DEPARTMENT OF SCIENCE AND TECHNOLOGY

BIOTECHNOLOGY

R&D ROADMAP

(2013-2019)
AGRICULTURE: CROPS
ABACA and COCONUT

**COCONUT:**
- M.M. for early flowering, fast growth, oil and nut yield and water content and quality *(JAN 14, 2019)*
- Varieties from M.A. breeding of Tall x Tall and Tall x Dwarf *(JAN 14, 2019)*
- Genetic linkage map derived from validated QTLs for routine M.A. breeding *(JAN 14, 2019)*
- Markers and NGS-Eco TILLING platform for glandular trichome genes; SNP markers for coconut scale insect resistance gene *(JAN 14, 2019)*

**COCONUT:**
- M.M. for dwarf variety, developmental processes, oil and lipid production, and metabolic processes *(JAN 14, 2017)*
- Transcriptome sequence of 8 coconut varieties & putative gene markers for early flowering, fast-growing, high nut yield and water content & quality *(JAN 14, 2017)*
- M.M. for oil biosynthesis of high oil-yielding, makapuno & lono coconuts *(JAN 14, 2017)*
- Genes involved in metabolic pathways & oil biosynthesis *(JAN 14, 2017)*

**COCONUT:**
- Dev't of linkage map early flowering, oil, nut yield, H2O content
- Ident'n of early flowering, high nut yield, H2O content & quality
- Dev't of M.M. for use in M.A. selection and breeding
- Regeneration of transformed tissues into whole plantlets in bottles
- Dev't of composite/synthetic varieties from M.A. breeding
- Mapping of QTLs of productivity & yield/quality of copra oil & by-products
- NGS-Eco TILLING platform for glandular trichomes genes

**COCONUT:**
- Dev't of markers for dwarf variety, developmental processes oil & lipid prod'n & metabolism
- Dev't of primers for t M.A. breeding, hybridity testing, forensics, fingerprinting, genotyping
- Dev't of draft transcriptome sequences of the 8 coconut varieties & putative gene markers
- Comparison of listings and Identificat'n of candidate genes and relevant gene networks
- Dev't of at least 5 constructs with one or two genes for oil biosynthesis

**COCONUT:**
- Generating contig assemblies of the transcriptomes of normal, makapuno and lono phenotypes
- Gene discovery of at least 5 coconut genes involved in several metabolic pathways
- Dissemination of Outstanding Tall coconut selections in target growing regions based on genetic relationships
- Dev't of polymorphic DNA markers bet. parental populat'ns
- Construct'n of web-based genome database of Cocos nucifera

**ABACA:**
- M.M. for fiber quality & virus resistance *(APRIL 30, 2014)*

**ABACA:**
- Identificat'n of genes for fiber quality & ABTV resistance and construction of genomic DNA library/ database

**COCONUT:**
- Establishment of biomarkers for early flowering, fast growth, oil & nut yield and water content & quality
- Genomic sequencing of Laguna Tall (LAGT) and Catigan Green Dwarf (CATD) of Cocos nucifera
- Purification of total RNA from 8 rep coconut varieties

**ABACA:**
- Development of SSR based primers from the NGS Abuab and gDNA library
AGRICULTURE: CROPS
COFFEE, SUGARCANE, RICE, RUBBER and CACAO

- **RUBBER & CACAO**: Validated PCR primers for possible two (2) trait association *(JAN 2018)* [19]

- **RUBBER & CACAO**: Designed primers *(DEC 2017)* [19]

- **SUGARCANE**:
  - Protocol of M.A. mobilization for improvement *(AUG 16, 2016)* [12]
  - 5 New Improved Varieties with high sucrose content & resistance to fungal diseases through MAS *(AUG 16, 2016)* [13]

- **CLOVE**: Gene-enriched gDNA libraries for cacao *(APRIL 2015)* [19]

- **COFFEE**: M.M. for pest/disease resistance, yield & aroma *(OCT 2016)* [10]

- **RICE**:
  - Technology on Radiation-Modified Carrageenan & Chitosan Rice management *(MAY 16, 2016)* [14]
  - Varieties resistant to tungro disease & best pest treatment *(MAY 16, 2016)* [15]

