Virgin Cocoa Butter from Modified Cocoa Bean Processing

Ariza Budi Tunjung Sari 1, 2, 3, Priscilla Efraim 2, 4, Susanne Naumann 2

1 Faculty of Food Technology and Biotechnology, University of Bonn, Bonn 53113, Germany. www.ilt.uni-bonn.de
2 Fraunhofer Institute for Food and Packaging Technology (IVV), Freising, Bayern 85354, Germany. www.ivv.fraunhofer.de
3 Indonesian Coffee and Cocoa Research Institute (ICCRI), Jember, East Java 68118, Indonesia. www.iccri.net
4 Faculdade de Engenharia de Alimentos, Universidade Estadual de Campinas (Unicamp), Campinas 13083-000, Brasil. www.fea.unicamp.br

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Cocoa butter production method

1. **Cocoa Fruit**
   - Harvesting
   - Pod opening
   - Cocoa seeds
   - Fermentation
   - Drying
   - Cocoa beans

2. **Cocoa beans**
   - Roasting
   - Deshelling
   - Cocoa nibs
   - Grinding
   - Cocoa liquor

3. **Cocoa liquor**
   - Extraction
   - Cocoa butter
   - Cocoa solids
   - Crushing
   - Cocoa powder

(Okiyama et al., 2017)

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Possible modifications:

- Cocoa Fruit
  - Harvesting
  - Pod opening
  - Cocoa seeds
  - Fermentation
  - Drying
  - Cocoa beans
- Cocoa beans
  - Roasting
  - Deshelling
  - Cocoa nibs
  - Grinding
  - Cocoa liquor
- Cocoa liquor
  - Extraction
  - Cocoa butter
  - Cocoa solids
  - Crushing
  - Cocoa powder

(Okiyama et al., 2017)
Cocoa butter extraction

- Mechanical pressing
- Solvent extraction with hexane
- Supercritical fluid extraction
## Treatments

<table>
<thead>
<tr>
<th>Code</th>
<th>Fermentation</th>
<th>Deshelling</th>
<th>Roasting</th>
<th>Pressing</th>
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<td>Yes</td>
<td>No</td>
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<td>No</td>
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<td>Hydraulic/expeller</td>
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<tr>
<td>FSR</td>
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<td>No</td>
<td>Yes</td>
<td>Expeller</td>
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</tbody>
</table>

### Evaluations

**Cocoa butter**
- Yield of extraction
- Free fatty acid content
- Solid fat content
- Triacylglycerol content
- Oxidation stability

**Cocoa solids**
- Total phenolic content
- Phenolic compounds

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Analyses

Cocoa butter

- Free fatty acids (FFA) content: titration based on AOCS Cd 3d-63 official method
- Solid fat content (SFC): nuclear magnetic resonance (NMR) (Rothkopf & Danzl, 2015)
- Fatty acids composition: Gas chromatography (GC)
- Oxidation stability (Rancimat analysis)

Cocoa solids

- Total polyphenol content (TPC): Folin-Ciocalteu method (Rodríguez et al., 2014)
WP 1 (Leader Uni Gießen)

Research Institute: Universität Gießen (Prof. Zorn); Fraunhofer IVV (evaluation of mushroom ingredients for food applications)
Industrial Partner: Van Hees GmbH (application of mushroom ingredients in premixes for meat industry)

WP 2 (Leader Fraunhofer IVV)

Research Institute: Fraunhofer IVV
Industrial Partner: Valensina + Oetker + Firmenich (Symrise?)

WP 3 (Leader ICCRI)

Research Institute: ICCRI (Prof. Misnawi); Fraunhofer IVV (evaluation and application of cocoa butter)
Industrial Partner: Ritter, Oetker, Bahlsen, Indonesian Partners

WP 4 (Leader ICCRI)

Research Institute: ICCRI (Prof. Misnawi), Fraunhofer IVV (evaluation dietary fiber enriched powder)
Industrial Partner: Ritter, Oetker, Bahlsen, Indonesian partners

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RESULTS AND DISCUSSION

Free fatty acid (FFA) content

- FFA contents were lower in the cocoa butter from treatments without fermentation and with expeller pressing.

Cocoa butter
- U  unfermented, no shell
- US unfermented, shell
- UR unfermented, no shell, roasted
- USR unfermented, shell, roasted
- F  fermented, no shell
- FS fermented, shell
- FR fermented, no shell, roasted
- FSR fermented, shell, roasted

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Solid fat content (SFC)

Expeller pressing

Hydraulic pressing

Concentration (% w/w)

82,0
80,0
78,0
76,0
74,0
72,0
70,0

U
US
UR
USR
F
FS
FR
FSR
U
UR
F
FR

Conventional processing

• SFC values were higher in the cocoa butter from treatments with expeller pressing

Cocoa butter
U unfermented, no shell
US unfermented, shell
UR unfermented, no shell, roasted
USR unfermented, shell, roasted
F fermented, no shell
FS fermented, shell
FR fermented, no shell, roasted
FSR fermented, shell, roasted

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Yield of extraction

• Yields of extraction were higher in the cocoa butter from treatments with hydraulic pressing

Cocoa butter
- U unfermented, no shell
- US unfermented, shell
- UR unfermented, no shell, roasted
- USR unfermented, shell, roasted
- F fermented, no shell
- FS fermented, shell
- FR fermented, no shell, roasted
- FSR fermented, shell, roasted

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RESULTS AND DISCUSSION

Cocoa butter
- Unfermented, no shell
- Unfermented, shell
- Unfermented, no shell, roasted
- Unfermented, shell, roasted
- Fermented, no shell
- Fermented, shell
- Fermented, no shell, roasted
- Fermented, shell, roasted

Triacylglycerol contents were varied across different treatments

POP = Palmitic – Oleic – Palmitic
SOS = Stearic – Oleic – Stearic
POS = Palmitic – Oleic – Stearic

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The onset of oxidation was delayed in the cocoa butter from treatment without fermentation.

The mixing of unfermented cocoa butter with a regular cocoa butter has resulted in the delay in the onset of oxidation.

Cocoa butter
U unfermented, no shell
FR fermented, no shell, roasted

Extraction method:
hydraulic pressing
Proposed modifications on the cocoa bean processing

• Cocoa bean processing without fermentation
• Expeller pressing at a higher quantity to increase the yield of cocoa butter extraction

Potential outputs

• Cocoa butter with minimal induction of enzymatic and thermal damage → Virgin Cocoa Butter
• Cocoa solids with higher phenolic content
Significance of study

• Product diversification:
  • virgin cocoa butter,
  • phenolic-rich cocoa powder

• Utilization of smallholder farmer’s product
  • Some farmers in Indonesia operate small land (<1ha) at low productivity (<500 kg/year).
  • Conducting proper fermentation is very challenging at a low amount of cocoa beans
  • It is suggested that these farmers produce unfermented cocoa beans as the raw material of virgin cocoa butter
Thank you very much for your attention

We are looking forward to your comments and inputs

For further communication, please kindly contact me at ariza.bts@gmail.com