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Gram-positive bacteria with commercial potentials from the intestines of *Holothuria* (*Mertensiothuria*) *leucospilota* (Brandt, 1835) (Timun laut) and *Stichopus horrens* Selenka, 1867 (Gamat) from Malaysia

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Overview

Gamat is a local name for all species of family Stichopodidae.

- Genera of *Stichopus* and *Thelenota* are the two members of family Stichopodidae which can be found in Malaysian coastal waters e.g. *Stichopus horrens* Selenka, 1867 and *Thelenota anax* H.L. Clark, 1921.
- *Gamat* has been exploited for its body fluid extracts i.e. ***air gamat*** and lipid extracts i.e. ***minyak gamat***.
- In line with the development of science and technology, modern-formularised *gamat*-based products sold by Malaysian companies e.g. Gamat eMas Sdn. Bhd., Nur Af Enterprise, Nutrifes Food & Beverages Industries Sdn. Bhd., and Luxor Network Sdn. Bhd. are also available in the markets.
- ***S. horrens* or *Gamat Emas*** has been used as the main ingredient.

Timun laut is a general local name for all species of sea cucumbers in Malaysia including *gamat* species, and can be used to refer to non-*gamat* species.

- ***Holothuria (Mertensiothuria) leucospilota* (Brandt, 1835)** is suggested as the most abundant *timun laut* in Malaysia.
- This species is one of the commercial species of sea cucumbers exploited as food in Malaysia, Thailand, Indonesia, the Philippines, and Vietnam (Choo 2008).
- In Malaysia, this soft-bodied species or *timun laut* is locally known as *bat puntil*, *bat hitam,* or *balat hitam*.

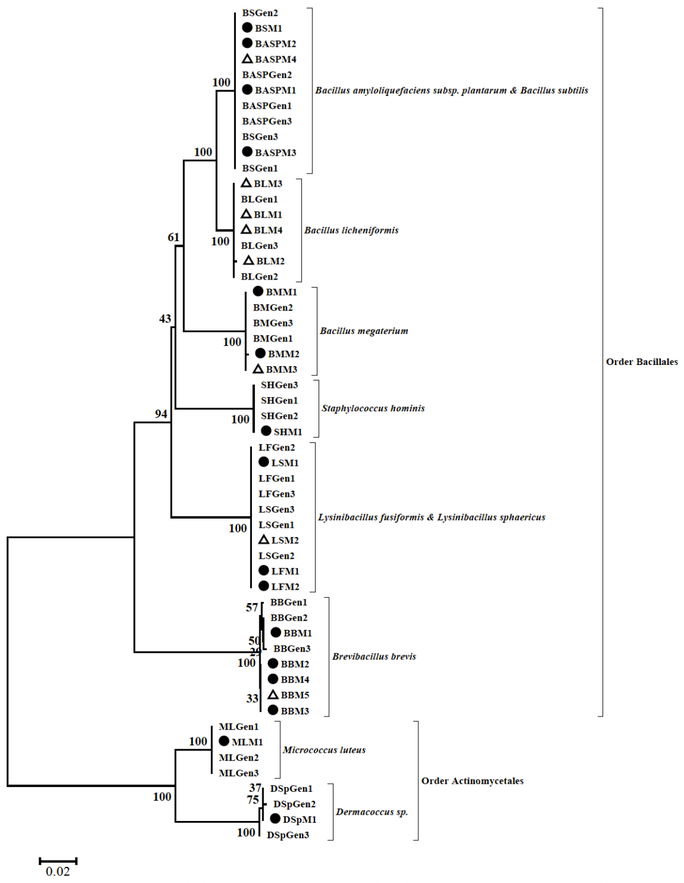
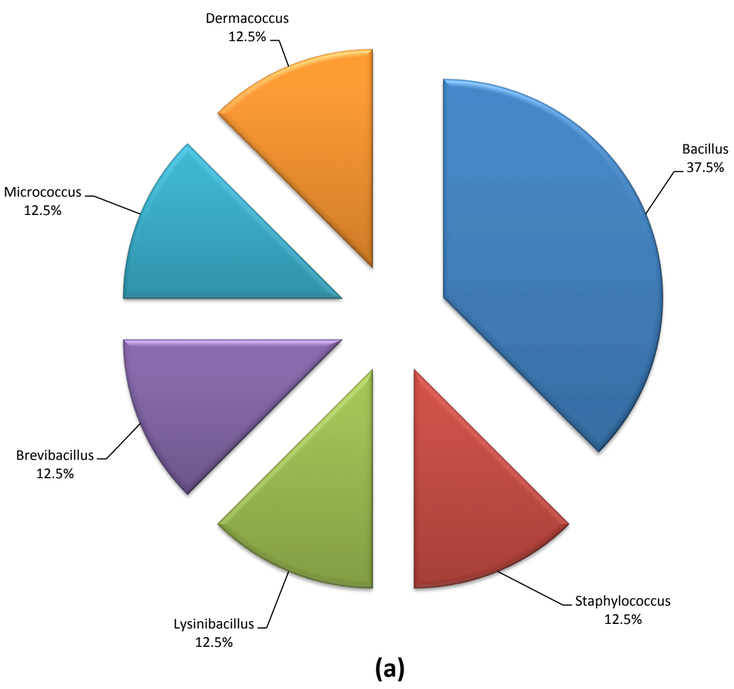
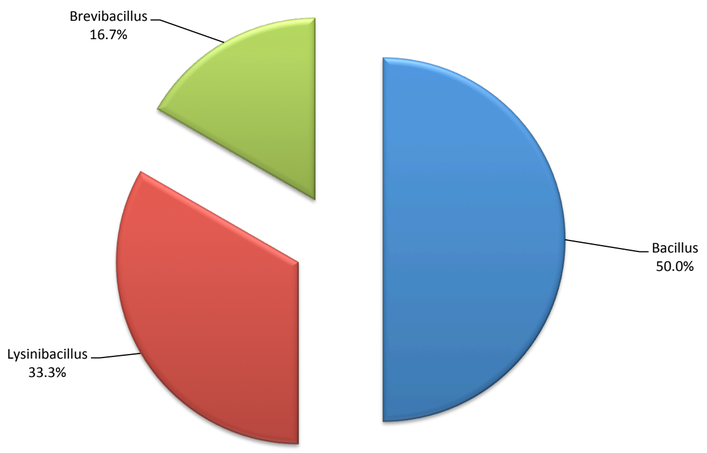


