

DAFTAR PUSTAKA

- Afoakwa, E. O. (2016). *Chocolate science and Technology, Second Edition*.
- Afoakwa, E. O., Paterson, A., Fowler, M., & Ryan, A. (2009). Matrix effects on flavour volatiles release in dark chocolates varying in particle size distribution and fat content using GC-mass spectrometry and GC-olfactometry. *Food Chemistry*, 113(1), 208–215. <https://doi.org/10.1016/j.foodchem.2008.07.088>
- Afoakwa, Emmanuel Ohene, Paterson, A., Fowler, M., & Ryan, A. (2008). Flavor formation and character in cocoa and chocolate: A critical review. *Critical Reviews in Food Science and Nutrition*, 48(9), 840–857. <https://doi.org/10.1080/10408390701719272>
- Albertini, B., Schoubben, A., Guarnaccia, D., Pinelli, F., Della Vecchia, M., Ricci, M., Di Renzo, G. C., & Blasi, P. (2015). Effect of Fermentation and Drying on Cocoa Polyphenols. *Journal of Agricultural and Food Chemistry*, 63(45), 9948–9953. <https://doi.org/10.1021/acs.jafc.5b01062>
- Apriyanto, M., Sutardi, S., Harmayani, E., & Supriyanto, S. (2017). Perbaikan Proses Fermentasi Biji Kakao Non Fermentasi dengan Penambahan Biakan Murni *Saccharomyces cerevisiae*, *Lactobacillus lactis* dan *Acetobacter aceti* (Fermentation Process Improvement of Cocoa Beans with Addition of Non Fermentation Inoculum of *Saccharomyces cerevisiae*, *Lactobacillus lactis* and *Acetobacter aceti*). *Agritech*, 36(4), 410. <https://doi.org/10.22146/agritech.16764>
- Aprotosoae, A. C., Luca, S. V., & Miron, A. (2016). Flavor Chemistry of Cocoa and Cocoa Products-An Overview. *Comprehensive Reviews in Food Science and Food Safety*, 15(1), 73–91. <https://doi.org/10.1111/1541-4337.12180>
- Ardhana, M. M., & Fleet, G. H. (2003). The microbial ecology of cocoa bean fermentations in Indonesia. *International Journal of Food Microbiology*, 86(1–2), 87–99. [https://doi.org/10.1016/S0168-1605\(03\)00081-3](https://doi.org/10.1016/S0168-1605(03)00081-3)
- Balcázar-Zumaeta, C. R., Castro-Alayo, E. M., Cayo-Colca, I. S., Idrogo-Vásquez, G., & Muñoz-Astecker, L. D. (2023). Metabolomics during the spontaneous fermentation in cocoa (*Theobroma cacao* L.): An exploraty review. In *Food Research International* (Vol. 163). Elsevier Ltd. <https://doi.org/10.1016/j.foodres.2022.112190>
- Beckett, S. T. (2009). *Industrial chocolate manufacture and use*. Wiley-Blackwell.