- **RUBBER & CACAO**: Sequencing of 200 colonies, identified SSR markers from sequenced colonies and designed primers; test designed primers to the 10 NSIC varieties [19]

- **RUBBER & CACAO**: Selection of SSR markers from exome databases for primer design (gene mining) [19]

- **RUBBER & CACAO**: Sequencing of 200 colonies, identified SSRs from sequenced colonies and designed primers; test designed primers to the 10 NSIC varieties [19]

- **SUGARCANE**:
  - Testing and validation of some of these markers in sugarcane breeding populations/lines [11]
  - Evaluation of the effectivity of markers in identifying the true hybrids [12]

- **RICE**:
  - Technology on Radiation-Modified Carrageenan & Chitosan Rice management *(MAY 16, 2016)* [14]
  - Varieties resistant to tungro disease & best pest treatment *(MAY 16, 2016)* [15]

- **CACAO**: Gene-enriched gDNA libraries for cacao *(APRIL 2015)* [19]
High Yielding and Pest & Diseases Resistant crops

**AGRICULTURE: CROPS**
**MANGO, SQUASH and TOMATO**

**TOMATO:**
- Open-pollinated varieties and hybrids of fresh-market and processing resistant to ToLCPHV (2019)[22*]
- Genetic population/s of a fresh-market & processing for the target disease resistance and abiotic stress tolerance traits (2019)[22*]

**MANGO:**
- Database of morphological and molecular characteristics (2017)[18*]
- M.M for red blush, thick peel, resistance to insect pests (fruit fly, cecid fly, leaf hopper) and major diseases (anthracnose and stem-end rot) (2016)[18*]

**SQUASH:**
- One (1) improved population and 1 open-pollinated variety resistant to SLCV, ZYMV, and PRSV-W (MAR 2014)[20]
- Characterized virus resistance (MAR 2014)[20]

**TOMATO:**
- Characterized virus resistance to SLCV, ZYMV, and PRSV-W (MAR 2014)[20]
- DNA markers tagging the virus resistance (MAR 2014)[21]

**MANGO:**
- DNA markers for ‘Carabao-Mango’ (FEB 28 2015)[17]
- Ident’n of M.M in varieties associated with key traits [18*]

**TOMATO:**
- M.A. breeding for leaf curl virus resistant (2019)[22*]
- Multi-location field trial and Plant Variety Protection (PVP) filing towards commercial varietal release and Genomics & variability of Tomato leaf curl Philippine [22*]

**TOMATO:**
- Testing of the diagnostic kit (dipstick kit) in mango nurseries [18*]
- Conduct molecular characterization of induced resistance gene sequences [21]

**TOMATO:**
- Commercial release of virus resistant tomato (2018)[22*]
- Spin-off negotiations with local & intern’l breeding institutions/seed companies (2018)[22*]

**MANGO:**
- Ident’n of ‘Carabao’ mango specific proteins for dev’t of diagnostic kit (dipstick kit (2017)[18*]
- Genomic-assisted mapping & pyramiding of disease resistance & abiotic stress tolerance genes (2019)[22*]

**TOMATO:**
- Genomics-assisted mapping & pyramiding of disease resistance & abiotic stress tolerance genes (2019)[22*]

**SQUASH:**
- One (1) DNA clone for predominant strain of SLCV (MAR 2013)[20]
- Identify sources of genetic resistance to SLCV, the Zucchini yellow mosaic virus (ZYMV), and the Papaya ringspot virus type W (PRSV-W) in collaboration with AVRDC [20]

**TOMATO:**
- Open-pollinated varieties and hybrids of fresh-market and processing resistant to ToLCPHV (2019)[22*]
- Determination of predominant strains of squash-infecting Begomovirus and development of infectious DNA clones of local strains of the major squash virus, the Squash leaf curl virus (SLCV) [20]

**TOMATO:**
- Genotyping-aided mapping & pyramiding of disease resistance & abiotic stress tolerance genes [22*]
- Multi-location field trial and Plant Variety Protection (PVP) filing towards commercial varietal release and Genomics & variability of Tomato leaf curl Philippine [22*]

**SQUASH:**
- One (1) improved population and 1 open-pollinated variety resistant to SLCV, ZYMV, and PRSV-W (MAR 2014)[20]
- DNA markers tagging the virus resistance (MAR 2015)[21]