Figure 3. Neighbour joining phylogenetic tree of 16S rRNA gene sequences of bacteria associated with the intestines of *Holothuria* (*Mertensiothuria*) *leucospilota* (Brandt, 1835) and *Stichopus horrens* Selenka, 1867 from Malaysia. Software: MEGA5.

FIGURE 1. *Holothuria* (*Mertensiothuria*) *leucospilota* (Brandt, 1835). Photo source: Kamarul Rahim Kamarudin.

FIGURE 2. *Stichopus horrens* Selenka, 1867. Left photo = dorsal view, right photo = ventral view. Photo source: Ridzwan Hashim.





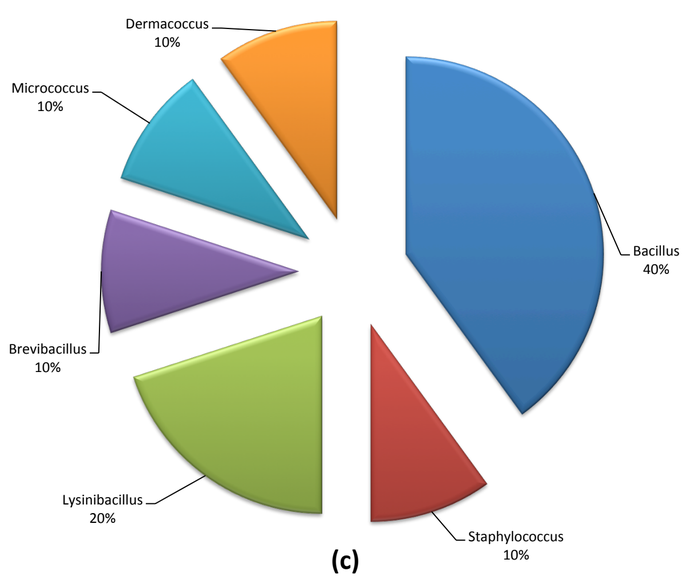


Figure 4. Composition of the bacterial community in the intestines of *Holothuria* (*Mertensiothuria*) *leucospilota* (Brandt, 1835) and *Stichopus horrens* Selenka, 1867 from Pangkor Island, Perak Darul Ridzuan, Malaysia identified by sequence analysis of 16S rRNA gene. (a) - composition in the intestines of *H. leucospilota*, (b) - composition in the intestines *of S. horrens*, (c) - total composition for both Malaysian species.

TABLE 1 List of Gram-positive bacteria isolated from the intestines of *Holothuria (Mertensiothuria) leucospilota* (Brandt, 1835) and *Stichopus horrens* Selenka, 1867 from Pangkor Island, Perak Darul Ridzuan, Malaysia. Mitochondrial 16S rRNA gene sequencing was done for the species identification.

Bacterial species	Sea cucumbers *Holothuria leucospilota*	*Stichopus horrens*	Remarks
Order Bacillales (8)			
- *Bacillus amyloliquefaciens subsp. plantarum*	x	x	*Important source of alpha-amylase and protease for industrial applications.
- *Bacillus megaterium*	x	x	*Antibiotics producer i.e. megacin
- *Lysinibacillus sphaericus*	x	x	*Important organism to study because it can be used as an insecticidal toxin that controls mosquito growth.
- *Brevibacillus brevis*	x	x	*Antibiotics producer i.e. gramicidin and tyrocidin
- *Bacillus licheniformis*		x	*Polypeptide antibiotics producer i.e. bacitracin.
- *Staphylococcus hominis*	x		Commensal of the skin.
- *Lysinibacillus fusiformis*	x		Unknown pathogenicity.
- *Bacillus subtilis*	x		*Antibiotics producer i.e. subtiline. May accumulate metal ions (aluminium, cadmium, iron and zinc) non-enzymically by adsorption to their cell surfaces and this can be of importance in waste treatment and natural environments.
Order Actinomycetales (2)			
- *Micrococcus luteus*	x		Part of the normal flora of the mammalian skin.
- *Dermacoccus* sp.	x		Undetermined species.