

MINISTRY OF HEALTH OF MALAYSIA

GUIDELINES ON THE SAFE USED OF PROCESSING AIDS

1.0 OBJECTIVES

The Guidelines aim to provide information for the safe used of processing aids in the preparation of foods and food ingredients as stipulated under Regulation 19A, Malaysia Food Regulatons 1985.

2.0 DEFINITION

"Processing Aid" means any substance that is used in the processing of raw materials, foods or ingredients, to fulfill a technological purpose relating to treatment or processing, but does not perform a technological function in the final food product and may result in an unavoidable presence of residues in the final food product.

Substances used as processing aids shall conform to the Guidelines on Substances used as Processing Aids (CAC/GL 75). "

3.0 PRINCIPLES FOR THE SAFE USE OF SUBSTANCES USED AS PROCESSING AIDS

3.1 The use of a substance as a processing aid is justified when such use performs one or more technological functions during treatment or processing of raw materials, foods, or ingredients. Any residues of processing aids remaining in the food after processing should not perform a technological function in the final product.

3.2 Substances used as processing aids shall be used under conditions of good manufacturing practices (GMP) which includes the following:

- The quantity of the substance used shall be limited to the lowest achievable level necessary to accomplish its desired technological function;
- Residues or derivatives of the substance remaining in food should be reduced to the extent reasonably achievable and should not pose any health risk; and
- The substance is prepared and handled in the same way as a food ingredient.

3.3 The safety of a substance used as a processing aid should be demonstrated by the supplier or the user of the substance. The demonstration of safety should include appropriate assessment of any unintended or unavoidable residues resulting from its use as a processing aid under conditions of GMP.

3.4 Substances used as processing aids should be of food grade quality. This can be demonstrated by conforming to the applicable specifications of identity and purity recommended by the Codex Alimentarius Commission or, in the absence of such a specification, with an appropriate specification developed by responsible national or international bodies or suppliers.

3.5 Substances used as processing aids should comply with any applicable microbiological criteria established in accordance with the Principles for the Establishment and Application of Microbiological Criteria for Foods (CAC/GL 21-1997) and should be prepared and handled in accordance with the Recommended International Code of Practice – General Principles of Food Hygiene (CAC/RCP 1-1969) and other relevant Codex texts”.

4.0 LABELLING

4.1 Labelling of Processing Aids When Sold As Such

The labels of processing aids sold by retail shall bear the information:

- The name of processing aids
- Date of expiry or minimum durability
- The words “For Food Use” or a statement substantially similar thereto
- Adequate information about the manner in which processing aids to be kept and to be used.

4.2 Labelling of Food Used of Processing Aids Derived from Animal

Where the used of processing aids derived from animal, the common name of such animal shall be stated on the label.

5.0 ANNEX

5.1 The Annex A consist of list of substances that may be used as processing aids. The lists as follows:

- a. TABLE I - Processing aids with specific function
- b. TABLE II - Processing aids with miscellaneous functions
- c. TABLE III - Processing aids used in packaged water and in water used as an ingredient in other foods
- d. TABLE IV – Enzymes

5.2 The list of substances are not exhaustive list and does not serve as a positive list for regulatory purposes. It is intended to be a source of information on substances used as processing aids and supporting safety information on unavoidable presence of residues in the final food product.

6.0 ENQUIRIES

Any enquiries may be forwarded to:

Senior Director for Food Safety and Quality
Ministry of Health of Malaysia
Level 4, Menara Prisma
No 26, Jalan Persiaran Perdana,
Presint 3, Federal Government Administrative Centre
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E-mail: fsq-division@moh.gov.my
Website: <http://fsq.moh.gov.my>

ANNEX A

TABLE I

Processing aids with specific function

Substance	Maximum residue limit (mg/kg)
Antifoam agents	
Butanol	10
Oxystearin	GMP
Polyethylene glycol diolate	GMP
Soap	GMP
Bleaching agents, washing and peeling agents	
Bromo-chloro-dimethylhydantoin	1.0 (available chlorine)
Calcium hypochlorite	1.0 (available chlorine)
Chlorine dioxide	1.0 (available chlorine)
Diammonium hydrogen orthophosphate	GMP
Dibromo-dimethylhydantoin	2.0 (inorganic bromide)
2-Ethylhexyl sodium sulphate	0.7
Hydrogen peroxide	5
Iodine	GMP
Oxides of nitrogen	GMP
Ozone	GMP
Peracetic acid	GMP
Sodium chlorite	1.0 (available chlorine)
Sodium dodecylbenzene sulphonate	0.7
Sodium hypochlorite	1.0 (available chlorine)
Sodium laurate	GMP
Sodium peroxide	5
Sodium persulphate	GMP
Triethanolamine	GMP

