



New Resistant Cocoa Selections from Costa Rica have Fine Aroma Potential

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Current situation in the cocoa sector

- Impact of diseases endanger cocoa plantations:



- Field trainings in phytosanitary management
- Rejuvenation of old plantations

- Growing demand for „Fine or Flavour“-cocoas



➔ **Selection and distribution of improved genetic material**

Six improved cocoa clones selected at CATIE, Costa Rica:

CATIE-R1 | CATIE-R4 | CATIE-R6 | PMCT-58 | CC-137 | ICS-95 (T1)

→ high yield potential and tolerant to „frosty pod“ and „black pod“

(PHILLIPS-MORA et al. 2013, PHILLIPS-MORA et al. 2007)



Clone	Average for all 11 years			Average for the last 5 years		
	Yield (kg/ha/yr)	% moniliasis	% black pod	Yield (kg/ha/yr)	% moniliasis	% black pod
CATIE-R6	1485	5	0	2363	4	0
CATIE-R4	1336	9	1	2070	12	1
CC-137	990	32	1	1321	43	0
CATIE-R1	1066	12	7	1674	15	6
PMCT-58	789	26	4	1036	35	2
ICS-95 T1	636	26	6	926	32	4

(PHILLIPS-MORA et al. 2013, modified)

→ **Aroma quality?**

(HEGMANN 2015)

Aroma quality

CHOCOLATE-AROMA



©v3wall

FINE-AROMA



fruity

©gomeal



©sitzberger

nutty



©medhost

floral

- all genotypes of *Theobroma cacao* L.
- develops during roasting through aroma-precursors:

aroma precursors are formed during fermentation and drying:

- free amino acids (FAA)
- oligopeptides
- reducing sugars

➤ **post harvest-management**

(PETTIPHER, 1986; AFOAKWA ET AL., 2008)

- strongly genotype-dependent
- components originating from secondary metabolism:

- terpenes
- alcohols
- derivatives
(aldehydes, methylketones, esters)

➤ **pulp, yeast activity, cotyledones**

(SCHWAN AND WHEALS, 2014; ESKES ET AL., 2009, KADOW ET AL. 2013)

A. Monoclonal Microfermentations in Costa Rica

- 1. Impact of genotype on course of fermentation**
temperature development, changes in pH and pulp sugars (°Bx), CUT-Test
- 2. Biochemical characteristics of the six CATIE-selections**
phenolic compounds, organic acids, free amino acids, reducing sugars

B. Aroma components in fresh fruit pulp

Headspace-SPME-GCMS

- 1. Fine-aroma potential?**
comparison with common „Fine or Flavour“-cocoas
- 2. Influence of the season during fruit ripening**
rainy season, dry season
- 3. Influence of the fruit ripening stage**
unripe, ripe, overripe fruits

Method: Aroma components in fresh fruit pulp

PMCT-58



ICS-95 (T1)



