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PLANT GENETICS AND BREEDING (2 JDL)

W.A. Jonfia-Essien, G. West, P.G. Alderson, G. Tucker, Phenolic content and antioxidant capacity of hybrid variety cocoa beans,
Food Chemistry, Volume 108, Issue 3, 1 June 2008, Pages 1155-1159, ISSN 0308-8146, DOI: 10.1016/j.foodchem.2007.12.001.
(http://www.sciencedirect.com/science/article/B6T6R-4R9JV07-1/2/e68a636a9a9507c16125c608a344e68c)

Abstract:

Cocoa (Theobroma cacao L.) is a major, economically important, international crop and has been associated with several nutritional benefits including high antioxidant capacity. New cocoa hybrids have been developed in Ghana that exhibit resistance to pest damage during storage. The aim of this work was to assess the phenolic content and antioxidant capacity of these new hybrids in comparison to more traditional cocoa varieties. Total extractable phenolics were similar in all the four hybrids tested ranging from 69.9 to 81.6 FAE g-1. These levels were very similar to that extracted from traditional beans (73.8 +/- 2.5 FAE g-1). The 'phenolic profile' was determined by HPLC. A total of 25 peaks was observed but there were only minor differences in this profile between traditional and hybrid bean extracts. Antioxidant capacity was determined using the FRAP assay and traditional beans were found to possess 12.4 [mu]mol TE g-1. In comparison the hybrid beans had antioxidant capacities ranging from 21.6 to 45.5 [mu]mol TE g-1, and these were significantly higher than in the traditional beans for three out of the four hybrids. Since the phenolic and antioxidant levels and in these hybrid varieties were either similar to, or higher than, that obtained from traditional beans, the introduction of these new varieties would be unlikely to impact detrimentally on these nutritional components of the beans.

Keywords: Cocoa beans; Hybrid varieties; Antioxidants; Phenolics

Timothy Lefeber, William Gobert, Gino Vrancken, Nicholas Camu, Luc De Vuyst, Dynamics and species diversity of communities of lactic acid bacteria and acetic acid bacteria during spontaneous cocoa bean fermentation in vessels,
Food Microbiology, Volume 28, Issue 3, May 2011, Pages 457-464, ISSN 0740-0020, DOI: 10.1016/j.fm.2010.10.010.
(http://www.sciencedirect.com/science/article/B6WFP-51BBKVR-5/2/1025ddfcb45b792d1540d4cbe1124c88)

Abstract:

To speed up research on the usefulness and selection of bacterial starter cultures for cocoa bean fermentation, a benchmark cocoa bean fermentation process under natural fermentation conditions was developed successfully. Therefore,

spontaneous fermentations of cocoa pulp-bean mass in vessels on a 20 kg scale were tried out in triplicate. The community dynamics and kinetics of these fermentations were studied through a multiphasic approach. Microbiological analysis revealed a limited bacterial species diversity and targeted community dynamics of both lactic acid bacteria (LAB) and acetic acid bacteria (AAB) during fermentation, as was the case during cocoa bean fermentations processes carried out in the field. LAB isolates belonged to two main (GTG)5-PCR clusters, namely Lactobacillus plantarum and Lactobacillus fermentum, with Fructobacillus pseudofilculneus occurring occasionally; one main (GTG)5-PCR cluster, composed of Acetobacter pasteurianus, was found among the AAB isolates, besides minor clusters of Acetobacter ghanensis and Acetobacter senegalensis. 16S rRNA-PCR-DGGE revealed that L. plantarum and L. fermentum dominated the fermentations from day two until the end and Acetobacter was the only AAB species present at the end of the fermentations. Also, species of Tatumella and Pantoea were detected culture-independently at the beginning of the fermentations. Further, it was shown through metabolite target analyses that similar substrate consumption and metabolite production kinetics occurred in the vessels compared to spontaneous cocoa bean fermentation processes. Current drawbacks of the vessel fermentations encompassed an insufficient mixing of the cocoa pulp-bean mass and retarded yeast growth.