Substance	Maximum residue limit (mg/kg)
Catalysts	
Chromium (excluding chromium VI)	0.1
Copper	0.1
Molybdenum	0.1
Nickel	1.0
Peracetic acid	0.7
Potassium ethoxide	1.0
Sodium ethoxide	1.0
Sodium methoxide	1.0
Carriers, solvents and diluents	
Benzyl alcohol	500
Croscarmellose sodium	GMP
Ethyl acetate	GMP
Ethyl alcohol	GMP
Glycerol diacetate	GMP
Glyceryl monoacetate	GMP
Glycerol triacetin	GMP
Glycine	GMP
Isopropyl alcohol	1000
L-leucine	GMP
Triethyl citrate	GMP
Contact freezing and cooling agents	
Dichlorofluoromethane	GMP
Decolourants, clarifying, filtration and adsorbent agents	
Acid clays of montmorillonite	GMP
Chloromethylated aminated styrene-divinylbenzene resin	GMP
Co-extruded polystyrene and polyvinyl polypyrrolidone	GMP
Copper sulphate	GMP
Dimethylamine-epichlorohydrin copolymer	150

Substance	Maximum residue limit (mg/kg)
Dimethyldialkylammonium chloride	GMP
Divinylbenzene copolymer	GMP
High density polyethylene co-extruded with kaolin	GMP
Fish collagen, including Isinglass	GMP
Modified polyacrylamide resins	GMP
Nylon	GMP
Phytates (including phytic acid, magnesium phytate & calcium phytate)	GMP
Polyester resins, cross-linked	GMP
Polyethylene	GMP
Polypropylene	GMP
Potassium ferrocyanide	0.1
Extraction solvents	
Acetone	0.1
Benzyl alcohol	GMP
Butane	0.1
Butanol	10
Cyclohexane	1
Dibutyl ether	2
Diethyl ether	2
Dimethyl ether	2
Ethyl acetate	10
Glyceryl triacetate	GMP
Hexanes	20
Isobutane	0.1
Methanol	5
Methylene chloride	2
Methylethyl ketone	2
Propane	1

Substance	Maximum residue limit (mg/kg)
General processing aids	
Activated carbon	GMP
Argon	GMP
Bone phosphate	GMP
Carbon monoxide	GMP
Diatomaceous earth	GMP
Ethoxylated fatty alcohols	GMP
Ethyl alcohol	GMP
Fatty acid polyalkylene glycol ester	GMP
Isopropyl alcohol	GMP
Oleic acid	GMP
Oleyl oleate	GMP
Oxygen	GMP
Perlite	GMP
Sodium lauryl sulphate	GMP
Ion exchange resins	
Completely hydrolysed copolymers of methyl acrylate and divinylbenzene	GMP
Completely hydrolysed terpolymers of methyl acrylate, divinylbenzene and acrylonitrile	GMP
Cross-linked phenol-formaldehyde activated with one or both of the following: triethylene tetramine and tetraethylenepentamine	GMP
Cross-linked polystyrene, chloromethylated, then aminated with trimethylamine, dimethylamine, diethylenetriamine, or dimethylethanolamine	GMP
Diethylenetriamine, triethylene-tetramine, or tetraethylenepentamin cross-linked with epichlorohydrin	GMP
Divinylbenzene copolymer	GMP
Epichlorohydrin cross-linked with ammonia	GMP
Epichlorohydrin cross-linked with ammonia and then quaternised with methyl chloride to contain not more than 18% strong base capacity by weight of total exchange capacity	GMP
Hydrolysed copolymer of methyl acrylate and divinylbenzene	GMP

