ENSIKLOPEDIA MINI PERIKANAN:

Siakap Putih

(*Lates calcarifer*)

Jabatan Perikanan Malaysia

Cetakan 2022

ENSIKLOPEDIA MINI PERIKANAN: IKAN SIAKAP PUTIH *(Lates calcarifer)*

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SENARAI KANDUNGAN

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PERUTUSAN PENGARAH KANAN

Assalammualaikum warahmatullahi wabarakatuh dan selamat sejahtera. Alhamdulillah, syukur ke hadrat Allah SWT kerana dengan izinNya, Buku Ensiklopedia Mini Perikanan: Ikan Siakap Putih *(Lates calcarifer)* berjaya diterbitkan. Di kesempatan ini, saya ingin merakamkan ucapan tahniah kepada semua pengarang kerana telah berjaya menghasilkan satu dokumen yang mempunyai banyak maklumat tentang ikan siakap putih khususnya maklumat setempat.

Seperti mana yang kita tahu maklumat dari sumber tempatan agak sukar didapati bagi tujuan rujukan. Justeru penerbitan ini adalah sangat tepat dan sesuai dan boleh dijadikan sumber rujukan oleh pihak berkepentingan seperti penternak, pelabur, pengusaha, pengurus perikanan, ahli akademik, penyelidik, pelajar serta masyarakat umum. Saya berharap selepas ini akan ada lagi siri ensiklopedia mini perikanan untuk spesies-spesies ikan utama lain di Malaysia.

Sekian, terima kasih.

YBrs. Dr. Azhar bin Hamzah
Pengarah Kanan
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PRAKATA

Setinggi-tinggi syukur ke hadrat Allah SWT kerana dengan izin dan limpah kurniaNya, penulisan buku “Ensiklopedia Mini Perikanan: Ikan Siakap Putih *(Lates calcarifer)*” ini berjaya disempurnakan dan diterbitkan. Buku ini diterbitkan untuk berkongsi maklumat-maklumat penting mengenai ikan siakap putih khususnya maklumat dari Malaysia seperti pola pengeluaran, pengeluar benih, potensi dan sebagainya. Perancangan kami juga adalah untuk mengadakan pangkalan data berkaitan hal yang sama supaya capaian yang lebih luas dapat dibuat serta data-data terkini dapat dimuatnaik seiring dengan masa. Ruangan yang lebih luas dilaman sesawang juga membolehkan kami memasukkan lebih banyak maklumat dan foto untuk rujukan semua.

Kami ingin merakamkan setinggi-tinggi penghargaan kepada penyumbang maklumat dan foto serta semua yang terlibat dalam penerbitan buku ini samada secara langsung ataupun tidak. Semoga buku ini dapat memberi manfaat kepada semua pembaca termasuk pengurus perikanan, pelabur, penternak, pelajar serta penggemar ikan siakap putih di Malaysia.

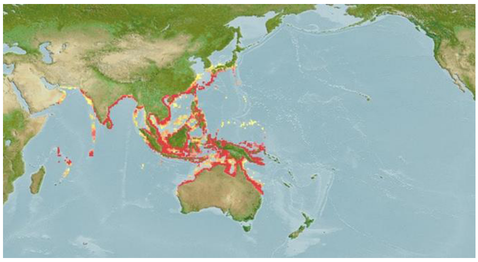
Pengenalan

Ikan siakap putih (*Lates calcarifer* (Bloch, 1790) atau nama Inggerisnya *Asian Seabass* atau *Giant Perch* adalah antara ikan komersial yang utama di seluruh dunia dan mempunyai nilai ekonomi yang tinggi. Ikan siakap putih penting sebagai ikan makan di banyak negara di dunia di samping, antara ikan ternak utama, ikan rekreasi serta ikan akuarium (Grey, 1987; Tucker et al., 2006). Ikan siakap putih adalah salah satu spesies di bawah Famili Latidae yang boleh diperolehi dari liar dan akuakultur. Pengeluaran dari sumber liar adalah sedikit dan tidak disenaraikan di dalam perangkaan perikanan global oleh Food and Agriculture Organization (FAO). Pengeluaran daripada aktiviti akuakultur adalah signifikan dengan ikan siakap putih tersenarai dalam 15 spesies utama yang diternak di seluruh dunia dari tahun 2000 hingga 2020 (Jadual 1) (FAO, 2020). Pengeluaran ikan siakap putih dunia daripada aktiviti akuakultur yang terkini adalah sebanyak 130,000 tan metrik (TM) dan diramalkan pasaran global ikan siakap putih akan meningkat pada kadar 5.5% setahun untuk tempoh 2021 – 2031 (Future Market Insight, 2021). Saiz pasaran ikan siakap putih dunia adalah USD 3.5 bilion pada tahun 2020 dan dijangka mencecah USD 7.9 bilion menjelang 2030 iaitu peningkatan Kadar Pertumbuhan Tahunan Kompaun (CAGR) sebanyak 6.8%.

Jadual 1: Pengeluaran spesis utama ternakan ikan laut dunia (ribu tan matrik, berat hidup)