- Berger, A., & Schechter, I. (1970). Mapping the active site of papain with the aid of peptide substrates and inhibitors. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 257(813), 249–264. <https://doi.org/10.1098/rstb.1970.0024>
- Bonvehí, J. S. (2005). Investigation of aromatic compounds in roasted cocoa powder. *European Food Research and Technology*, 221(1–2), 19–29. <https://doi.org/10.1007/s00217-005-1147-y>
- Britto de Andrade, A., Lins da Cruz, M., Antonia de Souza Oliveira, F., Soares, S. E., Druzian, J. I., Radomille de Santana, L. R., Oliveira de Souza, C., & da Silva Bispo, E. (2021). Influence of under-fermented cocoa mass in chocolate production: Sensory acceptance and volatile profile characterization during the processing. *LWT*, 149. <https://doi.org/10.1016/j.lwt.2021.112048>
- Calvo, A. M., Botina, B. L., García, M. C., Cardona, W. A., Montenegro, A. C., & Criollo, J. (2021). Dynamics of cocoa fermentation and its effect on quality. *Scientific Reports*, 11(1). <https://doi.org/10.1038/s41598-021-95703-2>
- Camu, N., De Winter, T., Verbrugghe, K., Cleenwerck, I., Vandamme, P., Takrama, J. S., Vancanneyt, M., & De Vuyst, L. (2007). Dynamics and biodiversity of populations of lactic acid bacteria and acetic acid bacteria involved in spontaneous heap fermentation of cocoa beans in Ghana. *Applied and Environmental Microbiology*, 73(6), 1809–1824. <https://doi.org/10.1128/AEM.02189-06>
- Castro-Alayo, E. M., Idrogo-V Asquez, G., Ul Siche, R., & Cardenas-Toro, F. P. (2019). Formation of aromatic compounds precursors during fermentation of Criollo and Forastero cocoa. *Forastero Cocoa. Heliyon*, 5, 1157. <https://doi.org/10.1016/j.heliyon.2019>
- Chibbar, R. N., Jaiswal, S., Gangola, M., & Båga, M. (2015). Carbohydrate Metabolism. In *Encyclopedia of Food Grains: Second Edition* (Vols. 2–4, pp. 161–173). Elsevier Inc. <https://doi.org/10.1016/B978-0-12-394437-5.00089-9>
- Colonges, K., Jimenez, J. C., Saltos, A., Seguíne, E., Llor Solórzano, R. G., Fouet, O., Argout, X., Assemat, S., Davrieux, F., Cros, E., Lanaud, C., & Boulanger, R. (2022). Integration of GWAS, metabolomics, and sensorial analyses to reveal novel metabolic pathways involved in cocoa fruity aroma GWAS of fruity aroma in *Theobroma cacao*. *Plant Physiology and Biochemistry*, 171, 213–225. <https://doi.org/10.1016/j.plaphy.2021.11.006>
- Crafack, M., Mikkelsen, M. B., Saerens, S., Knudsen, M., Blennow, A., Lowor, S., Takrama, J., Swiegers, J. H., Petersen, G. B., Heimdal, H., & Nielsen, D.

- S. (2013). Influencing cocoa flavour using *Pichia kluyveri* and *Kluyveromyces marxianus* in a defined mixed starter culture for cocoa fermentation. *International Journal of Food Microbiology*, 167(1), 103–116. <https://doi.org/10.1016/j.ijfoodmicro.2013.06.024>
- Cupp-Enyard, C., & Aldrich, S. (2008). Sigma's non-specific protease activity assay - Casein as a substrate. *Journal of Visualized Experiments*, 19. <https://doi.org/10.3791/899>
- de Melo Pereira, G. V., Magalhães, K. T., de Almeida, E. G., da Silva Coelho, I., & Schwan, R. F. (2013). Spontaneous cocoa bean fermentation carried out in a novel-design stainless steel tank: Influence on the dynamics of microbial populations and physical-chemical properties. *International Journal of Food Microbiology*, 161(2), 121–133. <https://doi.org/10.1016/j.ijfoodmicro.2012.11.018>
- De Vuyst, L., & Weckx, S. (2016). The cocoa bean fermentation process: from ecosystem analysis to starter culture development. In *Journal of Applied Microbiology* (Vol. 121, Issue 1, pp. 5–17). Blackwell Publishing Ltd. <https://doi.org/10.1111/jam.13045>
- Díaz, I., & Martinez, M. (2013). Plant C1A Cysteine Peptidases in Germination and Senescence. In *Handbook of Proteolytic Enzymes* (Vol. 2, pp. 1852–1858). Elsevier Ltd. <https://doi.org/10.1016/B978-0-12-382219-2.00417-8>
- Fang, Y., Li, R., Chu, Z., Zhu, K., Gu, F., & Zhang, Y. (2020). Chemical and flavor profile changes of cocoa beans (*Theobroma cacao* L.) during primary fermentation. *Food Science and Nutrition*, 8(8), 4121–4133. <https://doi.org/10.1002/fsn3.1701>
- Febrianto, N. A., & Zhu, F. (2022). Composition of methylxanthines, polyphenols, key odorant volatiles and minerals in 22 cocoa beans obtained from different geographic origins. *LWT*, 153. <https://doi.org/10.1016/j.lwt.2021.112395>
- Figueroa-Hernández, C., Mota-Gutierrez, J., Ferrocino, I., Hernández-Estrada, Z. J., González-Ríos, O., Cocolin, L., & Suárez-Quiroz, M. L. (2019). The challenges and perspectives of the selection of starter cultures for fermented cocoa beans. In *International Journal of Food Microbiology* (Vol. 301, pp. 41–50). Elsevier B.V. <https://doi.org/10.1016/j.ijfoodmicro.2019.05.002>
- Frauendorfer, F., & Schieberle, P. (2006). Identification of the key aroma compounds in cocoa powder based on molecular sensory correlations. *Journal of Agricultural and Food Chemistry*, 54(15), 5521–5529. <https://doi.org/10.1021/jf060728k>