Substance	Maximum residue limit (mg/kg)
Methacrylic acid-divinylbenzene copolymer	GMP
Methyl acrylate-divinylbenzene copolymer containing not less than 2% by weight of divinylbenzene, aminolysed with dimethylaminopropylamine	GMP
Methyl acrylate-divinylbenzene copolymer containing not less than 3.5% by weight of divinylbenzene, aminolysed with dimethylaminopropylamine	GMP
Methyl acrylate-divinylbenzene-diethylene glycol divinyl ether terpolymer containing not less than 3.5% by weight divinylbenzene and not more than 0.6% by weight of diethylene glycol divinyl ether, aminolysed with dimethaminopropylamine	GMP
Methyl acrylate-divinylbenzene-diethylene glycol divinyl ether terpolymer containing not less than 7% by weight divinylbenzene and not more than 2.3% by weight of diethylene glycol divinyl ether, aminolysed with dimethaminopropylamine and quaternised with methyl chloride	GMP
Reaction resin of formaldehyde, acetone, and tetraethylenepentamine	GMP
Regenerated cellulose, cross-linked and alkylated with epichlorohydrin and propylene oxide, then derivatised with carboxymethyl groups whereby the amount of epichlorohydrin plus propylene oxide is no more than 70% of the starting quantity of cellulose	GMP
Regenerated cellulose, cross-linked and alkylated with epichlorohydrin and propylene oxide, then derivatised with tertiary amine groups whereby the amount of epichlorohydrin plus propylene oxide is no more than 70% of the starting quantity of cellulose	GMP
Regenerated cellulose, cross-linked and alkylated with epichlorohydrin and propylene oxide, then derivatised with quaternary amine groups whereby the amount of epichlorohydrin plus propylene oxide is no more than 250% of the starting quantity of cellulose	GMP
Regenerated cellulose, cross-linked and alkylated with epichlorohydrin and propylene oxide, then sulphonated, whereby the amount of epichlorohydrin plus propylene oxide employed is no more than 250% of the starting quantity of cellulose	GMP
Styrene-divinylbenzene cross-linked copolymer, chloromethylated then aminated with dimethylamine and oxidised with hydrogen peroxide whereby the resin contains not more than 15% of vinyl N,N-dimethylbenzylamine-N-oxide and not more than 6.5% of nitrogen	GMP
Sulphite-modified cross-linked phenol-formaldehyde, with modification resulting in sulphonic acid groups on side chains	GMP
Sulphonated anthracite coal	GMP

Substance	Maximum residue limit (mg/kg)
Sulphonated copolymer of styrene and divinylbenzene	GMP
Sulphonated terpolymers of styrene, divinylbenzene, and acrylonitrile or methyl acrylate	GMP
Sulphonated tetrapolymer of styrene, divinylbenzene, acrylonitrile, and methyl acrylate derived from a mixture of monomers containing not more than a total of 2% by weight of acrylonitrile and methyl acrylate	GMP
Lubricants, release and anti-stick agents	
Thermally oxidised soya-bean oil	320
Microbial nutrients and microbial nutrient adjuncts	
Adenine	GMP
Adonitol	GMP
Ammonium sulphate	GMP
Ammonium sulphite	GMP
Aspartic acid	GMP
Calcium pantothenate	GMP
Cysteine monohydrochloride	GMP
Cystine	GMP
Ferrous sulphate	GMP
Glycine	GMP
Guanine	GMP
Histidine	GMP
Hydroxyethyl starch	GMP
Niacin	GMP
Nitric acid	GMP
Peptone	GMP
Phytates	GMP
Pyridoxine hydrochloride	GMP
Sodium formate	GMP
Sodium molybdate	GMP
Sodium tetraborate	GMP
Uracil	GMP

Substance	Maximum residue limit (mg/kg)
Xanthine	GMP
Propellant and packaging gases	
Air	GMP
Argon	GMP
Chloropentafluoroethane	GMP
Dichloropentafluoroethane	GMP
Helium	GMP
Hydrogen	GMP
Isobutane	GMP
Octafluorocyclobutane	GMP
Trichlorofluoromethane	GMP