Ikan	2000	2005	2010	2015	2020	% 2020
Atlantic salmon, *Salmon salar*	895.7	1 266.6	1 433.8	2 380.2	2 719.6	32.6
Milkfish, *Chanos chanos*	429.7	542.9	750.5	1 012.3	1 167.8	14.0
Mullet nei, *Mugilidae*	92.4	173.7	102.7	129.2	291.2	3.5
Gilthead seabream, *Sparus aurata*	87.3	110.8	142.3	168.8	282.1	3.4
Large yellow croaker, *Larimichthys croceus*	0.0	60.9	83.3	142.4	254.1	3.0
European seabass, *Dicentrarchus labrax*	60.7	90.9	118.0	149.1	243.9	2.9
Groupers nei, *Epinephelus spp.*	7.6	57.1	77.2	149.2	226.2	2.7
Coho (=Silver) salmon, *Oncorhynchus kisutch*	108.6	115.1	124.8	140.7	221.8	2.7
Rainbow trout, *Oncorhynchus mykiss*	155.3	202.0	287.7	204.1	220.7	2.6
Japanese seabass, *Lateolabrax japonicus*	0.6	79.6	104.8	120.6	196.9	2.4
Pompano, *Trachinotus ovatus*	0.0	0.0	80.0	110.0	160.0	1.9
Japanese Amberjack, *Seriola quinqueradiata*	136.8	159.7	138.9	140.3	137.1	1.6
Nile tilapia, *Oreochromis niloticus*	1.6	5.3	20.3	49.8	107.4	1.3
Barramundi (=Giant seaperch), *Lates calcarifer*	18.1	27.0	52.7	68.7	105.8	1.3
Red drum, *Sciaenops ocellatus*	2.1	42.4	53.0	71.3	84.3	1.0
Jumlah keseluruhan 15 spesies utama	**1 996.6**	**2 933.9**	**3 569.9**	**5 036.7**	**6 418.2**	**77.0**

Ikan siakap putih adalah ikan natif di rantau Indo-Pasifik Barat dari Teluk Arab hingga ke Selatan China, Taiwan, Papua New Guinea dan Utara Australia. Had sempadan di belah timur adalah hujung tenggara tanah besar Papua New Guinea, sebelah utara di Amoy China (24°30°N), sebelah barat di Teluk Parsi dan selatan di Sg. Noosa (26°30’s) dan Sg. Ashburton (22°30’S) di benua Australia (Grey, 1987). Ikan siakap putih diternak di merata dunia dari Teluk Parsi hingga ke India, Asia Tenggara, India, Papua New Guinea, utara Australia hingga ke rantau Pasifik Barat (Jerry, 2014). Rajah 1 menunjukkan taburan kawasan pengeluaran ikan siakap putih di dunia.



Rajah 1: Kawasan pengeluaran *L.calcarifer* (ikan siakap putih) dunia

Oleh kerana taburan geografinya yang luas, spesies ini dikenali dengan pelbagai nama tempatan. Menurut pangkalan data Fishbase, terdapat hampir 180 nama umum untuk ikan siakap putih. Jadual 2 menyenaraikan sebahagian daripada nama-nama inggeris dan nama tempatan bagi ikan ini. Untuk ensiklopedia mini ini, nama ikan siakap putih telah dipilih untuk digunakan bagi tujuan penyeragaman.

Jadual 2: Pelbagai nama umum ikan siakap putih di seluruh dunia

Lokasi	Nama	Lokasi	Nama
Nama Inggeris	Giant perch, white seabass, silver seaperch, giant perch, palmer	Vietnam	Ca-chem, cavuot, barramundi, giant sea perch
Malaysia	Siakap putih, kakap, kakap putih, siakap putih, kim bak lor, gelungsung, bukai-bukai, sea perch, sea bass	Cambodia	Trey spong, Cá vurot
Borneo utara	Salung – sung	China	Hih tsao, hak tso, tsa yu
India	Begti, bhekti, dangara, voliji, fitadar, todah, Nuddee-meen, nari-meen, nari-meen, nair-meen, koduva, koliji, keduwa, keliji, khajura, khajuri, durruah, fitadar, gariyu	Filipina	Apaap, apap, apahap, bolgan, bulungan, bulgan, burgan, kaka, laya, salungsungan, katuyot, matang pusa,mangagat, mata kuting, matakating, poyo, tul-wan, solong-solong
Bangladesh	Kora, boar, barramundi, bhetki	Indonesia	Kakap, pelak, petcham, telap, siakap putih, kanja, pica-pica
Sri Lanka	Modha koliya, keduwa, Painnee-meen, barramundi	Autralia	Barramundi, palmer, barra, giant perch, barga, barlga, barramunda, birloonkoordany, sea bass,
Thailand	Pla kapong kao, pla kapong pla kapong, nam-chut	Papua New Guinea	Barramundi
Japan	Akame	Myanmar	Ka ka tit, ka-ka-dit, ka-ka-htit, ka-kadit, nga-tha-dite

Ikan siakap putih berjaya dibiak dalam kurungan pada tahun 1973 (Barnabe, 1995) dan semenjak itu, ternakan ikan siakap putih telah berkembang dengan pesat terutama di Asia dan Australia termasuk Malaysia. Seawal tahun 1990an, ikan siakap putih menyumbang sehingga 50 - 90% daripada jumlah keseluruhan pengeluaran ikan marin dan air payau di Malaysia (Hussin & Ali, 1994). Pada tahun 2010, ikan siakap putih telah dipilih sebagai salah satu calon spesies ikan bernilai tinggi di bawah *National Key Economic Area*, *Economic Transformation Program* untuk sektor pertanian. Pemilihan ini berdasarkan sejarah ternakan yang bermula sejak tahun 1970an serta penyelidikan dan pembangunan berkaitan teknologi pembiakan, asuhan larva, asuhan dan ternakan yang telah banyak dilaksanakan di Institut Penyelidikan Perikanan (Fisheries Research Institute (FRI), Jabatan Perikanan Malaysia (Ali, 1987a; Ali, 1987b; Hussin 1987a; Hussin, 1987b; Liong et al., 1988). Sehingga kini, ikan siakap putih masih mendominasi pengeluaran ikan marin/payau di Malaysia iaitu sebanyak 34,186.73 TM atau 60.2% daripada jumlah keseluruhan pengeluaran dengan nilai RM 480,158,530 (Jabatan Perikanan Malaysia, 2021). Selain daripada itu, tarikan utama ikan siakap putih sebagai ikan ternak adalah rupanya yang menarik dengan bahagian luar berwana perak yang bersinar, isinya yang putih dengan rasa yang manis dan rasa hanyir ikan yang tidak begitu kuat. Isi yang sedap dan berwarna putih juga menyebabkan ikan ini menjadi salah satu pilihan utama industri pemprosesan ikan. Bukan itu sahaja, spesis ini telah berjaya dibiak dan dipelihara di dalam tangki simen di pusat-pusat pengeluaran benih secara semulajadi. Kelebihan-kelebihan lain ikan siakap putih sebagai ikan pilihan untuk akuakultur di senaraikan dalam Rajah 2.