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**TOMATO:**
- Conduct molecular characterization of induced resistance gene sequences [21]
- Screen the loss of susceptibility mutants of tomato against TYLCV/ToLCV, CMV [21]

**SQUASH:**
- One (1) DNA clone for predominant strain of SLCV (MAR 2013)[20]
- Genome charact’n & extent of genetic diversity among ToLCPHV species in the Philippines (2018)[22*]

**TOMATO:**
- Multi-location field trial and Plant Variety Protection (PVP) filing towards commercial varietal release and Genomics & variability of Tomato leaf curl Philippine [22*]

**SQUASH:**
- Six (6) germplasm resistant to SLCV, ZYMV, and PRSV-W (MAR 2014)[20]
- Multi-location field trial and Plant Variety Protection (PVP) filing towards commercial varietal release and Genomics & variability of Tomato leaf curl Philippine [22*]

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AGRICULTURE: LIVESTOCK & POULTRY

GOAT, WATER BUFFALO, SWINE, POULTRY and MEAT PRODUCTS

WATER BUFFALOES: Equation for predicting genetic merit of animals based on BLUP EBVs and GEBVs and Selection index for bulls and heifers incorporating BLUP EBVs and GEBVs. (NOV 30, 2017)

MEAT PRODUCTS: DNA barcode sequence of 12 animal species (MAR 31 2016)

SWINE: Policy brief to institutionalize the adoption of LAMP assays by state-based animal disease diagnostic laboratories (JUN 30 2016)

WATER BUFFALOES: genetic architecture of the Phil. dairy population (JUN 30 2016)

MEAT PRODUCTS: Optimum of PCR-based species ident’ protocol (for 12 animal species) for fresh meat & meat products

Ass’n analysis of genotype w/ phenotype & Establ’t of genetic service laboratory

SWINE: Field valid’n of PED in Reg. 3 & 4

WATER BUFFALOES: Genome ass’n studies, comparison of models & Principal component analysis

GOAT: LAMP primers and Phylogenetic Analyses for CAEV, (JUL 16 2014)

SWINE: LAMP Protocols for detection of PED virus, Salmonellosis & Cryptosporidiosis & LAMP test kit for PED virus (SEPT 30 2014)

Gene markers for ident’n of positive & disease resistance/ screening of genetic defects (DEC 31 2015)

LAMP Protocols respiratory & gastrointestinal diseases via “lab in a mug” heat blocks (JUN 30 2014)

SWINE & POULTRY: Bioprocessing technology for protein enrichment of copra meal (DEC 31 2014)

MEAT PRODUCTS: 4 sets of species-specific LAMP primers & 12 pairs of species-specific PCR primers (MAR 31 2015)

SWINE & POULTRY: PECM as a new feed product (DEC 31 2014)

WATER BUFFALOES: SNP markers for milk production traits (DEC 15, 2015)

GOAT: LAMP primers for PEDV, Salmonellosis & Cryptosporidiosis (JUL 16 2013)

SWINE: Design of LAMP primers & for PEDV, Salmonellosis, Cryptosporidiosis, identification & optimisation of gene primers of positive traits (litter size, growth rate, meat quality, muscle mass), disease resistance (salmonellosis, PRRSV, intracellular pathogen, E. coli and influenza) & screening of genetic defects (acid meat, stress syndrome and scrotal hernia)

GOAT: LAMP Protocol for the detection & screening of CAEV (JUL 16 2013)

SWINE: LAMP protocols, Dev’t & valid’n of LAMP-based quick test kit

Blood sample coll’n, DNA extraction and Genotyping of DNA samples to identify positive, disease resistance genes and screen genetic defects

Re-optimization of PED LAMP protocols using fabricated “Lab in a Mug” heat block

SWINE: Optimum of LAMP protocols, Dev’t & valid’n of LAMP-based quick test kit

GOAT: Primer design of the CAEV strains and field validation

SWINE & POULTRY: Establ’t of pilot scale prod’n system for protein enrichment of copra meal

WATER BUFFALOES: Dev’t of model for predicting genomic breeding values for marker genotypes using Valid’n of prediction eq’n
AGRICULTURE: INLAND AQUATIC
MILKFISH, MUSSEL SHRIMP and TILAPIA