TABLE II

Processing aids with miscellaneous functions

Substance	Function	Maximum residue limit (mg/kg)
Agarose ion exchange resin being agarose cross-linked and alkylated with epichlorohydrin and propylene oxide, then derivatised with tertiary amine groups whereby the amount of epichlorohydrin plus propylene oxide does not exceed 250% by weight of the starting quantity of agarose	Removal of specific proteins and polyphenols from beer	GMP
Ammonium persulphate	Yeast washing agent	GMP
Ammonium sulphate	Decalcification agent for edible casings	GMP
Cupric citrate	Removal of sulphide compounds from wine	GMP
β -Cyclodextrin	Used to extract cholesterol from eggs	GMP
Butanol	Suspension agent for sugar crystals	10
Cetyl alcohol	Coating agent on meat carcasses and primal cuts to prevent desiccation	1.0
Ethyl acetate	Cell disruption of yeast	GMP
Gibberellic acid	Barley germination	GMP
Gluteral	Manufacture of edible collagen casings	GMP
	Inhibiting agent for dried vine fruits, fruit and vegetable juices, sugar, vinegar and yeast autolysate	5
Hydrogen peroxide	Removal of glucose from egg products	5
	Removal of sulphur dioxide	5
1-Hydroxyethylidene-1,1-diphosphonic acid	Metal sequestrant for use with anti-microbial agents for meat, fruit and vegetables	GMP
Ice Structuring Protein type III HPLC 12	Manufacture of ice cream and edible ices	100
Indole acetic acid	Barley germination	GMP
L-Cysteine (or HCl salt)	Dough conditioner	75
Morpholine	Solubilising agent for coating mixtures on fruits	GMP
Oak	For use in the manufacture of wine	GMP

Substance	Function	Maximum residue limit (mg/kg)
Octanoic acid	Anti-microbial agent for meat, fruit and vegetables	GMP
Paraffin	Coatings for cheese and cheese products	GMP
Polyvinyl acetate	Preparation of waxes for use in cheese and cheese products	GMP
Potassium bromate	Germination control in malting	GMP
Sodium bromate	Germination control in malting	GMP
Sodium chlorite	Anti-microbial agent for meat, fish, fruit and vegetables	GMP
Sodium glycerophosphate	Cryoprotectant for starter culture	GMP
Stearyl alcohol	Coating agent on meat carcasses and primal cuts to prevent desiccation	GMP
Sulphurous acid	Softening of corn kernels	GMP
	Treatment of hides for use in gelatine and collagen manufacture	GMP
Triethanolamine	Solubilising agent for coating mixtures for fruits	GMP
Urea	Microbial nutrient and microbial nutrient adjunct for the manufacture of all foods, except alcoholic beverages	GMP
Woodflour from untreated <i>Pinus radiata</i>	Gripping agent used in the treatment of hides	GMP

TABLE III

Processing aids used in packaged water and in water used as an ingredient in other foods

Substance	Maximum residue limit (mg/kg)
Ammonium sulphate	GMP
Calcium hypochlorite	5 (available chlorine)
Calcium sodium polyphosphate	GMP
Chlorine dioxide	1
Cobalt sulphate	2
Cross-linked phenol-formaldehyde activated with one or both of triethylenetetramine or tetraethylenepentamine	GMP
Cross-linked polystyrene, first chloromethylated then aminated with trimethylamine, dimethylamine, diethylenetriamine or dimethylethanolamine	GMP
Diethylenetriamine, triethylenetetramine or tetraethylenepentamine cross-linked with epichlorohydrin	GMP
Ferric chloride	GMP
Ferric sulphate	GMP
Hydrofluorosilicic acid (fluorosilicic acid) (only in water used as an ingredient in other foods)	1.5 (as fluoride)
Hydrolyzed copolymers of methyl acrylate and divinylbenzene	GMP
Hydrolyzed terpolymers of methyl acrylate, divinylbenzene and acrylonitrile	GMP
Hydrogen peroxide	5
1-Hydroxyethylidene-1,1-diphosphonic acid	GMP
Lignosulphonic acid	GMP
Magnetite	GMP
Maleic acid polymers	GMP
Methyl acrylate-divinylbenzene copolymer containing not less than 2% divinylbenzene aminolysed with dimethylaminopropylamine	GMP