Rajah 2: Faktor-faktor kelebihan ikan siakap putih sebagai ikan pilihan untuk akuakultur

Sehingga kini ikan siakap putih terus mendapat permintaan yang tinggi daripada industri perkhidmatan makanan dan restoran. Siakap putih dihidang di rantaian penyediaan makanan multi-nasional termasuk di dalam kapal perlancongan, restoran makanan laut, sekolah dan hospital. Nilai harga borong ikan siakap putih yang terkini di Malaysia adalah sekitar RM 15.00 per kilogram manakala harga runcit pula adalah sekitar RM 20.00 per kilogram (LKIM, 2022). Harga hidangan ikan siakap putih di restoran makanan laut boleh mencecah sehingga beratus ringgit bergantung kepada saiz ikan dan jenis masakan seperti yang tular di media sosial pada hujung tahun 2021 di Langkawi, Kedah. Kalau dahulu siakap biasanya dibeli dari pasar basah, pasar mini dan pasar raya, tetapi kini saluran jualan adalah lebih pelbagai termasuk jualan atas talian. Terdapat peningkatan yang ketara dalam jualan atas talian semasa dan selepas pandemik Covid-19.

Dari segi industri hiliran ikan siakap putih pula, berbanding dengan ikan tilapia atau keli, tidak banyak produk hiliran yang dihasilkan daripada ikan ini. Ikan siakap putih biasanya dijual hidup, segar atau pun sejuk beku dalam bentuk keseluruhan ikan (*whole*), dibuang perut (gutted), filet (kepingan isi) dengan kulit atau tanpa kulit serta potongan isi ikan. Filet ikan siakap putih banyak diperdagangkan di seluruh dunia dan mempunyai permintaan yang tinggi kerana gaya hidup kini yang mengutamakan makanan siap untuk dimasak (*ready to cook*), siap untuk dihidang (*ready to serve*) dengan pembungkusan yang higenik serta tahan lama disimpan berbanding ikan segar yang cepat rosak. Walaupun tidak ada indutri pemprosesan ikan siakap yang signifikan di Malaysia, tetapi di negara lain kulit, sisik dan sisa dari pemprosesan ikan siakap digunakan untuk menghasilkan snek (seperti keropok kulit ikan, ramuan untuk produk farmaseutikal, neutraseutikal dan kosmetik (kolagen, gelatin, peptida, hidrolisat protein, enzim dan mineral).

"Ensiklopedia Mini Perikanan: Ikan Siakap Putih" ini disediakan untuk berkongsi maklumat berkaitan ikan siakap putih khususnya di Malaysia. Buku ini dibahagikan kepada tujuh bahagian. Bahagian pertama tentang pengenalan ringkas serta kepentingan ikan siakap putih. Bahagian dua tentang sejarah ternakan di dunia dan di Malaysia. Bahagian tiga menjurus kepada maklumat biologi manakala sistem-sistem ternakan yang digunakan untuk menternak siakap di Malaysia disentuh dalam bahagian empat. Bahagian lima menyenaraikan penyakit utama yang menyerang ikan siakap putih bahagian enam memperincikan tentang pola pengeluaran di peringkat global dan juga di Malaysia. Akhir sekali bab tujuh berkongsi maklumat berkenaan dengan senarai penyelidikan dan pembangunan ikan siakap putih yang dijalankan di Malaysia.

BAHAGIAN
2

Sejarah Ternakan

Ikan siakap putih telah berjaya dibiak secara semulajadi dalam kurungan pada tahun 1975 (Tattanon & Maneewongsa, 1982). Thailand merupakan negara pertama yang membangunkan teknik pembiakan dan ternakan ikan siakap putih. Kitaran hidup ikan siakap putih yang lengkap telah berjaya direkodkan dan Thailand berjaya mengeluarkan sehingga lebih 1.0 juta benih siakap putih setahun. Semenjak itu, dari tahun 1980an - 1990an, ternakan ikan siakap putih telah berkembang ke negara lain seperti China, India, Indonesia, Malaysia, Philippines, Singapore, Vietnam and Australia (Petersen et al., 2011). Pada masa ini, Amerika Syarikat, Netherlands, UK dan Israel juga telah mula menternak ikan siakap putih.

Di Malaysia, industri ternakan ikan siakap putih bermula sejurus selepas perkembangan di Thailand dengan menggunakan benih-benih liar dan benih yang diimport dari Thailand dan dipelihara di sangkar-sangkar terapung sekitar Pulau Pinang dan Lagun Setiu, Terengganu. Kaedah propagasi larva ikan siakap putih telah dibangunkan di Institut Penyelidikan Perikanan, Gelugor, Pulau Pinang pada tahun 1982 dan pembenihan dalam kurungan yang pertama di Malaysia telah berjaya dilaksanakan pada tahun 1985. Satu dokumen teknikal berkaitan kaedah menternak ikan siakap putih yang dialihbahasa daripada bahasa Thai telah diterbitkan pada tahun 1988 untuk rujukan pihak industri (Foto 1). Selepas itu, industri ternakan ikan siakap putih semakin berkembang sehingga ke hari ini dengan permintaan dan keperluan benih meningkat dari tahun ke tahun. Kebanyakkan pengeluaran adalah daripada sangkar terapung kerana kos pelaburan yang lebih rendah dan sangkar terapung lebih mudah dibina, diurus dan kegunaanya boleh dipelbagaikan (Buendia, 1997).