CATIE-R1



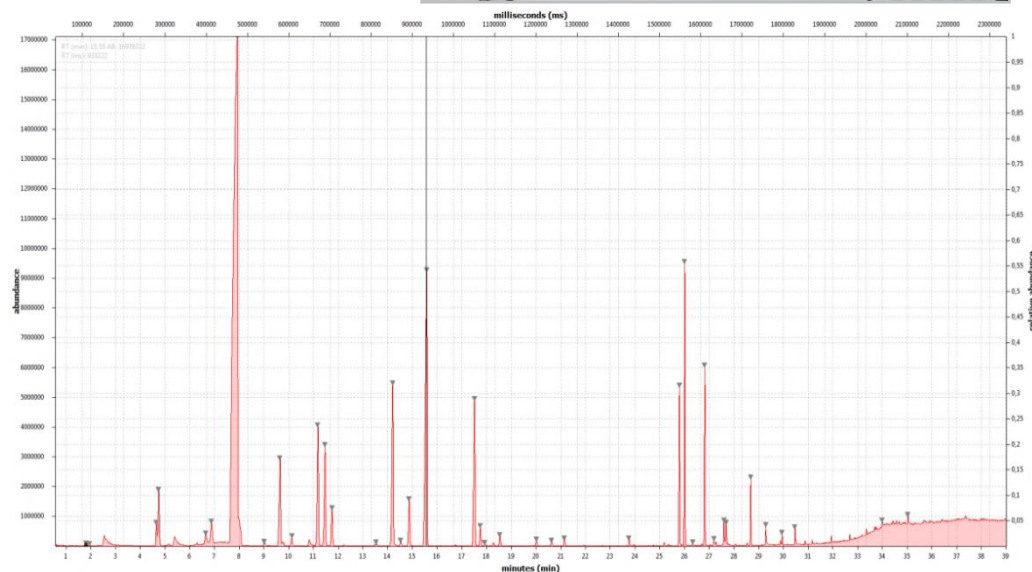
CATIE-R4



CATIE-R6



Fruit pulp analysis via Headspace-SPME-GCMS
GCMS-evaluation via OpenChrom 0.9.0



Various volatile aroma components were identified

- monoterpenes, sesquiterpenes, alcohols, esters, aldehydes and ketones
 - *green, herbal, fruity, floral, spicy, earthy, woody, cheesy, fermented*

Individual amounts differ strongly → major and minor components

- 2-heptanol, acetate (*green*) und 2-pentanol, acetate (*fruity*) predominate
- the individual aroma-character is defined by volatiles of low amounts (minor components, <1 %)* and traces (<0,1 %)*