Substance	Maximum residue limit (mg/kg)
Methacrylic acid-divinylbenzene copolymer	GMP
Methyl acrylate-divinylbenzene-diethylene glycol divinyl ether terpolymer containing not less than 3.5% divinylbenzene and not more than 0.6% diethylene glycol divinyl ether, aminolysed with dimethylaminopropylamine	GMP
Modified polyacrylamide resins	GMP
Monobutyl ethers of polyethylene-polypropylene glycol	GMP
Ozone	GMP
Phosphorous acid	GMP
Polyacrylamide (polyelectrolytes)	0.0002 (as acrylamide monomer)
Polyaluminium chloride	GMP
Polydimethyldiallyl ammonium chloride	GMP
Polyoxypropylene glycol	GMP
Potassium permanganate	GMP
Reaction resin of formaldehyde, acetone and tetraethylenepentamine	GMP
Regenerated cellulose, cross-linked and alkylated with epichlorohydrin and propylene oxide, then sulphonated whereby the amount of epichlorohydrin plus propylene oxide employed is no more than 250% of the starting quantity of cellulose	GMP
Silver ions	0.01
Sodium fluoride (only in water used as an ingredient in other foods)	1.5 (as fluoride)
Sodium fluorosilicate (Sodium silicofluoride) (only in water used as an ingredient in other foods)	1.5 (as fluoride)
Sodium glucoheptonate	0.08 (measured as cyanide)
Sodium humate	GMP
Sodium hypochlorite	5 (available chlorine)
Sodium lignosulphonate	GMP

Substance	Maximum residue limit (mg/kg)
Styrene-divinylbenzene cross-linked copolymer	0.03 (as styrene)
Sulphonated copolymer of styrene and divinylbenzene	GMP
Sulphonated terpolymers of styrene, divinylbenzene acrylonitrile and methyl acrylate	GMP
Sulphite modified cross-linked phenol-formaldehyde	GMP
Zinc sulphate	GMP

TABLE IV

Enzymes from animal origin

Enzyme	Source
Lipase, triacylglycerol EC 3.1.1.3	Bovine stomach; salivary glands or forestomach of calf, kid or lamb; porcine or bovine pancreas
Lactoperoxidase EC 1.11.1.7	Bovine milk
Pepsin EC 3.4.23.1	Bovine or porcine stomach
Phospholipase A ₂ EC 3.1.1.4	Porcine pancreas
Thrombin EC 3.4.21.5	Bovine or porcine blood
Trypsin EC 3.4.21.4	Porcine or bovine pancreas

Enzymes from plant origin

Enzyme	Source
α -Amylase EC 3.2.1.1	Malted cereals
β -Amylase EC 3.2.1.2	Sweet potato (<i>Ipomoea batatas</i>) Malted cereals
Actinidin EC 3.4.22.14	Kiwifruit (<i>Actinidia deliciosa</i>)
Ficin EC 3.4.22.3	<i>Ficus</i> spp.
Fruit bromelain EC 3.4.22.33	Pineapple fruit (<i>Ananas comosus</i>)
Papain EC 3.4.22.2	<i>Carica papaya</i>
Stem bromelain EC 3.4.22.32	Pineapple stem (<i>Ananas comosus</i>)

Enzymes from microbial origin

The sources listed in relation to enzymes of microbial origin may contain additional copies of genes from the same organism.

Enzyme	Source
1,4-alpha-glucan branching enzyme EC 2.4.1.18	<i>Bacillus subtilis</i> , containing the gene for 1,4-alpha-glucan branching enzyme from <i>Rhodothermus obamensis</i>
α-Acetolactate decarboxylase EC 4.1.1.5	<i>Bacillus amyloliquefaciens</i> <i>Bacillus subtilis</i> <i>Bacillus subtilis</i> , containing the gene for α-Acetolactate decarboxylase isolated from <i>Bacillus brevis</i> <i>Bacillus licheniformis</i> , containing the gene for α-Acetolactate decarboxylase from <i>Bacillus brevis</i>
Aminopeptidase EC 3.4.11.1	<i>Aspergillus oryzae</i> <i>Lactococcus lactis</i>
α-Amylase EC 3.2.1.1	<i>Aspergillus niger</i> <i>Aspergillus niger</i> , containing the gene for α-Amylase from <i>Rhizomucor pusillus</i> <i>Aspergillus oryzae</i> <i>Bacillus amyloliquefaciens</i> <i>Bacillus licheniformis</i> <i>Bacillus licheniformis</i> , containing the gene for α-Amylase isolated from <i>Geobacillus stearothermophilus</i> <i>Bacillus licheniformis</i> , containing the gene for α-Amylase from <i>Bacillus amyloliquefaciens</i> <i>Bacillus subtilis</i> <i>Bacillus subtilis</i> , containing the gene for α-Amylase isolated from <i>Geobacillus stearothermophilus</i> <i>Geobacillus stearothermophilus</i>
β-Amylase EC 3.2.1.2	<i>Bacillus amyloliquefaciens</i> <i>Bacillus licheniformis</i> , containing the gene for β-Amylase from <i>Bacillus flexus</i> <i>Bacillus subtilis</i>
Amylomaltase EC 2.4.1.25	<i>Bacillus amyloliquefaciens</i> , containing the gene for amylomaltase derived from <i>Thermus thermophilus</i>
Amyloglucosidase	
α-Arabinofuranosidase EC 3.2.1.55	<i>Aspergillus niger</i> <i>Trichoderma reesei</i> , containing the gene for α-Arabinofuranosidase from <i>Talaromyces pinophilus</i>
Asparaginase EC 3.5.1.1	<i>Bacillus subtilis</i> , containing the gene for Asparaginase from <i>Pyrococcus furiosus</i> <i>Aspergillus niger</i> <i>Aspergillus oryzae</i>
Bromelain	
Carboxyl proteinase EC 3.4.23.6	<i>Aspergillus melleus</i> <i>Aspergillus niger</i> <i>Aspergillus oryzae</i> <i>Rhizomucor miehei</i>