Foto 1: Dokumen teknikal kaedah menternak ikan siakap putih

Pada awal tahun 1990an kebanyakkan hatceri ini mendapatkan benih ikan siakap putih dari Institut Penyelidikan Perikanan Tg. Demong, Jabatan Perikanan Malaysia, Besut Terengganu (Norfatimah et al., 2009) atau dulunya dikenali sebagai Pusat Pembenihan dan Pengeluaran Ikan Laut (PPPIL). Foto 2 dan 3 menunjukkan gambar pusat, fasiliti yang terdapat serta aktiviti penyelidikan yang dijalankan pada masa tersebut. Pada masa sekarang pengeluaran benih siakap putih secara semulajadi telah banyak di lakukan dalam tangki ternakan di hatceri-hatceri swasta yang beroperasi di seluruh Malaysia

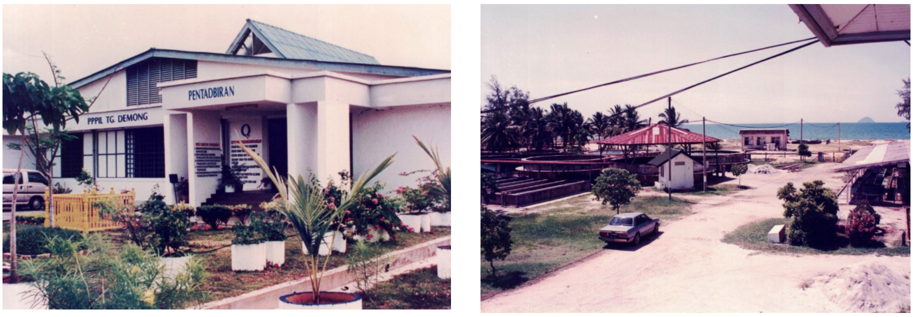


Foto 2: Gambar Pusat Pembenihan dan Pengeluaran Ikan Laut Tg Demong, Besut, Terengganu atau kini dikenali sebagai Institut Penyelidikan Perikanan Tg. Demong

Foto 3: Fasiliti dan aktiviti penyelidikan dan pengeluaran benih ikan siakap putih di Pusat Pembenihan dan Pengeluaran Ikan Laut Tg. Demong, Besut, Terengganu

Maklumat Biologi

3.1 Pengkelasan/Taksonomi

Lates calcarifer pertama kali diperincikan oleh Bloch (1790) menggunakan sampel yang diperolehi daripada rantau Indo-Pasifik daripada pedagang Belanda (Grey, 1987). Pada mulanya ia dinamakan *Holocentrus calcarifer* yang diterbitkan di Naturgeschichte der ausländischen Fische. Morino, Berlin. Genus Lates (Cuvier and Valenciennes) telah dicadangkan pada tahun 1828 untuk pengkelasan pada tahun 1828. Keputusan untuk meletakkan *L. calcarifer* dalam cadangan famili Percinae, Centropomidae, Latidae and Serranidae diperbincangkan dengan hebat adan akhir sekali diputuskan untuk diletakkan di bawah famili Latidae yang mempunyai tiga genera iaitu Psammoperca, Hypopterus and Lates.

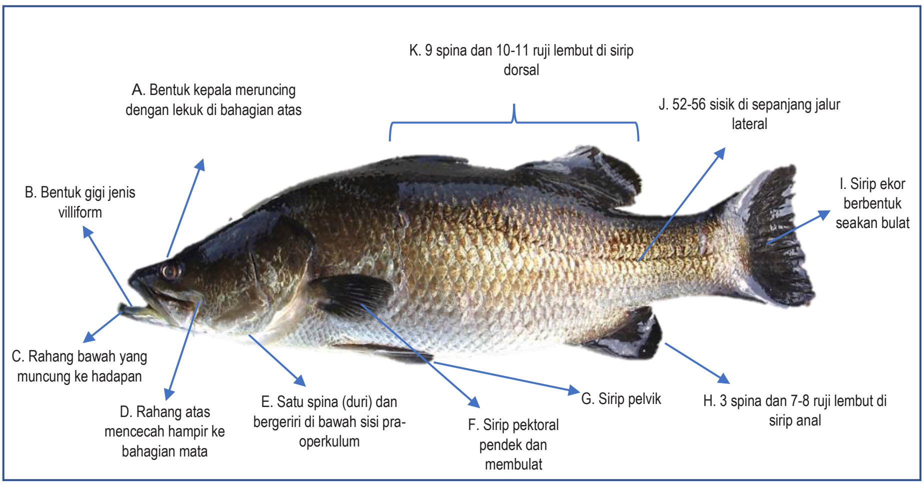
Berikut adalah pengkelasan siakap putih menurut World Register of Marine Species (WoRMS)

- Kingdom: Animalia
- Phylum: Chordata
- Subphylum: Vertebrata
- Class: Actinopteri
- Famili: Latidae
- Genus: Lates
- Spesies: *Lates calcarifer*

Perkataan Lates: Latin, lateo, latere bermaksud *to be hidden* atau tersembunyi (Fishbase) manakala perkataan '*calcarifer*' secara umumnya bermaksud *thorn carrier* atau pembawa duri. Nama ini diperolehi daripada duri *preopercular* yang terdapat pada ikan ini. Duri yang terdapat pada sirip dorsal ini menghalang pemangsa daripada menyerang ikan ini dari belakang kerana duri ini menghala ke arah belakang.

3.2 Ciri-ciri fizikal

Kekunci pengecaman utama ikan siakap putih dengan penerangan lanjut diperincikan dalam Rajah 3 dan Jadual 3.