Keywords: Cocoa bean fermentation; Vessel; Species diversity; Community dynamics; Lactic acid bacteria; Acetic acid bacteria

PLANT PHYSIOLOGY-BIOCHEMISTRY (1 JDL)

Hanhong Bae, Soo-Hyung Kim, Moon S. Kim, Richard C. Sicher, David Lary, Mary D. Strem, Savithiry Natarajan, Bryan A. Bailey, The drought response of Theobroma cacao (cacao) and the regulation of genes involved in polyamine biosynthesis by drought and other stresses,

Plant Physiology and Biochemistry, Volume 46, Issue 2, February 2008, Pages 174-188, ISSN 0981-9428, DOI: 10.1016/j.plaphy.2007.10.014.
(http://www.sciencedirect.com/science/article/B6VRD-4PXM68D-2/2/135e8ab2a438dce4b532661beef06cf8)

Abstract:

Drought can negatively impact pod production despite the fact that cacao production usually occurs in tropical areas having high rainfall. Polyamines (PAs) have been associated with the response of plants to drought in addition to their roles in responses to many other stresses. The constitutive and drought inducible expression patterns of genes encoding enzymes involved in PA biosynthesis were determined: an ornithine decarboxylase (TcODC), an arginine decarboxylase (TcADC), an S-adenosylmethionine decarboxylase (TcSAMDC), a spermidine synthase (TcSPDS), and a spermine synthase (TcSPMS). Expression analysis using quantitative real-time reverse transcription-PCR (QPCR) results showed that the PA biosynthesis genes were expressed in all plant tissues examined. Constitutive expression of PA biosynthesis genes was generally highest in mature leaves and open flowers.

Expression of TcODC, TcADC, and TcSAMDC was induced with the onset of drought and correlated with changes in stomatal conductance, photosynthesis, photosystem II efficiency, leaf water potential and altered emission of blue-green fluorescence from cacao leaves. Induction of TcSAMDC in leaves was most closely correlated with changes in water potential. The earliest measured responses to drought were enhanced expression of TcADC and TcSAMDC in roots along with decreases in stomatal conductance, photosynthesis, and photosystem II efficiency. Elevated levels of putrescine, spermidine, and spermine were detected in cacao leaves 13 days after the onset of drought. Expression of all five PA associated transcripts was enhanced (1.5-3-fold) in response to treatment with abscisic acid. TcODC and TcADC, were also responsive to mechanical wounding, infection by Phytophthora megakarya (a causal agent of black pod disease in cacao), the necrosis- and ethylene-inducing protein (Nep1) of Fusarium oxysporum, and flower abscission. TcSAMDC expression was responsive to all stresses except flower abscission. TcODC, although constitutively expressed at much lower levels than TcADC, TcSAMDC, TcSPDS, and TcSPMS, was highly inducible by the fungal protein Nep1 (135-fold) and the cacao pathogen Phytophthora megakarya (671-fold). The full length cDNA for ODC was cloned and characterized. Among the genes studied, TcODC, TcADC, and TcSAMDC were most sensitive to induction by drought in addition to other abiotic and biotic stresses. TcODC, TcADC, and TcSAMDC may share signal transduction pathways and/or the stress induced signal induction pathways may converge at these three genes leading to similar although not identical patterns of expression. It is possible altering PA levels in cacao will result in enhanced tolerance to multiple stresses including drought and disease as has been demonstrated in other crops.