Enzyme	Source
Carboxylesterase EC 3.1.1.1	<i>Rhizomucor miehei</i>
Catalase EC 1.11.1.6	<i>Aspergillus niger</i> <i>Micrococcus luteus</i>
Cellulase EC 3.2.1.4	<i>Aspergillus niger</i> <i>Penicillium funiculosum</i> <i>Trichoderma reesei</i> <i>Trichoderma viride</i>
Chymosin EC 3.4.23.4	<i>Aspergillus niger</i> <i>Escherichia coli</i> K-12 strain GE81 <i>Kluyveromyces lactis</i>
Cyclodextrin glucanotransferase EC 2.4.1.19	<i>Bacillus licheniformis</i> , containing the gene for Cyclodextrin glucanotransferase from <i>Thermoanaerobacter sp.</i> <i>Paenibacillus macerans</i>
Dextranase EC 3.2.1.11	<i>Chaetomium gracile</i> <i>Penicillium lilacinum</i>
Ficin	
Endo-arabinase EC 3.2.1.99	<i>Aspergillus niger</i>
Endo-protease EC 3.4.21.26	<i>Aspergillus niger</i>
α -Galactosidase EC 3.2.1.22	<i>Aspergillus niger</i>
β -Galactosidase EC 3.2.1.23	<i>Aspergillus niger</i> <i>Aspergillus oryzae</i> <i>Bacillus circulans</i> <i>Bacillus licheniformis</i> , containing the gene for β -Galactosidase from <i>Thermoanaerobacter sp.</i> <i>Kluyveromyces marxianus</i> <i>Kluyveromyces lactis</i>
Glucan 1,3- β - glucosidase EC 3.2.1.58	<i>Trichoderma harzianum</i>
β -Glucanase EC 3.2.1.6	<i>Aspergillus aculeatus</i> <i>Aspergillus niger</i> <i>Aspergillus oryzae</i> <i>Bacillus amyloliquefaciens</i> <i>Bacillus subtilis</i> <i>Disporotrichum dimorphosporum</i> <i>Humicola insolens</i> <i>Talaromyces emersonii</i> <i>Trichoderma reesei</i>