Rajah 3: Kekunci pengecaman utama aran ikan siakap putih (*L. calcarifer*) A: Bentuk kepala. B: Bentuk gigi. C: Rahang bawah. D: Rahang atas. E: Praoperkulum. F: Sirip pektoral. G Sirip pelvik. H: Sirip anal. I: Sirip ekor. J: Jalur lateral. K. Sirip dorsal

Jadual 3: Deskripsi ciri fizikal ikan siakap putih

Bahagian/ Ciri	Penerangan lanjut
Saiz	Panjang biasa: 1500 mm; Panjang maksimum: 2000 mm
Badan	Bentuk memanjang dan mampat dengan pedunkel kaudal yang panjang
Sisik	Besar dan kasar, berwarna perak dan boleh menjadi semakin cerah atau gelap mengikut keadaan persekitaran.
Mulut dan gigi	Mulut condong yang besar dengan bahagian rahang atas mencecah hampir ke orbit mata Bukaan mulut agak tirus dengan gigi yang runcing berbentuk villiform yang terdapat pada rahang dan lelangit. Tidak mempunyai taring
Warna	Benih ikan bersaiz 0.5 - 1.0 cm (panjang) berwarna perang gelap dengan bintik-bintik kuning. Benih yang lebih besar (2.0) cm panjang mempunyai satu jalur berwarna perang di bahagian atas badan daripada hujung mulut ke sirip belakang, dan sisi badan berwarna perang kekuningan dengan empat atau lima jalur kelabu gelap. Tanda-tanda ini akan hilang apabila ikan semakin membesar. Juvenil ikan berwarna keperang-perangan di bahagian atas manakala di bahagian tepi berwarna keperakan apabila di dalam air masin dan bertukar perang keemasan apabila di dalam air tawar. Induk/Dewasa: Bahagian atas badan berwarna hijau kebiru-biruan atau kelabu dan keperakan di bahagian bawah.  **Foto 4**: Pelbagai saiz benih siakap putih

Foto 5: Induk siakap putih jantan (sebelah kiri) dan siakap putih betina (sebelah kanan)

3.3 Ekologi dan pembenihan

Ikan siakap putih bersifat *euryhaline* iaitu boleh mendiami habitat air tawar, payau dan marin seperti di sungai, tasik, muara, lagun dan perairan pesisir pantai yang berbatu. Selain itu, ia juga mempunyai kitaran hidup yang kompleks dengan tabiat *catadromou*s dan *hermaphrodite protandrous* (Moore 1979, 1980, 1982; Moore & Reynolds, 1982; Reynolds & Moore, 1982; Russell & Garrett, 1983, 1985; Griffin, 1985, 1986; Davis, 1982, 1985). Tabiat *catadromous* adalah tabiat di mana ikan bermigrasi dari air masin ke air payau untuk melepaskan telur. Biasanya ikan siakap putih dewasa di habitat air tawar akan bergerak ke hilir sungai untuk bertelur di perairan yang mempunyai saliniti yang lebih tinggi kerana telur ikan siakap putih memerlukan air masin untuk berkembang sepenuhnya. Pembenihan selalunya berlaku di kawasan air payau dan bermusim mengikut lokasi dan perubahan tahunan.

Induk muda berumur 3 - 4 tahun dengan panjang keseluruhan 60 - 70 cm dan berat 2.6 – 4.2 kg akan mendiami kawasan pantai dengan tahap kemasinan antara 30 - 32 ppt yang biasanya dalam 5 km daripada pantai dengan kedalaman lebih kurang 14 m serta berhampiran muara sungai atau kawasan bakau. Induk dewasa yang telah matang akan berhijrah ke kawasan muara sungai dan bergerak dari hilir ke hulu sungai sehingga mencapai kematangan seksual sebagai induk jantan sebelum berhijrah ke kawasan hilir untuk bertelur dan membiak. Induk jantan ini akan kekal berada di dalam air pasang surut sungai untuk mengawan sebelum menukar jantina menjadi ikan siakap putih betina dalam tempoh masa antara 6 dan 8 tahun. Pada usia ini, induk ikan siakap putih betina bersaiz 85 - 100 cm (panjang) dengan berat (7.0 - 12.0 kg) (Davis, 1982).

Induk ikan siakap putih akan bertelur berpandukan kitaran bulan atau kalendar lunar dan kebiasaannya pada awal dan akhir bulan. Jangka masa bertelur adalah pada waktu malam (pukul 8.00 hingga 11.00 malam) dan seiring dengan permulaan air pasang. Rega yang menetas akan dihanyutkan oleh arus air pasang ke kawasan muara sungai dan kawasan hutan bakau (air payau) untuk membesar. Anak-anak ikan ini akan menduduki habitat air payau sehingga mencapai saiz 20 cm panjang.

3.4 Jantina dan kematangan seksual

Lates calcarifer bersifat *protandrous hermaphrodites* iaitu berlakunya perubahan jantina (daripada jantan kepada betina) dalam tumbesaran ikan yang sama. Ikan siakap putih akan matang sebagai jantan dan bertukar kepada betina selepas mencapai berat tertentu. Semasa peringkat peralihan, biasanya jantina tidak dapat dikesan melalui morfologi fizikal kecuali semasa musim pembiakan. Pengecaman boleh dibuat dengan mengambil sampel gonad dan memeriksa kehadiran sperma atau oosit. Peralihan gonad daripada testis ke ovari juga boleh ditentukan melalui pemeriksaan histologi (Davis 1984). Secara biologi, ikan jantan akan menjadi matang lebih awal berbanding dengan ikan betina. Namun begitu, bukan semua ikan betina sama ada yang liar atau dalam kurungan terhasil akibat daripada proses pertukaran jantina, ada juga yang memang ikan betina sejak kecil. Ikan siakap putih sangat subur dimana induk yang hanya bersaiz 100 cm boleh menghasilkan 10 juta telur dan sehingga 30 - 40 juta telur bagi induk bersaiz 120 cm (Davis, 1984c). Umur dimana jantan berubah menjadi betina berbeza mengikut faktor persekitaran dan fisiologi seperti yang ditunjukkan dalam Jadual 4.

