add 40 μL of Pyridine
and 50 μL of ECF

Vortex 30 s and
Left for 2-3 min



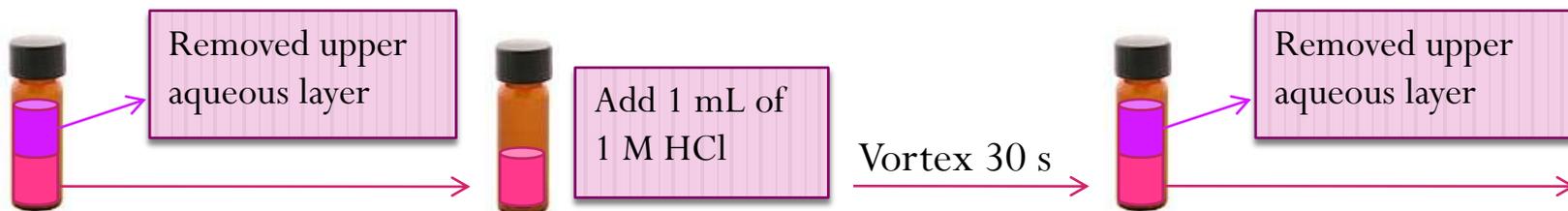
Transfer to



Containing 1 mL of CHCl_3
with 1%(v/v) ECF

Vortex 30 s and
Allowed to separate

Extraction of samples (cont.)



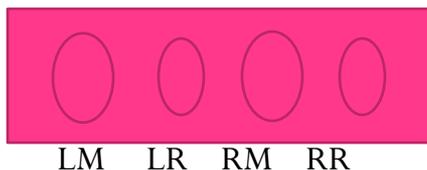
GC-MS

• Conditions

- Sample : 1 μ L
- Column : DB-17ms fused silica capillary
- Temperature : 250 °C
- Carrier gas : Helium (1 mL min⁻¹)
- MS mode : SIM (scan and selected ion monitoring)
- Monitor ions : 50 -500 m/z

Groomed samples

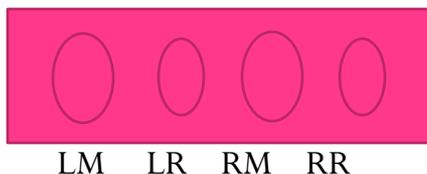
- rubbed their fingers across the forehead and nose ≈ 10 s and rubbed their hands together



10cm x 2cm Mylar
Polyester film

LM ; left middle finger
LR ; left ring finger
RM ; right middle finger
RR ; right ring finger

30 min
↓



8 μL l-p-chlorophenylalanine in
methanol ($0.3125 \mu\text{mol mL}^{-1}$) + 8
 μL nonadecanoic acid in hexane
($1.875 \mu\text{mol mL}^{-1}$)

Chemical Analysis

Differences of a natural sample and groomed samples as shown by differences in intensities of fingerprints after ninhydrin reaction.