Enzyme	Source
Glucoamylase EC 3.2.1.3	<i>Aspergillus niger</i> , containing the gene for Glucoamylase from <i>Gloeophyllum trabeum</i> <i>Aspergillus niger</i> , containing the gene for Glucoamylase from <i>Penicillium oxalicum</i> <i>Aspergillus niger</i> , containing the gene for Glucoamylase from <i>Talaromyces emersonii</i> <i>Aspergillus niger</i> , containing the gene for Glucoamylase from <i>Trametes cingulata</i> <i>Aspergillus niger</i> <i>Aspergillus oryzae</i> <i>Rhizopus delemar</i> <i>Rhizopus oryzae</i> <i>Rhizopus niveus</i>
Glucose isomerase	
Glucose oxidase EC 1.1.3.4	<i>Aspergillus niger</i> <i>Aspergillus oryzae</i> , containing the gene for glucose oxidase isolated from <i>Aspergillus niger</i>
α-Glucosidase EC 3.2.1.20	<i>Aspergillus oryzae</i> <i>Aspergillus niger</i>
β-Glucosidase EC 3.2.1.21	<i>Aspergillus niger</i>
Glutaminase EC 3.5.1.2	<i>Bacillus licheniformis</i>
Glycerophospholipid cholesterol acyltransferase, protein engineered variant EC 2.3.1.43	<i>Bacillus licheniformis</i> , containing the gene for glycerophospholipid cholesterol acyltransferase isolated from <i>Aeromonas salmonicida</i> subsp. <i>Salmonicida</i>
Hemicellulase endo-1,3-β xylanase EC 3.2.1.32	<i>Humicola insolens</i>
Hemicellulase endo-1,4-β-xylanase EC 3.2.1.8	<i>Aspergillus niger</i> <i>Aspergillus oryzae</i> <i>Aspergillus oryzae</i> , containing the gene for Endo-1,4-β-xylanase isolated from <i>Aspergillus aculeatus</i> <i>Aspergillus oryzae</i> , containing the gene for Endo-1,4-β-xylanase isolated from <i>Thermomyces lanuginosus</i> <i>Bacillus amyloliquefaciens</i> <i>Bacillus licheniformis</i> <i>Bacillus subtilis</i> <i>Humicola insolens</i> <i>Trichoderma reesei</i> <i>Trichoderma reesei</i> , containing the gene for Endo-1,4-β-xylanase from <i>Talaromyces leycettanus</i>
Hemicellulase multicomponent enzyme EC 3.2.1.78	<i>Aspergillus niger</i> <i>Bacillus amyloliquefaciens</i> <i>Bacillus subtilis</i> <i>Trichoderma reesei</i>
Hexose oxidase EC 1.1.3.5	<i>Hansenula polymorpha</i> , containing the gene for Hexose oxidase isolated from <i>Chondrus crispus</i>

Enzyme	Source
Inulinase EC 3.2.1.7	<i>Aspergillus niger</i>
Invertase EC 3.2.1.26	<i>Saccharomyces cerevisiae</i>
Lactase	
Lipase, monoacylglycerol EC 3.1.1.23	<i>Penicillium camembertii</i>
Lipase, triacylglycerol EC 3.1.1.3	<i>Aspergillus niger</i> <i>Aspergillus niger</i> , containing the gene for Lipase, triacylglycerol from <i>Candida antarctica</i> <i>Aspergillus oryzae</i> <i>Aspergillus oryzae</i> , containing the gene for Lipase, triacylglycerol isolated from <i>Fusarium oxysporum</i> <i>Aspergillus oryzae</i> , containing the gene for Lipase, triacylglycerol isolated from <i>Humicola lanuginosa</i> <i>Aspergillus oryzae</i> , containing the gene for Lipase, triacylglycerol isolated from <i>Rhizomucor miehei</i> <i>Candida rugosa</i> <i>Hansenula polymorpha</i> , containing the gene for Lipase, triacylglycerol isolated from <i>Fusarium heterosporum</i> <i>Mucor javanicus</i> <i>Penicillium roquefortii</i> <i>Rhizopus arrhizus</i> <i>Rhizomucor miehei</i> <i>Rhizopus niveus</i> <i>Rhizopus oryzae</i>
Lipase, triacylglycerol, protein engineered variant EC 3.1.1.3	<i>Aspergillus niger</i> , containing the gene for lipase, triacylglycerol isolated from <i>Fusarium culmorum</i>
Lysophospholipase EC 3.1.1.5	<i>Aspergillus niger</i>
Maltogenic α -amylase EC 3.2.1.133	<i>Bacillus subtilis</i> containing the gene for maltogenic α -amylase isolated from <i>Geobacillus stearothermophilus</i>
Malt carbohydrases	
Maltotetrahydrolase, protein engineered variant EC 3.2.1.60	<i>Bacillus licheniformis</i> , containing the gene for maltotetrahydrolase isolated from <i>Pseudomonas stutzeri</i>
Mannan endo-1,4-beta-mannosidase EC 3.2.1.78	<i>Aspergillus niger</i> , containing the gene for Mannan endo-1,4-beta-mannosidase from <i>Talaromyces leycettanus</i>
Metalloproteinase	<i>Aspergillus oryzae</i> <i>Bacillus amyloliquefaciens</i> <i>Bacillus coagulans</i> <i>Bacillus subtilis</i> <i>Bacillus subtilis</i> containing the gene for Metalloproteinase from <i>Bacillus amyloliquefaciens</i>