Jadual 4: Umur pertukaran jantina dalam ikan siakap putih yang pernah dilaporkan

Lokasi	Jenis	Umur pertukaran jantina	Rujukan
Australia	Liar	Matang dalam 3-5 tahun dan penukaran jantina 6-8 tahun kemudian	Davis (1984a); (1984b)
Teluk Carpentaria, Australia	Liar	Matang dalam 2 tahun dan penukaran jantina 4-5 tahun kemudian	Davis (1984a)
Asia dan Australia	Ternak	Matang dalam 2.5 tahun dan penukaran jantina berlaku dalam 3-4 tahun kemudian	Cheong & Yeng (1987)

3.5 Diet atau pemakanan

Ikan siakap putih bersifat karnivorus dan merupakan pemangsa opportunistik. Ikan siakap putih liar memakan krustasea mikro bersaiz sehingga 50 mm termasuk cengkerik, ikan, krustasea dan cacing yang ada di habitat tersebut. Anak ikan pula memakan zooplankton. Dalam operasi akuakultur, makanan hidup, rotifer akan diberikan pada anak-anak ikan dan kemudiannya digantikan dengan artemia semasa peringkat asuhan. Kemandirian boleh dipertingkatkan dengan pemberian rotifer dan artemia dengan kandungan asid lemak tak tepu yang tinggi (Rimmer & Reed, 1989). Disebabkan harga artemia yang mahal, diet boleh diganti dengan cladoceran seperti *Moina macropora* and *Diaphanosoma celebensis*. Sepanjang ikan membesar, diet dalam bentuk ikan baja menjadi pilihan. Namun pada masa kini, kebanyakkan operasi akuakultur menggunakan makanan rumusan. Memandangkan ikan siakap putih bersifat kanibal, maka stok ikan dalam kurungan perlu disaring setiap empat hari untuk mengelakkan kanibalisma (Parazo et al., 1991).

3.6 Nilai gizi zat makanan

Ikan siakap putih mempunyai nilai nutrisi yang baik dan sesuai untuk mereka yang menjaga hitungan kalori harian bagi tujuan untuk menurunkan berat badan. Ini adalah kerana, setiap 100 g hidangan siakap putih mengandungi kalori (kurang daripada 100 Kcal), lemak (kurang daripada 3 g) dan karbohidrat (kurang daripada 1.5 g) yang rendah serta protein yang tinggi (> 16.0 g) (Jadual 5). Ikan siakap putih juga mempunyai profil nutrisi yang impresif dengan kandungan vitamin (B dan A) dan mineral (potassium, fosforus, zink dan selenium) yang baik (USFDA, 2019). Kandungan potasium yang tinggi dalam siakap putih penting sebagai elektrolit yang berfungsi bersama-sama dengan natrium untuk mengimbangi cecair dalam tubuh manusia. Di samping itu, Ikan siakap putih juga mempunyai sumber asid lemak tak tepu omega-3 yang tinggi (Jadual 6) dan kandungan asid amino perlu seperti Leucine dan Lysine yang tinggi (Jadual 7). Asid lemak tak tepu omega-3 membantu kesihatan jantung, mengawal paras kolestrol HDL dan mengurangkan risiko kanser.

Jadual 5: Komposisi nutrien dalam ikan siakap putih di Malaysia (Tee et al., 1997) dan Amerika Syarikat (USFDA, 2022)

Nutrien	Nilai (100g)	USFDA
Proksimat (unit)		
Air (g)	78.1	72.1
Tenaga (Kcal)	83.0	124
Protein (g)	19.5	23.6
Lemak (g)	0.1	2.56
Karbohidrat (g)	1.0	
Serat (g)	0	0
Abu (g)	1.3	1.4
Mineral		
Calcium (mg)	28.0	13
Besi (mg)	0.4	0.37
Fosforus (mg)	220.0	248.0
Potassium (mg)	416.0	328.0
Sodium (mg)	76.0	87.0
Zink	Tiada rekod	0.52
Selenium (ug)	Tiada rekod	46.8
Vitamin		
Thiamin B1 (mg)	0.20	0.13
Riboflavin B2 (mg)	0.20	0.15
Niacin B3 (mg)	2.4	1.9
Retinol (µg)	14.0	64.0
Retinol Equivalents (µg)	21.0	
Vitamin A, IU	Tiada rekod	213 IU

Jadual 6: Kandungan asid lemak dan asid amino dalam ikan siakap putih (USFDA)

Jenis asid lemak	Jumlah (g)	Jumlah keseluruhan (g)
Asid lemak tepu SFA 14:0 SFA 16:0 SFA 18:0	 0.063 0.413 0.177	 0.655
Asid lemak mono tak tepu MUFA 16:1 MUFA 18:1	 0.167 0.377	 0.544
Asid lemak poli tak tepu PUFA 18:2 PUFA 18:4 PUFA 20:5 n-3 (EPA) PUFA 22:5 n-3 (DPA) PUFA 22:6 n-3 (DHA)	 0.031 0.059 0.206 0.097 0.556	 0.953
Kolesterol	53	

*Nota
SFA-Saturated Fatty Acid
MUFA-Mono Unsaturated Fatty Acid
PUFA-Poly Unsaturated Fatty Acid
EPA-Eicosapentaenoic Acid
DPA-Docosapentaenoic acid
DHA-Docosahexaenoic acid

Jadual 7: Kandungan asid amino dalam ikan siakap putih (USFDA)

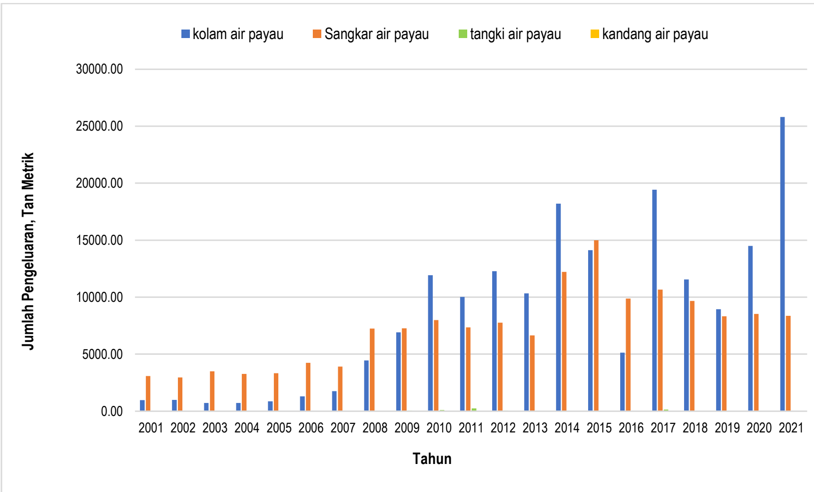
Jenis asid amino	Jumlah (g) dalam 100 g
Tryptophan	0.265
Threonine	1.04
Isoleucine	1.09
Leucine	1.92
Lysine	2.17
Methionine	0.699
Cystine	0.253
Phenylalanine	0.923
Tyrosine	0.798
Valine	1.22
Arginine	1.41
Histidine	0.696
Alanine	1.43
Aspartic acid	2.42
Glutamic acid	3.53
Glycine	1.13
Proline	0.836
Serine	0.964