Competitive and Sustainable Agriculture and Fisheries Sectors for Food Security and Increased Productivity

SHRIMP:
- Standard protocol for dsRNA mass production (JUN 2016) [9]
- Protocol on selection/sourcing of P. monodon seedstock (JUN 2016) [10]


MILKFISH:
- M.M. of best stock for breeding & distinction of wild fry vs. hatchery-bred fry (MAY 2015) [1]
- Procedure using fish scales to measure/detect early growth rates (MAY 2015) [2]
- M.M. for lectin to assess innate immunity (MAY 2015) [3]
- Diagnostic kit for Microbial Infection (MAY 2015) [4]
- Utilization and innovation of databases/methodologies and development of local applications to control and/or neutralize WSSV [9] [14]

MUSKISH: Identif'n of stains/varieties/populations for selective breeding and generate a genetic profile for the natural populations of this species. [5] [15]

SHRIMP:
- Dev't & eval'n LFSB prototype performance for WSSV screening & field test trials and Dev't of Nested PCR protocols for the detection of WSSV, IHHNV, MBV and Vibrio spp. [8] [17]
- Utilization and innovation of databases/methodologies and dev't of local applications to control and/or neutralize WSSV [9] [18]
- Utilization of NGS & bioinformatics to conduct "association studies" to identify a gene or a group of genes in tiger shrimp related to high growth, high health, disease tolerance etc [10] [19]

MUSSEL:
- Dev't of microsatellite and RAPD markers for evaluating the impact of domestication on local milkfish hatchery stocks [1]
- Sequencing of mitochondrial cytochrome b gene and control region [2]
- Cloning & sequencing of lectin genes from a pooled cDNA library from the liver, kidney, and spleen [3]
- Utilization of advanced molecular technologies to identify & detect pathogenic bacterial species from diseased fish samples [4]

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TILAPIA:
- Examination of levels of genetic diversity in improved strains of Nile and red tilapia [11]
- Generate scientific data of varieties (GIFT, FAST, GET-EXCEL, SEAFDEC, GST (GenoMar Supreme Tilapia)). [12]

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TILAPIA:
- Comparison of Genetic Variation of Philippine Tilapia & Other countries (i.e. China, Thailand & Malaysia) [SEP 2015] [11]
- Profile of hatcheries: strain, management applied, maturity status and production [SEP 2015] [12]

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ENVIRONMENT & NATURAL RESOURCES
EN ENVIRONMENT & NATURAL RESOURCES:
Biodiversity Conservation and Bioremediation Biotech

- Database for conservation, source of high quality seeds, potential industrial uses bioremediation technologies for contaminated wastewater and soil
- Field-based, gene-based conservation programs for identified aquatic, marine and terrestrial species
- Biotechnology based ecological restoration of polluted sites
- Development of policy recommendations on bioprospecting
- Genetic varieties of endemic species, ecotourism flora and fauna

Field-based, gene-based conservation programs for identified aquatic, marine and terrestrial species
Biotechnology based ecological restoration of polluted sites
Review of regulations on bioprospecting

- Compound /enzymes for bioremediation technologies, industrial, health & agricultural applications
- National Greening Program for reforestation project; database for conservation, source of high quality seeds, potential industrial uses
- Biosensor & test kits, for marine toxins photo bioreactor, biofertilizers, biofilters, identified species for bioremediation, marine detrivores & filter feeders
- Genetic & hydrodynamic connectivity patterns within archipelago and region,
  Baseline genetic diversity & resilience estimates for selected indicator species
- Field-based correlation of gene-markers & best properties of identified species
- Gene products from identified M.M. for Isolates microbial culture collection
- Compounds and enzymes from best genetic flora & fauna varieties
- Harmful algal blooms detection

Microorganisms effective in accumulating heavy metals and capable of biofilm formation [Feb 14, 2014][1]
Compounds & enzymes from best genetic varieties propagation protocol

Bacteria forming Biofilms for heavy metal absorption [Dec 31, 2013][2]
Key genes of plants, animals & microorganisms for conservation, disaster mitigation & remediation
Database of identified species and their genome