Natural sample

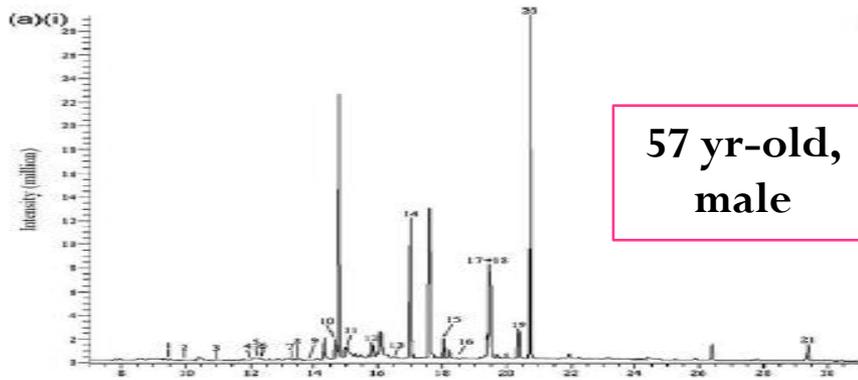


Groomed sample

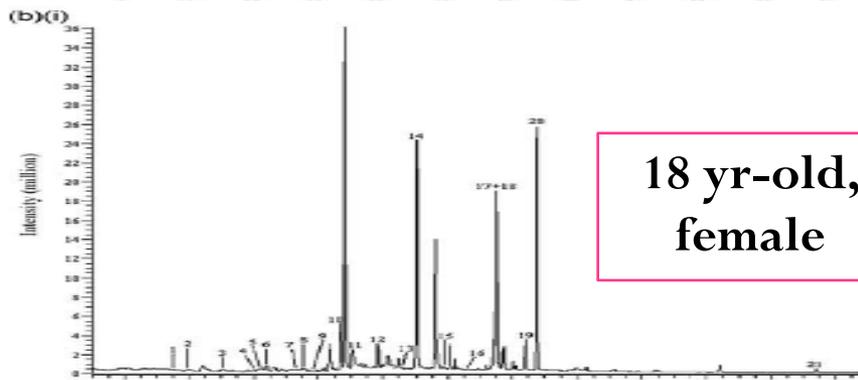
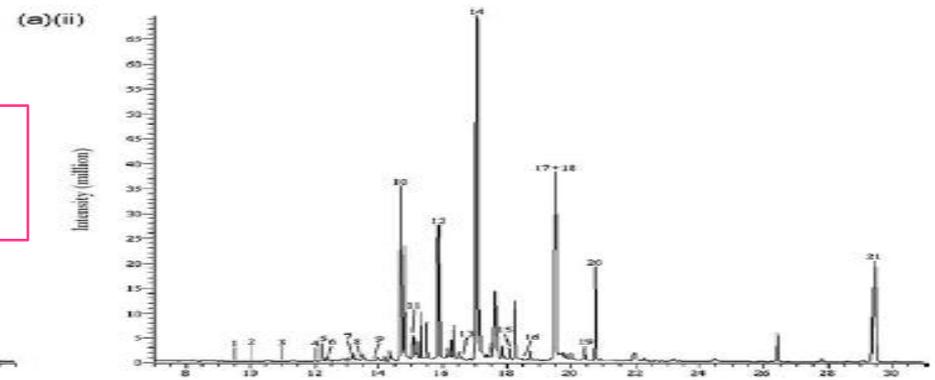
Result : Amino acids and fatty acids detected in latent fingerprint samples by GC-MS and their SIM programmed parameters

	Compound	Retention time (min)	Characteristic ions (m/z [relative abundance (%)])
1 ^a	Alanine	9.44	70 [7.4], <u>116^b</u> [100], 144 [1.7], 189 [0.4]
2	Glycine	9.92	74 [15], <u>102</u> [100], 130 [5.6], 175 [4.2]
3	Valine	11.02	72 [34], 116 [38], <u>144</u> [100],
4	Leucine	11.96	86 [8.3], 102 [39], 129 [4.2], <u>158</u> [100], 231 [0.3]
5	Isoleucine	12.19	102 [50], 129 [11], <u>158</u> [100]
6	Dodecanoic acid	12.36	101 [100], <u>157</u> [25], 228 [4.5]
7	Serine	13.18	60 [76], 86 [35], <u>132</u> [100]
8	Proline	13.49	114 [10], <u>142</u> [100], 170 [0.8], 215 [4.6]
9	Asparagine	13.79	69 [100], <u>141</u> [71], 174 [3.8]
10	Tetradecanoic acid	14.67	101 [100], <u>157</u> [32], 256 [6.1]
11	Aspartic acid	15.04	116 [28], 142 [25], <u>188</u> [100]
12	Pentadecanoic acid	16.01	101 [100], <u>157</u> [27], 270 [6.2]
13	Glutamic acid	16.57	<u>128</u> [100], 156 [83], 202 [75]
14	Hexadecanoic acid	17.04	101 [100], <u>157</u> [28], 284 [7.2]
15	Phenylalanine	17.88	102 [73], <u>176</u> [100], 192 [46]
16	Cysteine	18.49	74 [93], 102 [100], <u>220</u> [91]
17	Octadecanoic acid	19.50	101 [100], 157 [26], 312 [7.4], <u>313</u> [1.8]
18	cis-9-Octadecenoic acid	19.51	180 [100], 222 [97], <u>235</u> [15], 264 [94]
19	p-Chlorophenylalanine	20.36	102 [100], 125 [70], <u>210</u> [91]
20	Nonadecanoic acid	20.74	101 [100], <u>157</u> [29], 326 [10]