3.7 Status konservasi

Menurut IUCN Red List of Threatened Species ver 3.1, 2018, sehingga 15 Februari 2019, status konservasi ikan siakap putih adalah dikelaskan sebaga Least Concern (LC). Ini bermaksud ikan siakap putih bukanlah satu spesies yang diberi tumpuan untuk pemuliharaan atau konservasi kerana spesies ini masih banyak terdapat di perairan umum. Spesies ini tidak tersenarai di dalam *Convention on International Trade in Endangered Species* (CITES) dan dianggap tidak membahayakan manusia.

Sistem Ternakan

Sistem yang utama digunakan bagi ternakan ikan siakap putih ialah sistem kolam dan sangkar. Rajah 4 menunjukkan kaedah pengeluaran atau sistem ternakan ikan siakap putih paling utama di Malaysia dari tahun 2001-2021. Data terperinci berkaitan jumlah pengeluaran mengikut sistem ternakan dilampirkan di Apendiks. Ternakan dalam sangkar merupakan sistem ternakan yang paling banyak diamalkan di Malaysia daripada permulaan industri ikan siakap putih sehinggalah tahun 2009. Selepas tahun 2009, sistem kolam menjadi pilihan utama penternak ikan siakap putih. Pada tahun 2008, pengeluaran ikan siakap putih daripada sistem tangki mula direkodkan dan yang terbaharu sistem kandang. Namun jumlah pengeluaran daripada sistem tangki dan kandang adalah jauh lebih rendah. Di samping penggunaan sistem ternakan yang cekap, kadar hidup ternakan juga boleh ditingkatkan dengan pemilihan kawasan yang sesuai, amalan pergurusan akuakultur yang baik serta penggunaan induk berkualiti.



Rajah 4: Pengeluaran ikan siakap putih mengikut sistem ternakan air payau/ air masin di Malaysia dari tahun 2001-2021

4.1 Sistem pengeluaran benih

Benih yang mencukupi dan berkualiti penting untuk kelestarian industri akuakultur. Antara sistem yang biasa digunakan bagi pengeluaran benih siakap putih ialah kolam tanah, kolam konkrit, kolam separa konkrit dan tangki. Saiz induk betina yang sesuai untuk pengeluaran telur adalah antara 4.0 - 8.0 kg dan saiz induk jantan adalah lebih kecil antara 2.5 - 4.0 kg. Induk betina dapat menghasilan telur setelah mencapai tahap kematangan iaitu bermula umur 3 tahun. Anggaran pengeluaran telur antara 300 – 500 ribu biji per kilogram induk. Telur yang baik akan terapung dipermukaan air dan bersifat lutsinar sebelum dipungut dengan mengunakan pukat atau kaedah limpahan air pada tangki takungan telur.

Ternakan dalam sangkar kayu

Ternakan dalam sangkar HDPE

Ternakan dalam kolam

Ternakan dalam tangki RAS

Foto 6 : Sistem ternakan ikan siakap putih utama di Malaysia

Aktiviti penuaian benih siakap putih dalam kolam separa konkrit

Pengkelasan benih siakap putih

Pemindahan benih daripada kolam ke tangki asuhan

Benih siakap putih bersaiz 2.5 sm

Foto 7: Contoh sistem dan aktiviti penghasilan benih ikan siakap putih

Penyakit

Kematian dan morbiditi yang berkaitan dengan penyakit berjangkit telah dilaporkan sebagai punca utama kerugian ekonomi bagi industri penternakan siakap putih Asia di seluruh dunia. Menurut sorotan literatur, ikan siakap putih mudah terdedah kepada pelbagai patogen termasuk bakteria, virus dan parasit. Rajah 5 meringkaskan penyakit dan agen yang biasa dilaporkan menyerang ternakan ikan siakap putih. Antara penyakit utama yang sering dan pernah dilaporkan di Malaysia adalah Viral Nervous Necrosis (VNN) (Rangsangan & Marin, 2010), Scale Drop Disease (SSD) Nurliyana et al. 2020; Idris et al. 2013), Vibriosis (Al-Adlan & Nor 2017, Mohd Yazid et al. 2021). VNN adalah antara penyakit utama di hatceri di Malaysia. SSD yang menjangkiti ikan siakap putih dewasa dan anak ikan pertama kali dilaporkan di Pulau Pinang dalam tahun 1992.

Penyakit virus (Agen)

- Viral Nervous Necrosis (VNN) atau Viral encephalopathy and retinopathy (VER) disease.
- Lymphocystis (Lymphocystis virus)
- Scale Drop Disease SDD (Scale drop disease virus (SDDV). Tanda klinikal: Sisik hilang dan kadang-kadang “red belly”
- Lates calcarifer Birnavirus (LCBV)
- SDD like symptoms (Lates calcarifer herpesvirus (LCHV)
- Turbot reddish body iridovirus (TRBIV)
- Red sea bream iridovirus (RSIV)
- Infectious spleen and kidney necrosis disease- ISKND (Infectious spleen and kidney necrosis virus (ISKNV) or called Megalocytivirus ISKNV)

Penyakit bakteria (Agen)