Gene sequencing design, run & data analysis, identification of key genes of plants, animals & microorganisms for conservation, Disaster mitigation and remediation
Identification of the microorganisms effective in accumulating heavy metals and capable of biofilm formation [1]
Screening & Identification of Biofilm Formers as Potential Microbial Remediators for Heavy Metal Contaminated Wastewater [2]
Efficient and Sustainable Alternative Fuel Source

- Gene sequencing design, run & data analysis, & identification of key genes of marine & microbial samples for bioenergy.
- Identification and evaluation of appropriate enzymes and the appropriate pretreatments, saccharification and fermentation conditions for specific lignocellulosic feedstocks [1,3]
- Development of Microorganisms Capable of Utilizing Lignocellulosic Hydrolysates for Fuel Ethanol Production [2]
- Performance data at bench scale
- Algal based bioethanol using improved strains
- Algal based biodiesel using improved microbial strains
- Genetic engineering of microorganisms to express enzymes that produce ethanol for biofuels
- Energy biomass & substrate optimization for ethanol & lactic acid production for biofuels
- Small-scale genetically engineered microbial production of ethanol for biofuels
- Pilot-scale genetically engineered microbial production of ethanol & lactic acid for biofuels

Optimized Conditions for Pretreatment, Saccharification & Fermentation of Lignocellulosic Feedstocks [Mar 31, 2015][1,3]

- Identified Microbial Strains for bioethanol from
  a. Lignocellulosic feedstocks [Mar 31, 2015][2]
  b. Sugar-based feedstocks
  c. Macroalgae
- Nanostructure of microbial strains - Microbial strains biodiesel from microalgae
- Isolation, chemical, biochemical & functional characterization of genes, small molecules & enzymes for bioenergy

ENERGY: BIOFUELS
HEALTH

- Validation of published mutations in the KRAS, PIK3CA, BRAF, PTEN and AKT1 genes in Filipino colorectal cancer patients through next generation sequencing technology. *(Dec 2017)* [5]
- Detection of novel mutations in colorectal cancer tumors that can be further characterized in order to determine their molecular and biological functions in cancer development. *(Dec 2017)* [5]
- Validated and stable Lateral POC system for the detection of dengue *(June 30, 2014)* [1]
- Genomic SNP markers for cardiovascular conditions, and responses to treatment for cardiovascular diseases *(June 2016)* [3]
- SNPs Database for cardiovascular disease, hypertension and dyslipidemia *(June 2016)* [3]
- Biomarkers in the form of genetic and transcriptomic biomarkers that are predictive of T2DM, related medical conditions, complications and of clinical responses to various treatment *(Mar 2016)* [4]
- These markers can be translated to diagnostic kits to identify at-risk individuals who may require special and tailored interventions and/or counseling *(Mar 2016)* [4]
- A descriptive database for the prevalence of these SNPs among Filipinos *(Mar 2016)* [4]
- Prototype of the Lateral POC System *(Dec 31, 2014)* [1]
- Data on the advantage of MODS Assay in terms of rapid production of test results and major advantage in terms of performance, efficiency, and cost effectiveness *(March 2014)* [1]
- Production, screening and characterization of immuno reagents for the lateral flow test *(January 2015)* [1]
- Design and development of a Lateral POC System[1]
- Patient recruitment, sample collection & baseline data collection for 2,850 participants (Hypertension, Coronary Artery Disease, Dyslipidemia) *(March 2015)* [3] and for 2,062 participants (Type 2 Diabetes Mellitus) *(April 2016)* [4]
- Criteria for evaluation are specificity and sensitivity of the tests as well as convenience, efficiency, and cost-effectiveness *(March 2016)* [6]
- Comparative evaluation of TB diagnostic tests such as the gold standard Lowenstein-Jensen Method, the automated MB Bac/t system, and the MODS Assay for the determination of TB and MDR-TB positive among sputum samples from the PGH and the NTRL Laboratories *(March 2016)* [6]
- Small scale validation, stability testing and community-based testing of the POC kit *(January 2017)* [1]
- Genotyping for Type 2 Diabetes Mellitus, SNP Screening, Processing of samples for microarray procedures *(March 2016)* [4]
- Genotyping, SNP Screening, Processing of samples for microarray procedures (Hypertension, Coronary Artery Disease & Dyslipidemia) *(March 2016)* [3]
- Comparative laboratory performance testing between dengue-seco against the liquid format *(March 2015)* [2]
- Identification of mutations in the KRAS, PIK3CA, BRAF, PTEN and AKT1 genes will be determined via targeted sequencing (Colorectal Cancer) *(January 2017)* [5]
- Assessment of the mutations in the KRAS, PIK3CA, BRAF, PTEN and AKT1 genes using various mutational assays (Colorectal Cancer) *(January 2017)* [5]