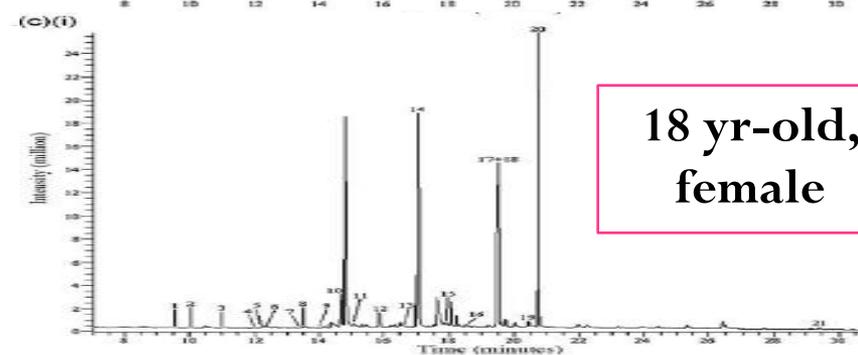
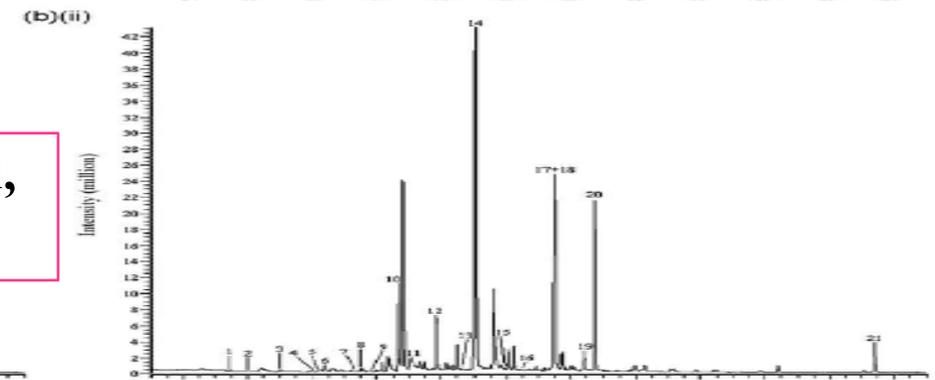
Result : Total ion chromatograms (TIC)