- Gosalia, D. N., Salisbury, C. M., Ellman, J. A., & Diamond, S. L. (2005). High throughput substrate specificity profiling of serine and cysteine proteases using solution-phase fluorogenic peptide microarrays. *Molecular and Cellular Proteomics*, 4(5), 626–636. <https://doi.org/10.1074/mcp.M500004-MCP200>
- Harris, J. L., Backes, B. J., Leonetti, F., Mahrus, S., Ellman, J. A., & Craik, C. S. (2000). *Rapid and general profiling of protease specificity by using combinatorial fluorogenic substrate libraries*. www.pnas.org/cgi/doi/10.1073/pnas.140132697
- Hashim, P., Selamat, J., Kharidah, S., Muhammad2, S., & Ali2, A. (1998). Changes in Free Amino Acid, Peptide-N, Sugar and Pyrazine Concentration during Cocoa Fermentation. In *J Sci Food Agric* (Vol. 78).
- Hinne, M., Semanhyia, E., Van de Walle, D., De Winne, A., Tzompa-Sosa, D. A., Scalone, G. L. L., De Meulenaer, B., Messens, K., Van Durme, J., Afoakwa, E. O., De Cooman, L., & Dewettinck, K. (2018). Assessing the influence of pod storage on sugar and free amino acid profiles and the implications on some Maillard reaction related flavor volatiles in Forastero cocoa beans. *Food Research International*, 111, 607–620. <https://doi.org/10.1016/j.foodres.2018.05.064>
- Ho, V. T. T., Zhao, J., & Fleet, G. (2014). Yeasts are essential for cocoa bean fermentation. *International Journal of Food Microbiology*, 174, 72–87. <https://doi.org/10.1016/j.ijfoodmicro.2013.12.014>
- Kadow, D., Niemenak, N., Rohn, S., & Lieberei, R. (2015). Fermentation-like incubation of cocoa seeds (*Theobroma cacao* L.) - Reconstruction and guidance of the fermentation process. *LWT*, 62(1), 357–361. <https://doi.org/10.1016/j.lwt.2015.01.015>
- Kongor, J. E., Hinne, M., de Walle, D. Van, Afoakwa, E. O., Boeckx, P., & Dewettinck, K. (2016). Factors influencing quality variation in cocoa (*Theobroma cacao*) bean flavour profile - A review. In *Food Research International* (Vol. 82, pp. 44–52). Elsevier Ltd. <https://doi.org/10.1016/j.foodres.2016.01.012>
- Kurozawa, L. E., Park, K. J., & Hubinger, M. D. (2008). Optimization of the enzymatic hydrolysis of chicken meat using response surface methodology. *Journal of Food Science*, 73(5). <https://doi.org/10.1111/j.1750-3841.2008.00765.x>
- Misnawi, selamat jinap, Jamilah, B., & Nazamid, S. (2003). *Effects of incubation and polyphenol oxidase enrichment on colour, fermentation index,*

procyanidins and astringency of unfermented and partly fermented cocoa beans. <https://doi.org/https://doi.org/10/1046/j.1365-2621.2003.00674.x>