Harnessing Biotechnology to Boost National Competitiveness in the Development of Health Care Solutions and Services for Inclusive Growth

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Product and process technologies,
1. From Healthy sugars (xylitol from the hydrolysis products of corn cobs, corn fibers & sugarcane bagasse) (Proposal) [41]
2. From Microbial-Based Colorants and Flavorings (Feb 28, 2015) [29]
Upscale Production using conventional fermentation runs of Industrial Enzymes (Proposal) [35]
Commercial products of Industrial Enzymes (Feb 9, 2015) [30]

Identified strains, cultures, applications on Inoculants for fermentation in cacao beans (Dec 31, 2014) [22]
Preliminary Extraction & Application Studies of Industrial Enzymes (Jan 31, 2014) [23]
Upscale Production of Industrial Enzymes (Feb 28, 2014), (Feb 9, 2015) [30]
Microbial cultures and Product Application for Functional Food Ingredients (Aug 31, 2013) [20].
Commercial products
1. From plant-growth hormone producers/biofertilizers (Aug 31, 2014) [24], (June 30, 2014) [25], (June 30, 2014) [26].
2. Of Innuont for Fermentation Process in cacao beans (Dec 31, 2014) [22]
3. Of Industrial Enzymes (Feb 28, 2014) [28],
Product & processing technology:
1. For Plant Growth Hormone Producers/ Biofertilizers (Aug 31, 2014) [24], (June 30, 2014) [25] (June 30, 2014) [26].
2. And new packaging for fermentation process inoculant in cacao beans (Dec 31, 2014) [2].
3. For Protein-Rich-by-Products feeds from Enzyme Processing (Feb 28, 2014) [28].
4. For Colorants and Flavorings (Feb 28, 2015) [29]
5. For Aquaculture Probiotic feeds (June 30, 2014) [27].
6. From Pili pulp oil and by-product feed (June 30, 2014) [40].

Identified strains, stable starter, cultures, targeted applications on Inoculants for fermentation in cacao beans (Dec 31, 2014) [22]
Product & processing technology

Microbial cultures and Product Application for:
 a. Functional Food Ingredients (Aug 31, 2013) [20],
b. Colorants & Flavoring (Mar 31, 2013) [19].

Identified strains, stable starter, cultures, applications for Indigenous Food Fermentation (April 31, 2013) [21]
INDUSTRIAL BIOTECH: Continuation...

Globally Competitive and Innovative Industry and Biotechnology Services

- Upscale processing technology of pili resin (Proposal) [42]
- Product Safety Sheets, Stable Products, Shelf Life Information (Feb 28, 2015) [29], (Proposals) [31] [32] [33]
- Large Scale Production using vectors for cry proteins as fertilizers (Proposal) [43]
- Formulated Bacteriocin Product, Optimized Process (Proposal) [34]
- Lab Scale Production Technology of Other Industrial Enzymes (Proposal) [37]
- Product and process technologies from Enzymes from Yacon (Proposal) [37]
- Commercial products of Industrial Enzymes for Food and Beverage Applications (Proposal) [35]

- Pilot-scale genetically engineered microbial production of ethanol & lactic acid for industrial consumption.
- Review and updating
- Stabilization studies, packaging
- Advanced delivery studies
- Field testing, market testing, commercialization

- Stable Strains, Patent Organisms, customized starter cultures, optimized process for starters of Indigenous Food Fermentation (Proposal) [36]
- Upscale Production using conventional fermentation runs of Industrial Enzymes (Proposal) [35]

1. From Healthy sugars (xylitol from the hydrolysis products of corn cobs, corn fibers and sugarcane bagasse) (Proposal) [41]
2. From Microbial-Based Colorants and Flavorings (Proposal) [31] [32] [33]
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