Keywords: Polyamine; Theobroma cacao; Drought; Nep1; Wounding; Phytophthora; ODC; ADC; SAMDC; SPDS; SPMS

PLANT PHYSIOLOGY- REPRODUCTION (1 JDL)

Janna H. Groeneveld, Teja Tscharntke, Gerald Moser, Yann Clough, Experimental evidence for stronger cacao yield limitation by pollination than by plant resources, Perspectives in Plant Ecology,

Evolution and Systematics, Volume 12, Issue 3, 20 August 2010, Pages 183-191, ISSN 1433-8319, DOI: 10.1016/j.ppees.2010.02.005.
(http://www.sciencedirect.com/science/article/B7GVV-4YP6SR1-3/2/ffeb8e863145e3666ebb0c987103c29f)

Abstract:

Both pollination and resource limitation may cause low fruit:flower ratios in plants, but pollen and resource limitation have never been contrasted in commercially important crop species. Here we experimentally investigated the relative effect of pollen limitation and resource limitation in Theobroma cacao. In Central Sulawesi, Indonesia, we applied different relative levels of hand pollination (10%, 40%, 70% and 100% of available flowers up to 2 m height) to mature cacao trees in two separate

experiments encompassing (1) different light (shade roofs) and nitrogen (fertilizer application) treatments, and (2) water availability (throughfall displacement) treatments. None of the resource availability treatments had a significant effect, while number of mature pods and yield increased non-linearly with pollination intensity up to 200% of current yield levels. The largest benefits were reached by increasing pollination from 10% to 40%, with non-significant increases beyond that level. Despite an increase of fruit abortion with pollination intensity, T. cacao yield is determined, at least on the short term, by the number of flowers pollinated. This suggests pollination deficit in crops can be very large and that a better knowledge of pollen and resource limitation to devise adequate pollinator management strategies may be critical for increasing production.

Keywords: Agroforestry; Drought; Fruit:flower ratio; Nitrogen; Theobroma cacao; Water availability

PLANT DISEASES (4 JDL)

Rogerio E. Hanada, T. de Jorge Souza, Alan W.V. Pomella, K. Prakash Hebbar, Jose O. Pereira, Adnan Ismaiel, Gary J. Samuels, Trichoderma martiale sp. nov., a new endophyte from sapwood of Theobroma cacao with a potential for biological control, ***Mycological Research***, Volume 112, Issue 11, November 2008, Pages 1335-1343, ISSN 0953-7562, DOI: 10.1016/j.mycres.2008.06.022.
(http://www.sciencedirect.com/science/article/B7XMR-4SYJSDV-1/2/c22810734432138a60aa0c80fb9eb9a2)

Abstract:

The new species Trichoderma martiale was isolated as an endophyte from sapwood in trunks of Theobroma cacao (cacao, Malvaceae) in Brazil. Based on sequences of translation-elongation factor 1-alpha (tef1) and RNA polymerase II subunit (rpb2) T. martiale is a close relative of, and morphologically similar to, T. viride, but differs in the production of discrete pustules on corn meal-dextrose agar (CMD) and SNA, in having a faster rate of growth, and in being a tropical endophyte. This new species was shown, in small-scale, in situ field assays, to limit black pod rot of cacao caused by Phytophthora palmivora, the cause of black pod disease.

Keywords: Brazil; Black pod disease; Cacao; Diversity; Hypocrea; Hypocreales; New species; Phytophthora; Plant disease; Systematics

Odalys Garcia, Joci A.N. Macedo, Ricardo Tiburcio, Gustavo Zaparoli, Johana Rincones, Livia M.C. Bittencourt, Geruza O. Ceita, Fabienne Micheli, Abelmon Gesteira, Andrea C. Mariano, Marlene A. Schiavinato, Francisco J. Medrano, Lyndel W. Meinhardt, Goncalo A.G. Pereira, Julio C.M. Cascardo, Characterization of necrosis and ethylene-inducing proteins (NEP) in the basidiomycete Moniliophthora perniciosa, the causal agent of witches' broom in Theobroma cacao,

Mycological Research, Volume 111, Issue 4, April 2007, Pages 443-455, ISSN 0953-7562, DOI: 10.1016/j.mycres.2007.01.017.
(http://www.sciencedirect.com/science/article/B7XMR-4N1JRXT-2/2/e2c1d321cc5f9afc1b08169129ad60c3)
Abstract:

The hemibiotrophic basidiomycete Moniliophthora perniciosa causes witches' broom disease of Theobroma cacao. Analysis of the M. perniciosa draft genome led to the identification of three putative genes encoding necrosis and ethylene-inducing proteins (MpNEPs), which are apparently located on the same chromosome. MpNEP1 and 2 have highly similar sequences and are able to induce necrosis and ethylene emission in tobacco and cacao leaves. MpNEP1 is expressed in both biotrophic and saprotrophic mycelia, the protein behaves as an oligomer in solution and is very sensitive to temperature. MpNEP2 is expressed mainly in biotrophic mycelia, is present as a monomer in solution at low concentrations (<40 [mu]m) and is able to recover necrosis activity after boiling. These differences indicate that similar NEPs can have distinct physical characteristics and suggest possible complementary roles during the disease development for both proteins. This is the first report of NEP1-like proteins in a basidiomycete.
Keywords: Basidiomycota; Cacao; Plant pathology; WBD

Rachel L. Melnick, Carmen Suarez, Bryan A. Bailey, Paul A. Backman, Isolation of Endophytic Endospore-Forming Bacteria from Theobroma cacao as Potential Biological Control Agents of Cacao Diseases,
Biological Control, ***In Press, Accepted Manuscript, Available online*** 14 March 2011, ISSN 1049-9644, DOI: 10.1016/j.biocontrol.2011.03.005.
(http://www.sciencedirect.com/science/article/B6WBP-52CNMGS-1/2/98544f2c4ebab9caefa9abb7906db957)
Abstract:

Sixty-nine endospore-forming bacterial endophytes consisting of 15 different species from 5 genera were isolated from leaves, pods, branches, and flower cushions of Theobroma cacao as potential biological control agents. Sixteen isolates had in vitro chitinase production. In antagonism studies against cacao pathogens, 42% inhibited Moniliophthora roreri, 33% inhibited M. perniciosa, and 49% inhibited Phytophthora capsici. Twenty-five percent of isolates inhibited the growth of both Moniliophthora spp., while 22% of isolates inhibited the growth of all three pathogens. Isolates that were chitinolytic and tested negative on Bacillus cereus agar were tested with in planta studies. All 14 isolates colonized the phyllosphere and internal leaf tissue when introduced with Silwet L-77, regardless of the tissue of origin of the isolate. Eight isolates significantly inhibited P. capsici lesion formation (P=0.05) in detached leaf assays when compared to untreated control leaves. ARISA with bacilli specific primers amplified 21 OTUs in field grown cacao leaves, while eubacteria specific primers amplified 58 OTUs. ARISA analysis of treated leaves demonstrated that inundative application of a single bacterial species did not cause a long-term shift of native bacterial communities. This research illustrates the presence of endospore-forming

bacterial endophytes in cacao trees, their potential as antagonists of cacao pathogens, and that cacao harbors a range of bacterial endophytes.

Keywords: cacao; Bacillus; endophyte; cacao; Moniliophthora; Phytophthora; ARISA

Rogerio Eiji Hanada, Alan William V. Pomella, Heron Salazar Costa, Jose Luiz Bezerra, Leandro L. Loguercio, Jose O. Pereira, Endophytic fungal diversity in Theobroma cacao (cacao) and T. grandiflorum (cupuacu) trees and their potential for growth promotion and biocontrol of black-pod disease,

Fungal Biology, Volume 114, Issues 11-12, November-December 2010, Pages 901-910, ISSN 1878-6146, DOI: 10.1016/j.funbio.2010.08.006.
(http://www.sciencedirect.com/science/article/B9879-511C07S-1/2/72af16035748c60300521515c49e8edf)

Abstract:

The endophytic niches of plants are a rich source of microbes that can directly and indirectly promote plant protection, growth and development. The diversity of culturable endophytic fungi from stems and branches of Theobroma cacao (cacao) and Theobroma grandiflorum (cupuacu) trees growing in the Amazon region of Brazil was assessed. The collection of fungal endophytic isolates obtained was applied in field experiments to evaluate their potential as biocontrol agents against Phytophthora palmivora, the causal agent of the black-pod rot disease of cacao, one of the most important pathogens in cocoa-producing regions worldwide. The isolated endophytic fungi from 60 traditional, farmer-planted, healthy cacao and 10 cupuacu plants were cultured in PDA under conditions inducing sporulation. Isolates were classified based upon the morphological characteristics of their cultures and reproductive structures. Spore suspensions from a total of 103 isolates that could be classified at least up to genus level were tested against P. palmivora in pods attached to cacao trees in the field. Results indicated that ~70 % of isolates showed biocontrol effects to a certain extent, suggesting that culturable endophytic fungal biodiversity in this system is of a mostly mutualistic type of interaction with the host. Eight isolates from genera Trichoderma (reference isolate), Pestalotiopsis, Curvularia, Tolypocladium and Fusarium showed the highest level of activity against the pathogen, and were further characterized. All demonstrated their endophytic nature by colonizing axenic cacao plantlets, and confirmed their biocontrol activity on attached pods trials by showing significant decrease in disease severity in relation to the positive control. None, however, showed detectable growth-promotion effects. Aspects related to endophytic biodiversity and host-pathogen-endophyte interactions in the environment of this study were discussed on the context of developing sustainable strategies for biological control of black-pod rot of cacao.

Keywords: Beneficial effects; Fungal endophytes; Microbial colonization; Phytophthora; Symbiotic interactions; Tropical perennial plants

BIOLOGICAL CONTROL (1 JDL)

Luis C. Mejia, Enith I. Rojas, Zuleyka Maynard, Sunshine Van Bael, A. Elizabeth Arnold, Prakash Hebbar, Gary J. Samuels, Nancy Robbins, Edward Allen Herre, Endophytic fungi as biocontrol agents of Theobroma cacao pathogens,
Biological Control, Volume 46, Issue 1, Special Issue: Endophytes, July 2008, Pages 4-14, ISSN 1049-9644, DOI: 10.1016/j.biocontrol.2008.01.012.
(http://www.sciencedirect.com/science/article/B6WBP-4RR1NS9-1/2/2086b8247960587fb787588172c00328)

Abstract:

Fungal endophytes isolated from healthy Theobroma cacao tissues were screened in vitro for antagonism against major pathogens of cacao. Of tested endophytic morphospecies, 40% (21/52), 65% (28/43) and 27% percent (4/15) showed in vitro antagonism against Moniliophthora roreri (frosty pod rot), Phytophthora palmivora (black pod rot) and Moniliophthora perniciosa (witches broom), respectively. The most common antagonistic mechanism was simple competition for substrate. Nonetheless, 13%, 21%, and 0% of tested morphospecies showed clear antibiosis against M. roreri, P. palmivora, and M. perniciosa, respectively. One isolate of Trichoderma was observed to be parasitic on M. roreri. Endophyte species that were common in the host plants under natural conditions often are good colonizers and grow fast in vitro whereas antibiosis producers usually appear to be relatively rare in nature, tend to grow slowly in vitro, and often are not good colonizers. We suggest that there is an inherent general trade-off between fast growth (high colonization) and production of chemicals that produce antibiosis reactions. Finally, field trials assessing the effects of three endophytic fungi (Colletotrichum gloeosporioides, Clonostachys rosea and Botryosphaeria ribis) on pod loss due to M. roreri and Phytophthora spp. were conducted at four farms in Panama. Although the overall incidence of black pod rot was very low during the tests, treatment with C. gloeosporioides significantly decreased pod loss due to that disease. We observed no decrease in pod loss due to frosty pod rot, but treatment with C. rosea reduced the incidence of cacao pods with sporulating lesions of M. roreri by 10%. The observed reduction in pod loss due to Phytophthora spp., and sporulation by M. roreri, supports the potential of fungal endophytes as biological control agents. Further, these studies suggest that combined information from field censuses of endophytic fungi, in vitro studies, and greenhouse experiments can provide useful a priori criteria for identifying desirable attributes for potential biocontrol agents.