*share in total aroma

Abundance of aroma-active compounds in fresh fruit pulp

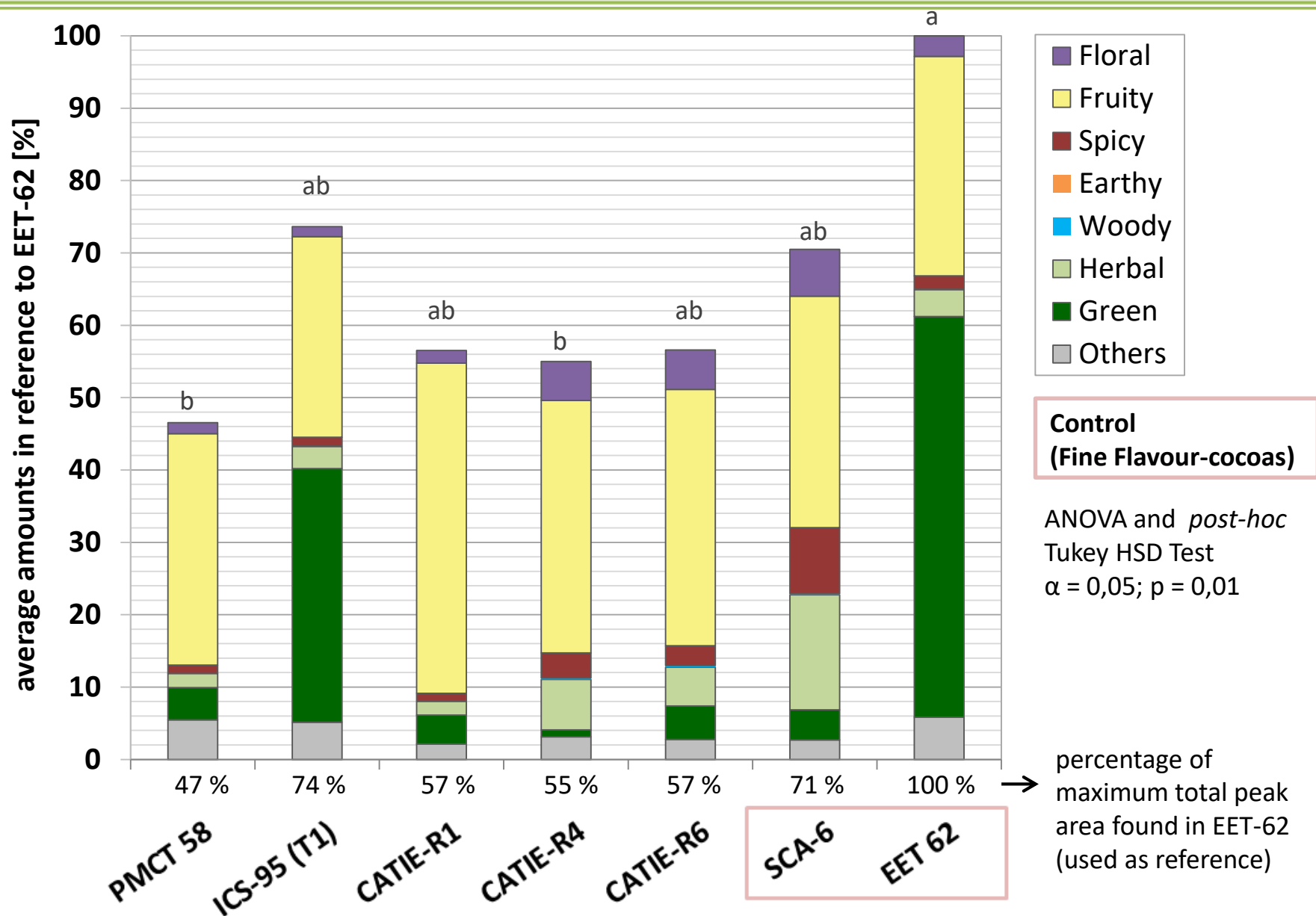
	monoterpenes	sesquiterpenes	alcohols <i>floral</i>	alcohols <i>other</i>	esters	ketones	aldehydes
<i>examples</i>	<i>α-ocimene</i>	<i>α-bergamotene</i>	<i>linalool</i>	<i>2-heptanol</i>	<i>2-heptanol acetate</i>	<i>2-nonanone</i>	<i>nonanal</i>
CATIE-R1	+	+++	++	+	++	+	-
CATIE-R4	+++	+++	+++	++	+	+	++ ¹⁾
CATIE-R6	+++	+++	+++	+	++	+	-
ICS-95 T1	+	-	++	+++	+++	+++	+++
PMCT-58	+	±	+	++	+++	++	+

¹⁾ only unripe fruits

Categorization according to number of components or peak area

+++ = predominant / **++ = medium** / **+** = less / **±** = 1 compound detected / **-** = not detected

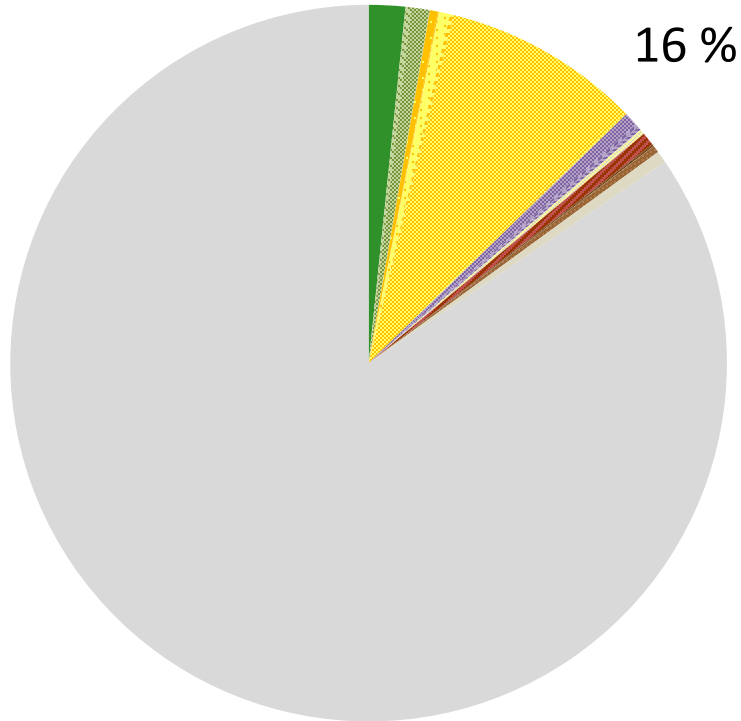
Ripe and overripe cocoa fruits: aroma compositions of fresh fruit pulp