Enzyme	Source
Mucorpepsin EC 3.4.23.23	<i>Aspergillus oryzae</i> <i>Aspergillus oryzae</i> , containing the gene for Aspartic proteinase isolated from <i>Rhizomucor meihei</i> <i>Rhizomucor meihei</i> <i>Cryphonectria parasitica</i>
Papain	
Pectinase	
Pectin lyase EC 4.2.2.10	<i>Aspergillus niger</i>
Pectinesterase EC 3.1.1.11	<i>Aspergillus niger</i> <i>Aspergillus oryzae</i> , containing the gene for pectinesterase isolated from <i>Aspergillus aculeatus</i>
Pepsine	
Phosphatidylinositol phospholipase C EC 3.1.4.11	<i>Bacillus licheniformis</i> , containing the gene for Phosphatidylinositol phospholipase C from <i>Pseudomonas sp.</i>
Phospholipase A ₁ EC 3.1.1.32	<i>Aspergillus niger</i> , containing the gene for phospholipase A ₁ from <i>Talaromyces leycettanus</i> <i>Aspergillus oryzae</i> , containing the gene for phospholipase A ₁ isolated from <i>Fusarium venenatum</i> <i>Aspergillus oryzae</i> , containing the gene for phospholipase A ₁ from <i>Valsaria rubricosa</i>
Phospholipase A ₂ EC 3.1.1.4	<i>Aspergillus niger</i> , containing the gene isolated from porcine pancreas <i>Streptomyces violaceoruber</i>
Phospholipase C EC 3.1.4.3	<i>Bacillus licheniformis</i> , containing the gene for Phospholipase C from <i>Bacillus thuringiensis</i>
3-Phytase EC 3.1.3.8	<i>Aspergillus niger</i>
4-Phytase EC 3.1.3.26	<i>Aspergillus oryzae</i> , containing the gene for 4-phytase isolated from <i>Peniophora lycii</i>
Protease	
Proteinase	
Polygalacturonase or Pectinase multicomponent enzyme EC 3.2.1.15	<i>Aspergillus aculeatus</i> <i>Aspergillus niger</i> <i>Aspergillus oryzae</i> <i>Trichoderma reesei</i>

Enzyme	Source
Pullulanase EC 3.2.1.41	<i>Bacillus acidopullulyticus</i> <i>Bacillus amyloliquefaciens</i> <i>Bacillus licheniformis</i> <i>Bacillus subtilis</i> <i>Bacillus subtilis</i> , containing the gene for pullulanase isolated from <i>Bacillus acidopullulyticus</i> <i>Bacillus subtilis</i> , containing the gene for pullulanase from <i>Bacillus deramificans</i> <i>Bacillus licheniformis</i> , containing the gene for pullulanase from <i>Bacillus deramificans</i> <i>Klebsiella pneumoniae</i>
Rennet and protein congelating enzymes	
Serine protease (Chymotrypsin) EC 3.4.21.1	<i>Bacillus licheniformis</i> , containing the gene for Serine protease (Chymotrypsin) from <i>Nocardioopsis prasina</i>
Serine protease with trypsin specificity EC 3.4.21.4	<i>Fusarium venenatum</i> , containing the gene for Serine protease from <i>Fusarium oxysporum</i>
Serine proteinase EC 3.4.21.14	<i>Aspergillus oryzae</i> <i>Bacillus amyloliquefaciens</i> <i>Bacillus halodurans</i> <i>Bacillus licheniformis</i> <i>Bacillus subtilis</i>
Transglucosidase EC 2.4.1.24	<i>Aspergillus niger</i>
Transglutaminase EC 2.3.2.13	<i>Streptomyces mobaraensis</i>
Trehalase EC 3.2.1.28	<i>Aspergillus niger</i> , containing the gene for Trehalase from <i>Gloeophyllum sepiarium</i> and <i>Myceliophthora sepedonium</i>
Urease EC 3.5.1.5	<i>Lactobacillus fermentum</i>
Xylose isomerase EC 5.3.1.5	<i>Actinoplanes missouriensis</i> <i>Bacillus coagulans</i> <i>Microbacterium arborescens</i> <i>Streptomyces olivaceus</i> <i>Streptomyces olivochromogenes</i> <i>Streptomyces murinus</i> <i>Streptomyces rubiginosus</i>

Note:

GMP means Good Manufacturing Practice

EC means the number which the enzyme commission uses to classify the principal enzyme activity.