Keywords: Biological control; Endophytic fungi; Theobroma cacao; Moniliophthora; Phytophthora; Crinipellis; Colletotrichum; Clonostachys; Botryosphaeria

FOOD COMPOSITION (2 JDL)

J. Rodriguez-Campos, H.B. Escalona-Buendia, I. Orozco-Avila, E. Lugo-Cervantes, M.E. Jaramillo-Flores, Dynamics of volatile and non-volatile compounds in cocoa (Theobroma cacao L.) during fermentation and drying processes using principal components analysis,

Food Research International, Volume 44, Issue 1, January 2011, Pages 250-258, ISSN 0963-9969, DOI: 10.1016/j.foodres.2010.10.028.
(http://www.sciencedirect.com/science/article/B6T6V-51BNWRV-1/2/e8c4b6a5cc00d6716381b1bc80e55b84)

Abstract:

Different volatile and non-volatile compounds produced during the fermentation-drying process are considered as indicatives of cocoa beans quality. We found thirty-nine different compounds identified by SPME-HS/GC-MS and related to the desirable notes and off-flavor that have been reported. Volatile and non-volatile compounds were associated with acidity and changes of pH, such as acetic and lactic acid. Using the principal component analysis (PCA), relations between compounds and fermentation and drying day were associated with dynamics of these compounds. The identification of principal compound produced during the fermentation and drying processes can be helpful in searching for off-flavor indicator and as a fermentation index, such as isobutyric, isovaleric and propionic acids. Oxidation of 3-methyl-1-butanol-to-3-methyl-1-butanol acetate can be of use in evaluating the degree of fermentation. At drying, the compounds with the highest levels were acetic and isobutyric acid, ethyl and 3-methyl-1-butanol acetate, pentanal and 2,3-pentanedione, and 1,3-butanediol and 2,3-butanediol. Therefore, acetic acid and isobutyric acid, due to their high levels and their low threshold value could play an important role in the aromatic quality of cacao drying.

Keywords: Cocoa beans; Fermentation process; GC-MS; Volatile compounds

Marco Arlorio, Monica Locatelli, Fabiano Travaglia, Jean-Daniel Coisson, Erika Del Grosso, Alberto Minassi, Giovanni Appendino, Aldo Martelli, Roasting impact on the contents of clovamide (N-caffeoyl-L-DOPA) and the antioxidant activity of cocoa beans (Theobroma cacao L.),

Food Chemistry, Volume 106, Issue 3, 1 February 2008, Pages 967-975, ISSN 0308-8146, DOI: 10.1016/j.foodchem.2007.07.009.
(http://www.sciencedirect.com/science/article/B6T6R-4P61NCN-4/2/19928bd5fbfe325aed04ef8f808df0de)

Abstract:

The caffeoylated amino acid clovamide [(-)-N-[3'-4'-dihydroxy-(E)-cinnamoyl]-dihydroxyphenylalanine] was identified in the antioxidant polyphenolic fraction of cocoa (Theobroma cacao L.). As a naturally occurring caffeoyl conjugate, clovamide represents an interesting antiradical/antioxidant compound. We have streamlined the synthesis of clovamide, investigating the effect of roasting on its content in different samples of cocoa beans from different geographic origin. Within the samples analyzed, those from Ghana showed the highest clovamide content (2.637 mg/kg, powder from

fermented beans, dry weight; 1.264 mg/kg, powder from roasted nibs, dry weight), while the Arriba samples showed the lowest values. A poor correlation existed between the contents of clovamide and the antioxidant properties of cocoa, while roasting caused a dramatic reduction in the clovamide contents (up to 59.13% in Arriba cocoa), paralleled by an overall decrease of the antioxidant properties, as measured by the DPPH method. Taken together, results show that while roasting is detrimental for the clovamide contents of cocoa, no correlation exists between the concentration of this compound and the overall antioxidant properties of cocoa samples, and suggest that clovamide is important but not critical for the antioxidant activity of cocoa.