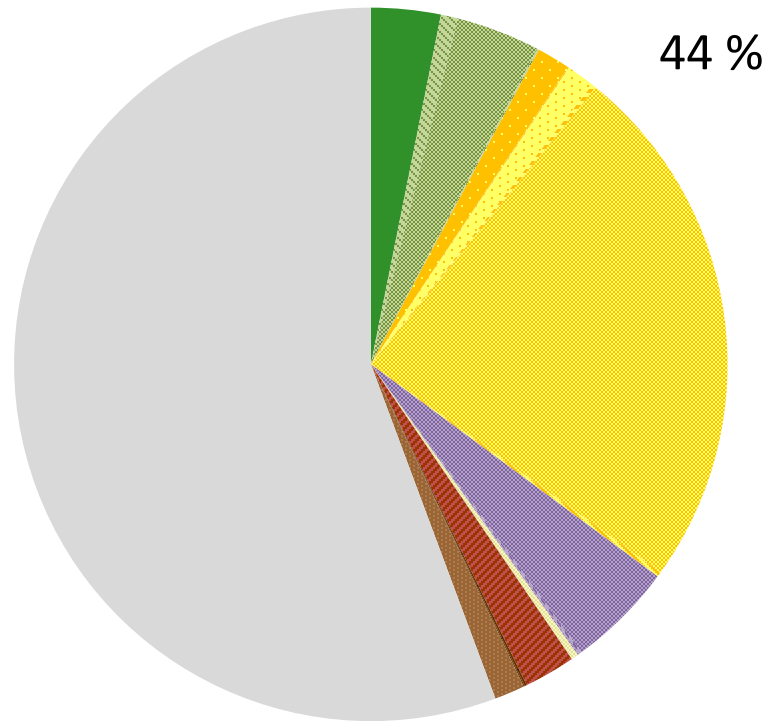
Aroma differences in main crop and mid-crop

- increased **aroma intensity** in the rainy season
- depending on the genotype, increased **aroma diversity** in the dry season

CATIE-R6



Dry season



Rainy season

Reference area: maximum total peak area detected = fine aroma cocoa EET 62
ANOVA and *post-hoc* Tukey HSD Test with $\alpha = 0,05$ und $p \leq 0,001$

Results: Influence of the fruit ripening stage at time of harvest

Increasing aroma intensity from *unripe* → *ripe* → *overripe*

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various **green** and **herbal** aromas, resp., appear **only** in pulp of **unripe** cocoa fruits

eg. trans-2-hexenal, hexanal, heptanal, cis-3-hexenol, 2-pentyl furan

Ripening stages show different aroma compounds

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alpha-ocimene, trans-ocimene as well as alcohols and ketones with **floral aroma** appear **mostly** in fresh pulp when fruits are **ripe**
eg. linalool, acetophenone