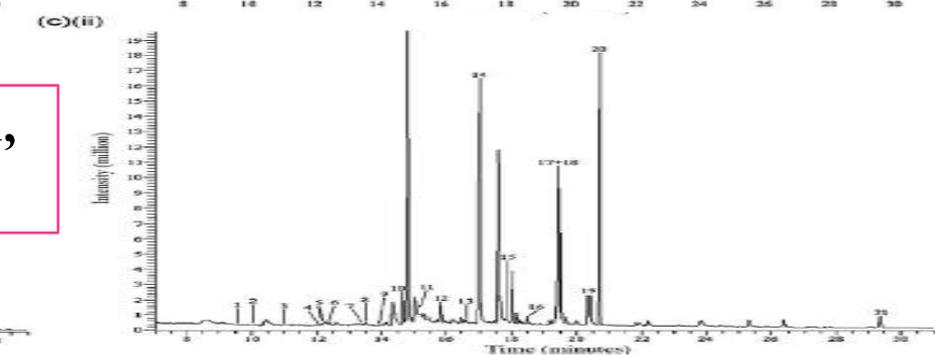
57 yr-old,
male



18 yr-old,
female

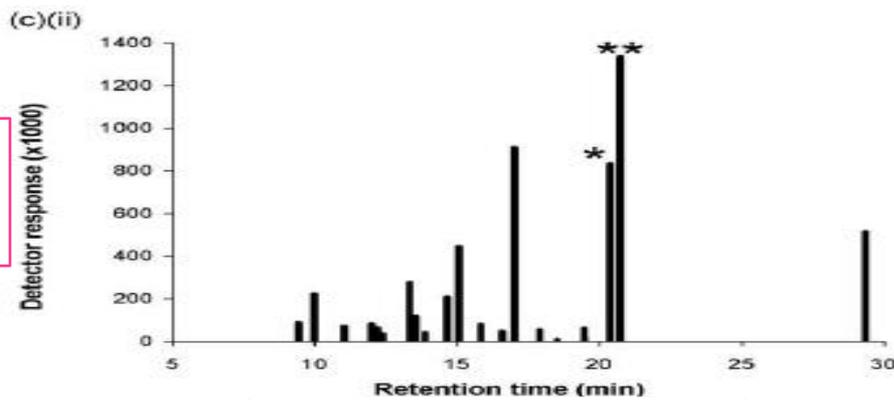
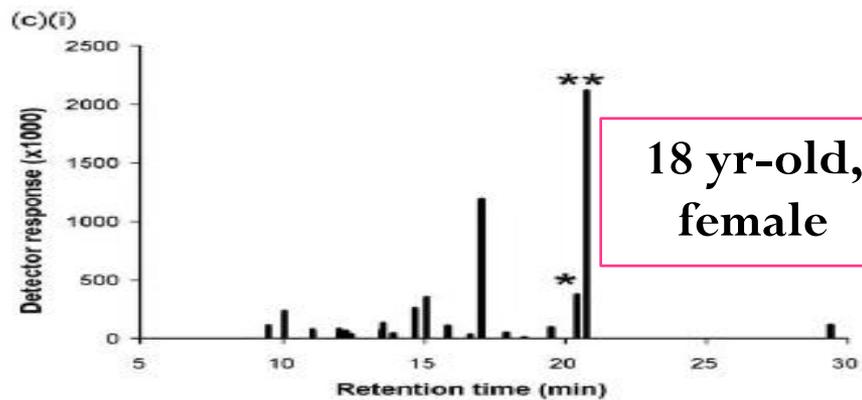
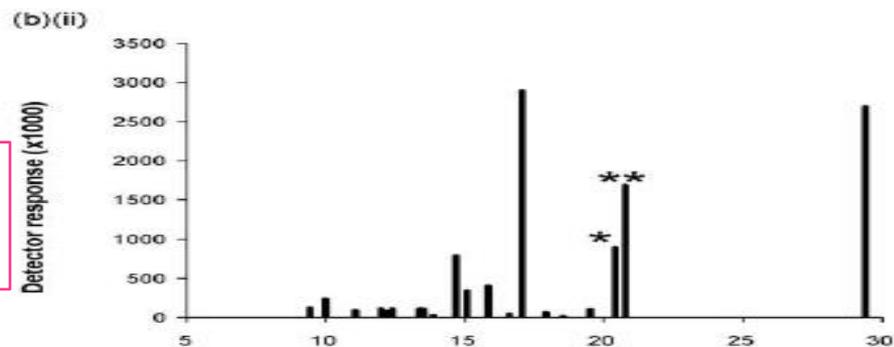
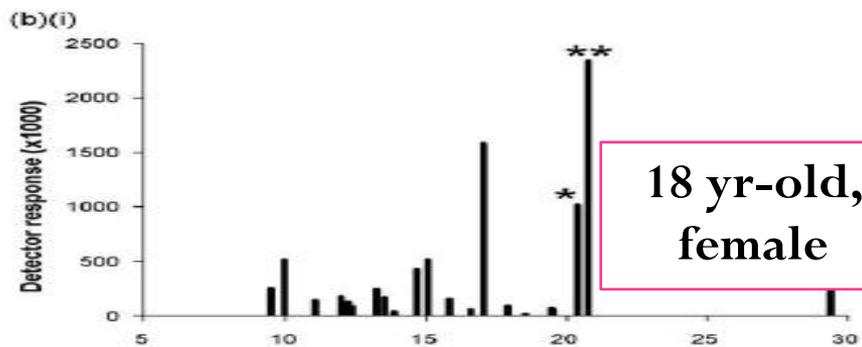
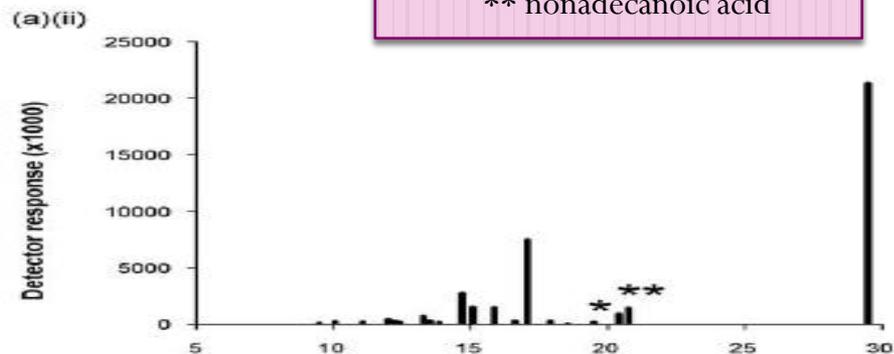
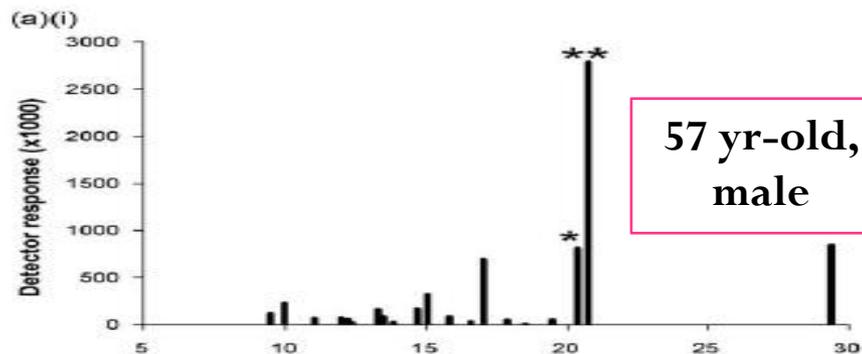