Keywords: Theobroma cacao; (-)-N-(3'-4'-dihydroxy-(E)-cinnamoyl)-dihydroxyphenylalanine; Clovamide; Antioxidant properties; Cocoa astringency

FOOD TECHNOLOGY (4 JDL)

C.L. Hii, C.L. Law, M. Cloke, S. Suzannah, Thin layer drying kinetics of cocoa and dried product quality,

Biosystems Engineering, Volume 102, Issue 2, February 2009, Pages 153-161, ISSN 1537-5110, DOI: 10.1016/j.biosystemseng.2008.10.007.
(http://www.sciencedirect.com/science/article/B6WXV-4V38XS9-1/2/a6935f1a203416a88e2703410491fa86)

Abstract:

Studies were carried out to investigate the cocoa drying kinetics and compare the quality of the dried beans produced from sun and artificial hot air drying. Currently, these are the methods commonly used by cocoa farmers and plantations to dry cocoa beans. Drying trials were conducted in thin layer using natural sun light and by hot air inside an air-ventilated oven at air temperatures of 60 [degree sign]C, 70 [degree sign]C and 80 [degree sign]C. Comparison was also made against freeze-dried cocoa beans for quality assessment. The quality attributes assessed were colour (L*, a*, b* and hue angle), texture (hardness and fracturability) and polyphenol content (total polyphenols, epicatechin and catechin contents). Theoretical modelling was performed on the drying kinetics using Fick's law of diffusion and to determine the effective diffusivity values. Reasonable values were obtained for the coefficient of determination (R2) between the experimental and predicted moisture ratio data (range 0.9845-0.9976). Effective diffusivity values were found within the range reported in literatures (range 1.61 x 10-10 m2 s-1-8.01 x 10-11 m2 s-1). Quality assessment showed significant differences ($p < 0.05$) among the sun dried, freeze-dried and oven dried samples in texture, colour and polyphenol content.

D. Paramo, P. Garcia-Alamilla, M.A. Salgado-Cervantes, V.J. Robles-Olvera, G.C. Rodriguez-Jimenes, M.A. Garcia-Alvarado, Mass transfer of water and volatile fatty acids in cocoa beans during drying,
Journal of Food Engineering, Volume 99, Issue 3, August 2010, Pages 276-283, ISSN 0260-8774, DOI: 10.1016/j.jfoodeng.2010.02.028.
(http://www.sciencedirect.com/science/article/B6T8J-4YJT59P-1/2/2d47570a304af6df5ed155284a1f6503)

Abstract:

In order to elucidate the phenomena involved in the remnant acidity of cocoa beans dried artificially, the diffusivities of water, and volatile fatty acids (VFAs: acetic, propionic, butyric and iso-butyric acids) in cocoa beans during drying were evaluated. Experimental drying kinetics of the acids were conduced at 40-60 [degree sign]C with and without shell. Samples were taken at different drying times for moisture and acids content evaluation. VFAs content was evaluated by GC in a methanolic extract, and moisture content by a vacuum oven. Mass diffusivity was estimated from the fitting of experimental kinetics to a theoretical model that takes into consideration the beans' shape. Acetic, propionic and butyric acids diffusivities were significantly ($p < 0.05$) smaller than water diffusivities both with and without shell. VFAs diffusivities were between 1/6 and 1/22 diffusivities values for water. Iso-butyric acid diffusivity was not statistically significant but the value was smaller than for the other VFAs. The diffusivities of VFAs may explain the remnant acidity in artificially dried cocoa beans.