- Misnawi, Selamat Jinap, Nazamid, S., & Jamilah, B. (2002). *Activation of remaining key enzymes in dried under-fermented cocoa beans and its effect on aroma precursor formation.* www.elsevier.com/locate/foodchem
- Neto, D. P. de C., de Melo Pereira, G. V., Finco, A. M. O., Letti, L. A. J., da Silva, B. J. G., Vandenberghe, L. P. S., & Soccol, C. R. (2018). Efficient coffee beans mucilage layer removal using lactic acid fermentation in a stirred-tank bioreactor: Kinetic, metabolic and sensorial studies. *Food Bioscience*, 26, 80–87. <https://doi.org/10.1016/j.fbio.2018.10.005>
- Noman, A., Xu, Y., AL-Bukhaiti, W. Q., Abed, S. M., Ali, A. H., Ramadhan, A. H., & Xia, W. (2018). Influence of enzymatic hydrolysis conditions on the degree of hydrolysis and functional properties of protein hydrolysate obtained from Chinese sturgeon (*Acipenser sinensis*) by using papain enzyme. *Process Biochemistry*, 67, 19–28. <https://doi.org/10.1016/j.procbio.2018.01.009>
- Nurhayati, T., Hasan Sanapi, C., Perikanan dan Ilmu Kelautan, F., & Pertanian Bogor, I. (2018). *Masyarakat Pengolahan Hasil Perikanan Indonesia 207 KARAKTERISASI HIDROLISAT PROTEIN IKAN LELE DUMBO (Clarias gariepinus) Characterization of Protein Hydrolysates from African Catfish (Clarias gariepinus).* 1–6.
- Porter, L. J., Ma+, Z., & Chant, B. G. (1991). *CACAO PROCYANIDINS: MAJOR FLAVANOIDS AND OF SOME MINOR METABOLITES* (Vol. 30, Issue 5).
- Purbaningrum, K., Hidayat, C., Witasari, L. D., & Utami, T. (2023). Flavor Precursors and Volatile Compounds Improvement of Unfermented Cocoa Beans by Hydrolysis Using Bromelain. *Foods*, 12(4). <https://doi.org/10.3390/foods12040820>
- Puspita Kusumadjaja, A., Puspa Dewi, R., & Kondisi Optimum Enzim Papain Dari Pepaya Burung Varietas Jawa, P. (2005). DETERMINATION of OPTIMUM CONDITION of PAPAIN ENZYME FROM PAPAYA VAR JAVA (*Carica papaya*). In *Indo. J. Chem* (Vol. 5, Issue 2).
- Putra, S. N. K. M., Ishak, N. H., & Sarbon, N. M. (2018). Preparation and characterization of physicochemical properties of golden apple snail (*Pomacea canaliculata*) protein hydrolysate as affected by different proteases. *Biocatalysis and Agricultural Biotechnology*, 13, 123–128. <https://doi.org/10.1016/j.bcab.2017.12.002>
- Rodriguez-Campos, J., Escalona-Buendía, H. B., Contreras-Ramos, S. M., Orozco-Avila, I., Jaramillo-Flores, E., & Lugo-Cervantes, E. (2012). Effect

of fermentation time and drying temperature on volatile compounds in cocoa.
Food Chemistry, 132(1), 277–288.
<https://doi.org/10.1016/j.foodchem.2011.10.078>

Rojas, M., Hommes, A., Heeres, H. J., & Chejne, F. (2022). Physicochemical Phenomena in the Roasting of Cocoa (*Theobroma cacao* L.). In *Food Engineering Reviews* (Vol. 14, Issue 3, pp. 509–533). Springer.
<https://doi.org/10.1007/s12393-021-09301-z>

Rottiers, H., Tzompa Sosa, D. A., De Winne, A., Ruales, J., De Clippeleer, J., De Leersnyder, I., De Wever, J., Everaert, H., Messens, K., & Dewettinck, K. (2019). Dynamics of volatile compounds and flavor precursors during spontaneous fermentation of fine flavor Trinitario cocoa beans. *European Food Research and Technology*, 245(9), 1917–1937.
<https://doi.org/10.1007/s00217-019-03307-y>

Schechter, I., & Berger, A. (1967). *BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS ON THE SIZE OF THE ACTIVE SITE IN PROTEASES. I. PAPAIN* (Vol. 27, Issue 2).