18 yr-old,
female

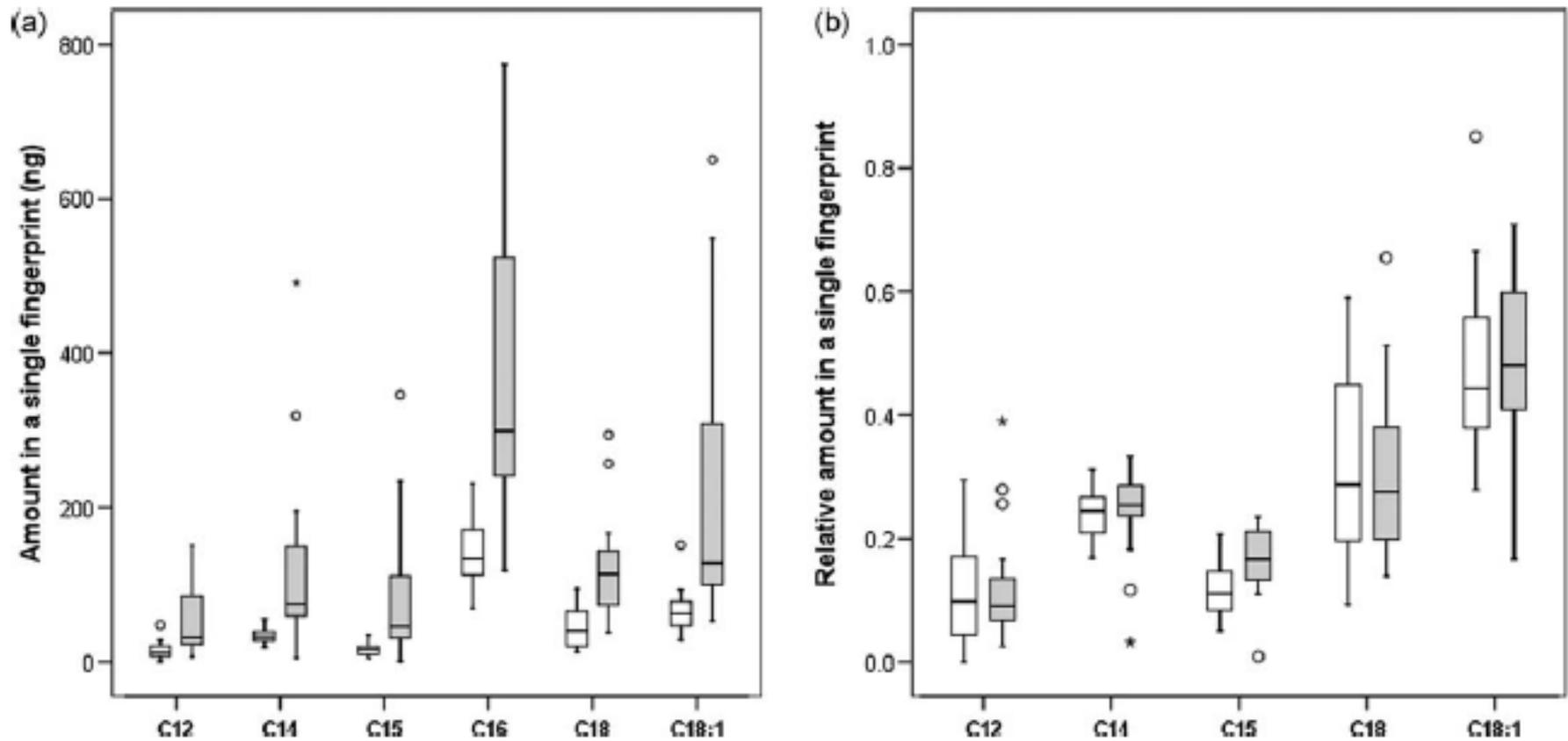


Result : Target compound chromatograms (TCC)

* Chlorophenylalanine
** nonadecanoic acid



Result : Fatty acid content of fingerprint samples.