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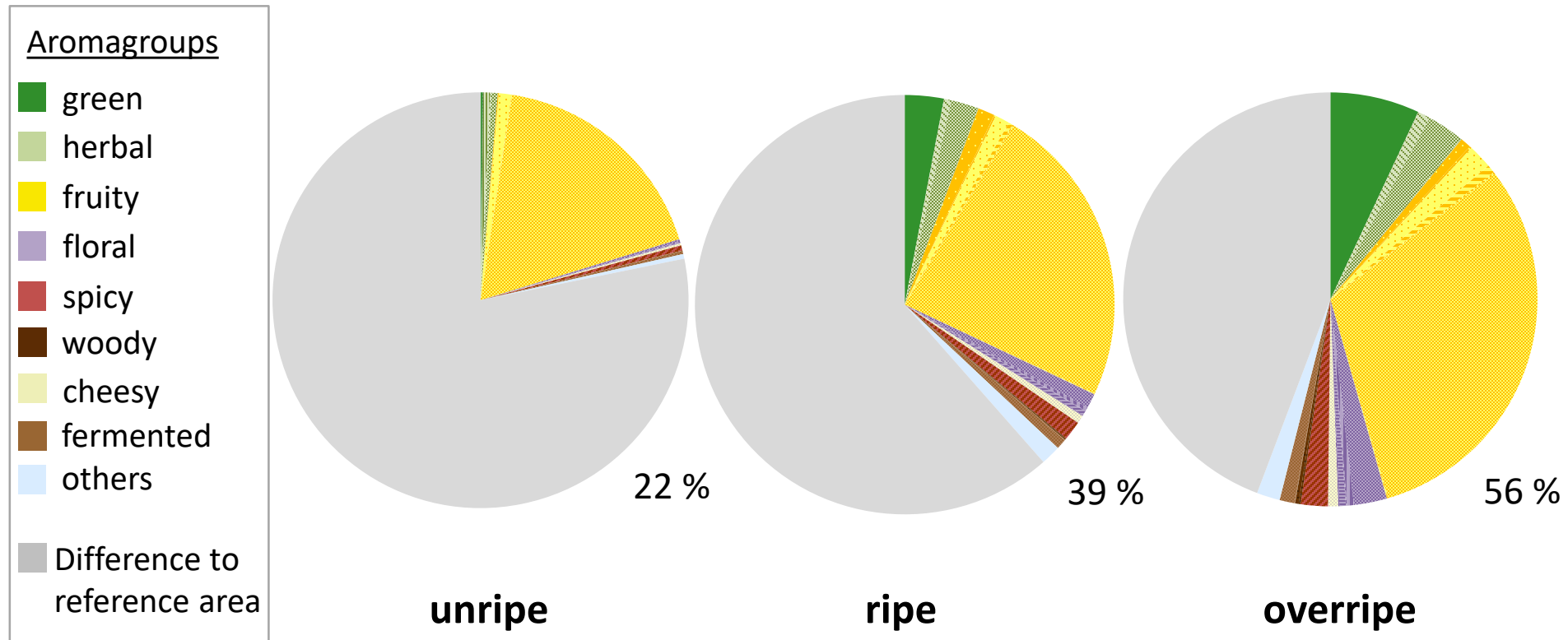


©alraune esoterik

traces of **sesquiterpenes** with **woody** and **spicy** aroma often appear for the first time in pulp of **overripe** fruits

eg. alpha-bergamotene, alpha-gurjunene, delta-cadinene

CATIE-R6



Reference area: maximum total peak area detected = fine aroma cocoa EET 62

ANOVA and *post-hoc* Tukey HSD Test with $\alpha = 0,05$ and $p = 0,007$

Conclusions

1. **Volatile aromas** identified in commonly known “Fine or Flavour”- Cocoas (EET-62, SCA 6) were detected **in fresh fruit pulps** of the cocoa clones **CATIE-R1, CATIE-R4, CATIE-R6, PMCT-58 and ICS-95 (T1)**
 - These findings allow their classification as “Fine or Flavour”- Cocoas
2. Fine aroma potential is **strongly genotype-dependent** and **varies with the season** and **the fruit ripening stage**
 - The CATIE-clones show individual aroma profiles and intensities, resp.
 - Different aroma-qualities to be expected in main crop and mid-crop



Many thanks
for your attention

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