Singh, T. P., Siddiqi, R. A., & Sogi, D. S. (2019). Statistical optimization of enzymatic hydrolysis of rice bran protein concentrate for enhanced hydrolysate production by papain. *LWT*, 99, 77–83.
<https://doi.org/10.1016/j.lwt.2018.09.014>

Tamimi, K. Al, Hidayat, C., Utami, T., & Witasari, L. D. (2023). Flavor precursor formation of non-fermented forastero cocoa beans after flavourzyme® and glucose treatment. *LWT*, 184, 114910.
<https://doi.org/10.1016/j.lwt.2023.114910>

Tarigan, E. B., Iflah, T., Penelitian, B., Industri, T., Penyegar, D., Raya, J., & Km, P.-P. 2. (2017). *BEBERAPA KOMPONEN FISILOGOKIMIA KAKAO FERMENTASI DAN NON FERMENTASI SOME PHYSICOCHEMICAL COCOA FERMENTATION AND NON FERMENTATION* (Vol. 3, Issue 1).

Utrilla-Vázquez, M., Rodríguez-Campos, J., Avendaño-Arazate, C. H., Gschaedler, A., & Lugo-Cervantes, E. (2020). Analysis of volatile compounds of five varieties of Maya cocoa during fermentation and drying processes by Venn diagram and PCA. *Food Research International*, 129.
<https://doi.org/10.1016/j.foodres.2019.108834>

Viesser, J. A., de Melo Pereira, G. V., de Carvalho Neto, D. P., Rogez, H., Góes-Neto, A., Azevedo, V., Brenig, B., Aburjaile, F., & Soccol, C. R. (2021). Co-culturing fructophilic lactic acid bacteria and yeast enhanced sugar metabolism and aroma formation during cocoa beans fermentation.

International Journal of Food Microbiology, 339.
<https://doi.org/10.1016/j.ijfoodmicro.2020.109015>

- Voigt, J., Biehl, B., Heinrichs, H., Kamaruddin, S., Marsoner, G. G., & Hugl, A. (1994). In-vitro formation of cocoa-specific aroma precursors: aroma-related peptides generated from cocoa-seed protein by co-operation of an aspartic endoprotease and a carboxypeptidase. *Food Chemistry*, 49(2), 173–180. [https://doi.org/10.1016/0308-8146\(94\)90155-4](https://doi.org/10.1016/0308-8146(94)90155-4)
- Voigt, J., Heinrichs, H., Voigt, G., & Biehl, B. (1994). Cocoa-specific aroma precursors are generated by proteolytic digestion of the vicilin-like globulin of cocoa seeds. In *Food Chemistry* (Vol. 50).
- Voigt, J., Textoris-Taube, K., & Wöstemeyer, J. (2018). pH-Dependency of the proteolytic formation of cocoa- and nutty-specific aroma precursors. *Food Chemistry*, 255, 209–215. <https://doi.org/10.1016/j.foodchem.2018.02.045>
- Wollgast, J., & Anklam, E. (2000). *Review on polyphenols in Theobroma cacao: changes in composition during the manufacture of chocolate and methodology for identification and quantification*. www.elsevier.com/locate/foodres
- Yuniar, L., Rachman, S. D., & Soedjanaatmadja, R. U. M. S. (2018). Pengaruh Fermentasi Biji Kakao dengan Menggunakan *Kluyveromyces* sp., *Lactobacillus plantarum*, *Acetobacter xylinum*, Enzim Papain dan Bromelain serta Sistein Terhadap Prekursor Cita Rasa serta Kandungan Nutrisi dan Polifenolnya. *Chimica et Natura Acta*, 6(3), 127. <https://doi.org/10.24198/cna.v6.n3.20859>
- ziegleder, gottfried. (2017). *Flavor development in cocoa and chocolate*. 185–215. <https://doi.org/https://doi.org/10.1002/9781118923597.ch8>