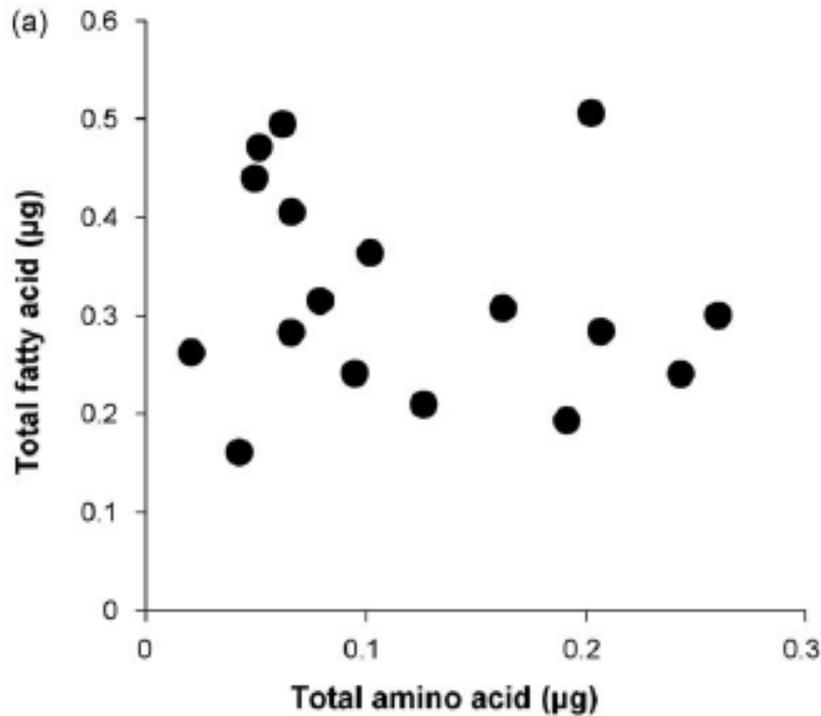


Amount in a single fingerprint (a) in nanograms (b) relative to C16 (hexadecanoic acid)

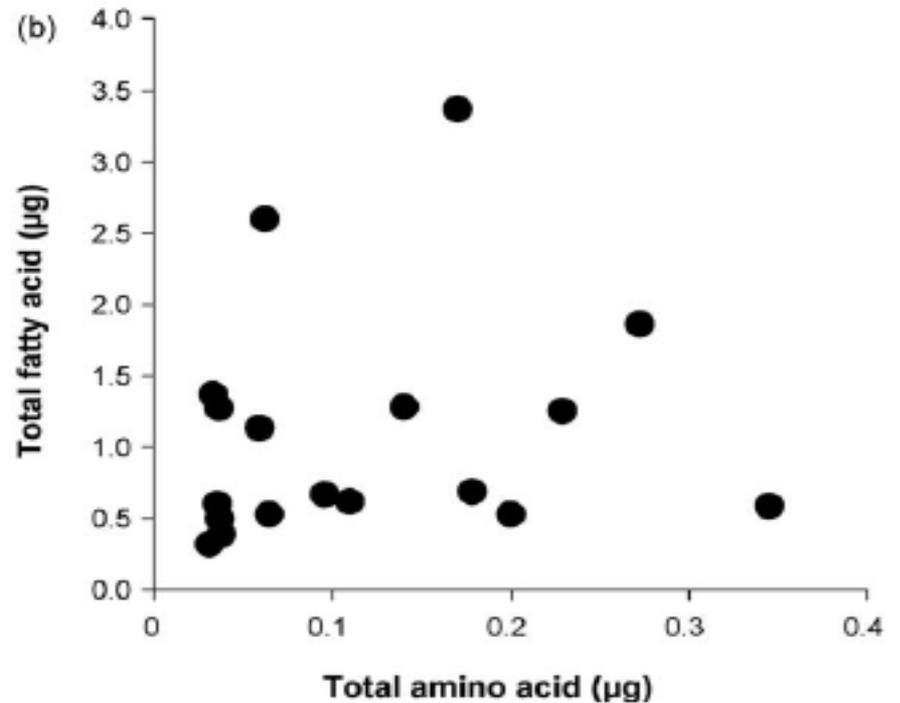
★ An extreme value (3 times) and ○ an outlier value (1.5-3 times).