Keywords: Cocoa beans; Drying; Volatile fatty acids; Mass transfer; Ellipsoidal cylindrical coordinates

M. Sanchez-Hervas, J.V. Gil, F. Bisbal, D. Ramon, P.V. Martinez-Culebras, Mycobiota and mycotoxin producing fungi from cocoa beans,
International Journal of Food Microbiology, Volume 125, Issue 3, 31 July 2008, Pages 336-340, ISSN 0168-1605, DOI: 10.1016/j.ijfoodmicro.2008.04.021.
(http://www.sciencedirect.com/science/article/B6T7K-4SDPX40-4/2/17e1c863bc68e4f0a1673f87961db266)

Abstract:

The present study reports on the natural mycobiota occurring in cocoa beans, paying special attention to the incidence of fungal species that are potential producers of mycotoxins. The results show that predominant fungi were different species of the genus Aspergillus belonging to section Flavi and Nigri. Of the 214 strains of Aspergillus section Flavi collected from cocoa beans, 120 were identified as A. flavus and 94 as A. tamarii. Of Aspergillus section Nigri 138 strains were isolated, with 132 belonging to A. niger aggregate and 6 to A. carbonarius species. Potential ability to produce aflatoxins (AFs) B1, B2, G1 and G2, cyclopiazonic acid (CPA) and ochratoxin A (OTA) was studied by isolate culture followed by HPLC analysis of these mycotoxins in the culture extracts. Results indicated that 64.1% and 34.2% of the A. flavus strains produced AFs and CPA, respectively. Most of the A. flavus strains presented moderate toxigenicity with mean levels of AFs ranging from 100 ng g- 1 to 1000 ng g- 1. All the CPA-producing strains of A. flavus were highly toxigenic producing > 30 [mu]g g- 1 of CPA.

Furthermore, 98% of A. tamarii strains produced CPA and over 50% of them were highly CPA toxigenic. With respect to OTA-producing fungi, a high percentage of black aspergilli strains (49.2%) were able to produce OTA. Additionally, most of the OTA-producing isolates were of moderate toxigenicity, producing amounts of OTA from 10 [mu]g g- 1 to 100 [mu]g g- 1. These results indicate that there is a possible risk factor posed by AFs, CPA and OTA contamination of cocoa beans, and consequently, cocoa products.

Keywords: Aflatoxin; Aspergillus; Cyclopiazonic acid; Cocoa beans; HPLC; Ochratoxin A

Juliana Teixeira de Magalhaes, George Andrade Sodre, Henry Viscogliosi, Marie-Florence Grenier-Loustalot, Occurrence of Ochratoxin A in Brazilian cocoa beans, ***Food Control,*** Volume 22, Issue 5, May 2011, Pages 744-748, ISSN 0956-7135, DOI: 10.1016/j.foodcont.2010.11.006.
(http://www.sciencedirect.com/science/article/B6T6S-51G3W5V-1/2/7c3921123bbf70fb48d3097e8f0e71b4)

Abstract:

In the present work studied the occurrence of Ochratoxin A (OTA) in dried beans from southern Bahia (Brazil) harvested in two periods of the year (early crop and harvest seasons) then fermented and dried under the sun. Nearly 92.5% of the cocoa samples presented OTA levels below the limits suggested by the European Community (2 [mu]g/kg). The highest toxin content was found in fine and flavour cocoa beans harvested in the early crop. Ochratoxigenic species of the genera Aspergillus and Penicillium were isolated from the cocoa beans. Both harvesting time and production model influenced OTA content in cocoa. These results show that, according to the current world standards for Ochratoxin A levels, beans from southern Bahia give a good quality cocoa.

Keywords: Cocoa beans; Mycotoxin; Ochratoxin