Unshaded boxes = natural sample and shaded boxes = groomed samples

Result : Comparison of total amino acid and fatty acid contents

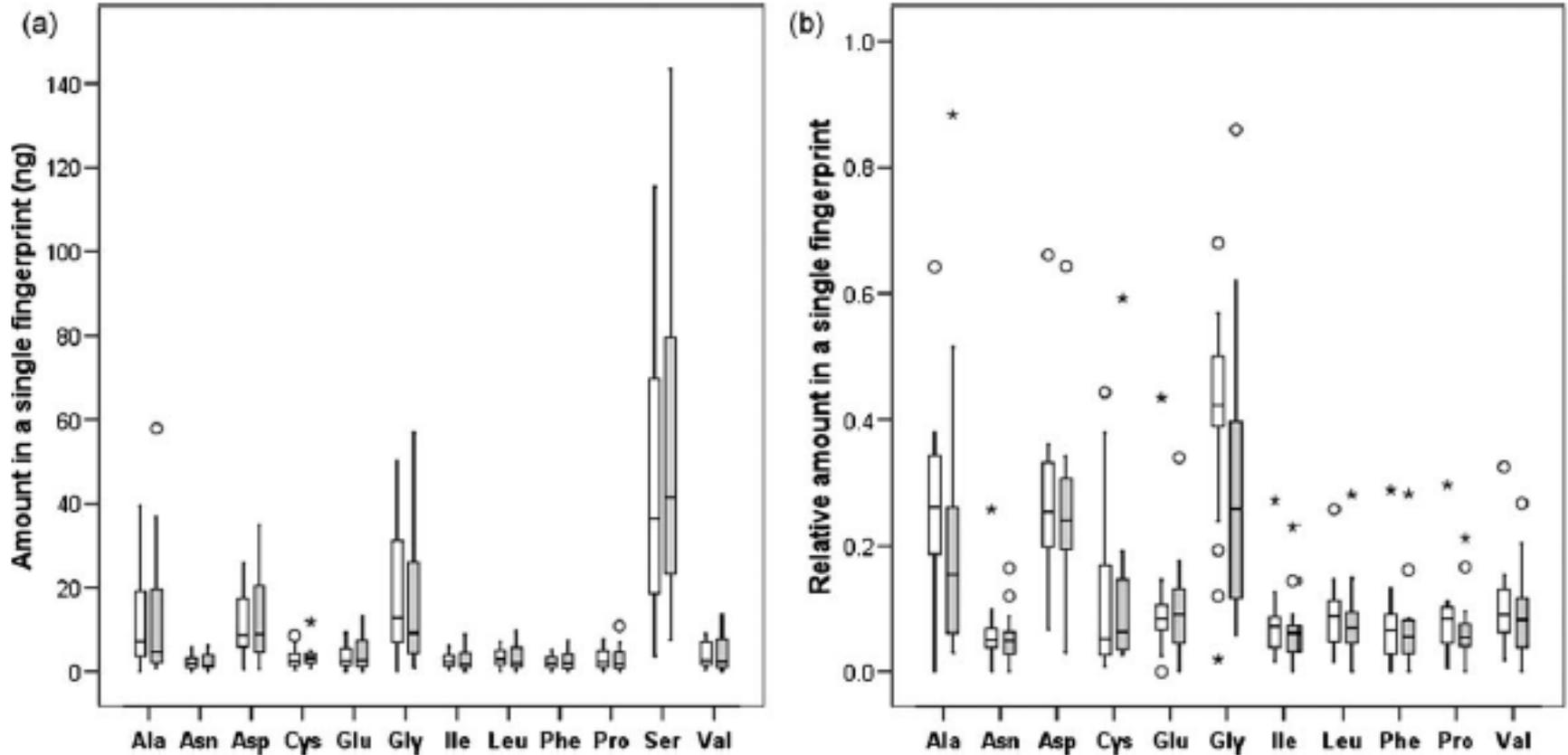


Natural samples



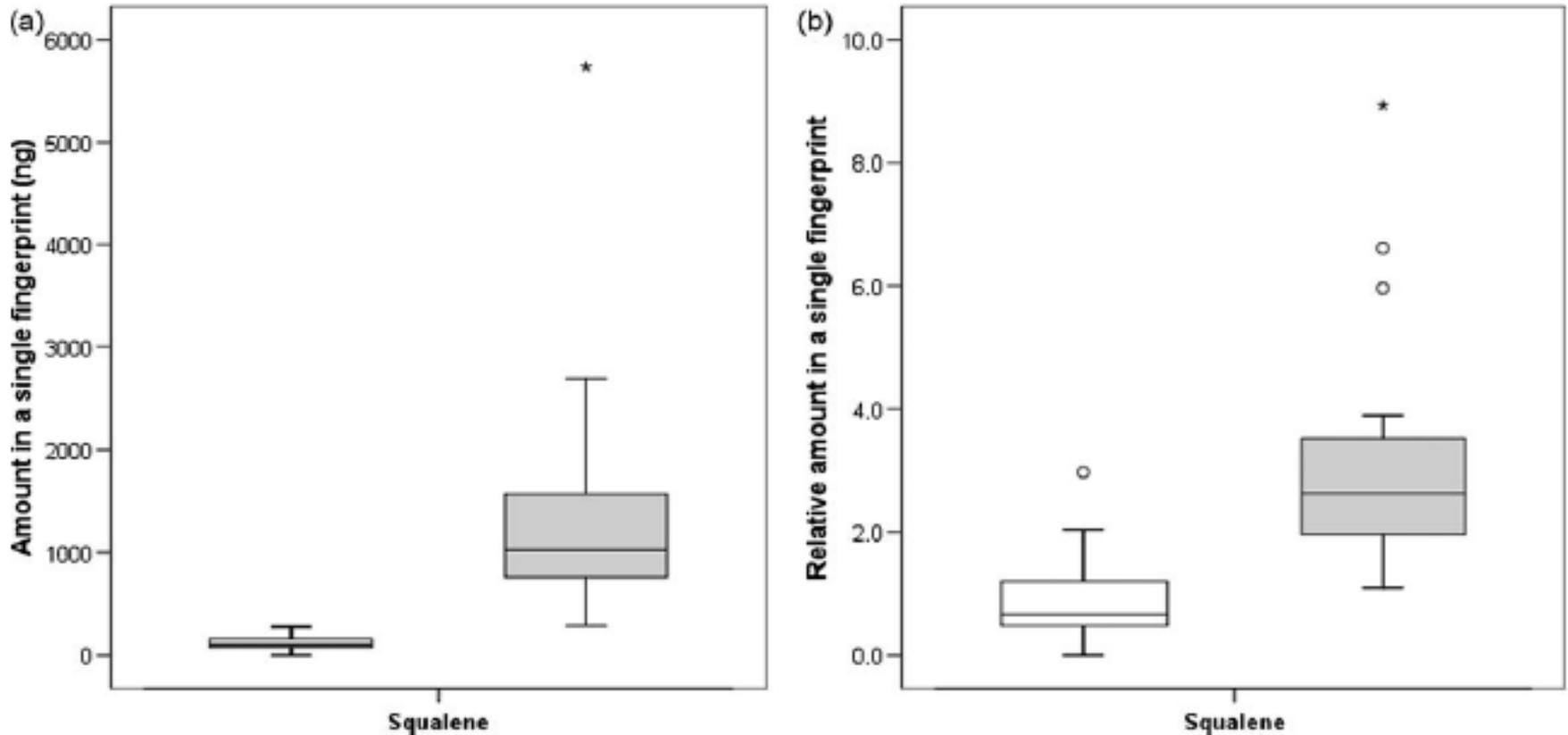
Groomed samples

Result : Amino acid content of fingerprint samples



Amount in a single fingerprint (a) in nanograms (b) relative to serine.
★ An extreme value (3 times) and ○ an outlier value (1.5-3 times).
Unshaded boxes = natural sample and shaded boxes = groomed samples

Result : Squalene content of fingerprint samples



Amount in a single fingerprint (a) in nanograms (b) relative to serine.

★ An extreme value (3 times) and ○ an outlier value (1.5-3 times).

Unshaded boxes = natural sample and shaded boxes = groomed samples

Conclusions

- Amino acid, fatty acid and squalene composition of latent fingerprints was found to vary quantitatively between individual donors.
- Whilst many of the compounds studied were found to be common to all samples, the relative amounts were found to differ.
- The act of ‘grooming’ prior to depositing latent fingerprints had a significant effect quantitatively on the fatty acid composition of the samples.

Conclusions

- Principal component analysis allowed the differentiation of the 'natural' and 'groomed' fingerprint samples.
- There was no such differentiation found on the basis of gender, diet, age or smoking.
- Analyses here indicate that the use of 'groomed' or 'enhanced' fingerprints could seriously compromise the validity of fingerprint reagent assessments.