- Vibriosis (*Vibrio harveyi; Vibrio* spp.).
- Columnaris (*Flavobacterium columnare; F. johnsoniae*; & *Flavobacterium* sp. dalam air tawar dan *Tenacibaculum marinimum* dalam air laut).
- Bacterial peritonitis (bakteria gram-negatif & Gram-positif termasuk *V. harveyi* & *Aeromonas hydrophila*)
- Bacterial enteritis (pelbagai bakteria Gram-negatif)
- Streptococcosis (*Streptococcus iniae*)
- Penyakit reput sirip dan ekor (*Aeromonas* sp.; *Pseudomonas* sp.; *Vibrio* sp.; *Flavobacterium* sp.; *Cytophaga* spp

Penyakit parasit (Agen)

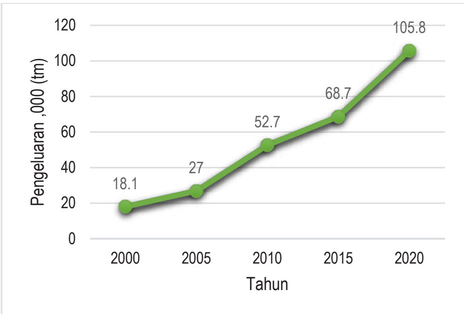
- Bintik Putih (*Cryptocaryon irritans* (air laut), *Ichthyophthirius multifiliis* (air tawar)
- Chilodonelliasis (*Chilodonella* spp.; *Chilodonella hexasticha*)
- Trichodiniasis (*Trichodina complex* spp.)
- Ichthyobodosis (costiasis) (*Ichthyobodo necator*)
- Amyloodiniasis (*Amyloodinium ocellatum*)
- Gill fluke (*Diplectanum* sp.; *Dactylogyrus* sp.)
- Skin fluke (*Neobenedinia melleni*; *Gyrodactylus* spp.)
- Lintah marin (*Zeylanicobdella arugamensis*)
- Infestasi oleh *Caligus* sp.

Rajah 5: Jenis-jenis penyakit dan agen yang biasa dilaporkan menyerang ternakan ikan siakap putih

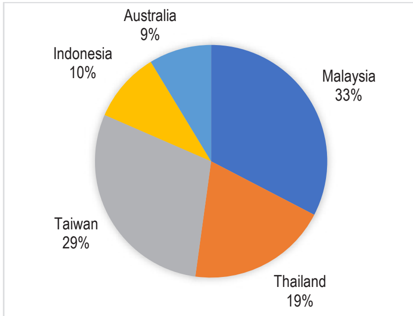
Pola pengeluaran

6.1 Peringkat global

Statistik perikanan dunia daripada FAO 2020, menunjukan pengeluaran ikan siakap putih dunia adalah meningkat secara positif (FAO, 2020). Pada tahun 2000, pengeluaran ikan siakap putih dunia adalah hanya sebanyak 18,100 TM dan meningkat secara konsisten kepada 105,800 TM pada tahun 2020 (Rajah 6) dengan Taiwan, Thailand, Indonesia, Australia dan Malaysia sebagai negara pengeluar utama (Rajah 7).



Rajah 6: Jumlah pengeluaran ikan siakap putih dunia daripada sektor akuakultur dari tahun 2000-2020

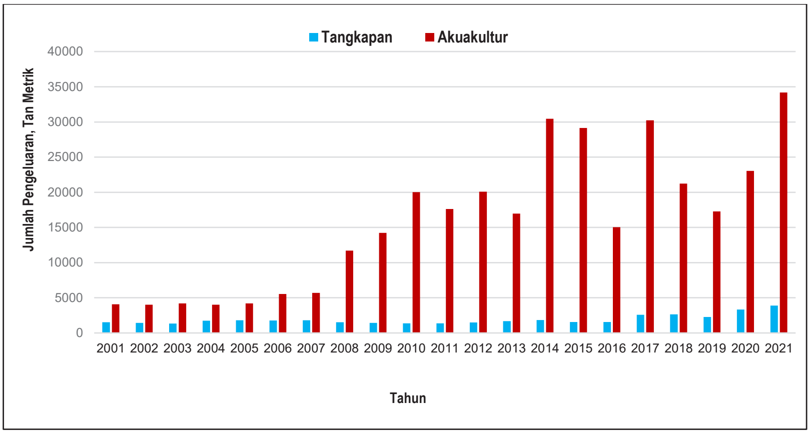


Rajah 7: Pengeluaran ikan siakap putih negara-negara utama dunia tahun 2017

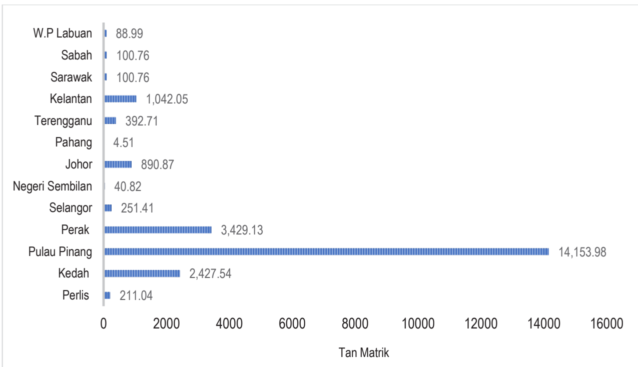
6.2 Malaysia

Di Malaysia, sumber utama ikan siakap putih adalah daripada aktiviti akuakultur dan sedikit daripada perikanan tangkapan. Menurut Perangkaan Perikanan tahun 2020, pengeluaran daripada perikanan tangkapan adalah sekitar 3,322 TM berbanding dengan akuakultur (23,033 TM) dengan nilai RM 327.4 juta.

Rajah 8 menunjukkan data pendaratan ikan siakap putih di Malaysia daripada perikanan tangkapan dan akuakultur dari tahun 2000-2018. Jumlah pengeluaran ikan siakap putih daripada aktiviti perikanan tangkapan dan akuakultur pada tahun 2018 adalah 23,879.89 TM dengan nilai hampir RM 357 juta. Pada tahun 2000, data menunjukkan jumlah pengeluaran ikan siakap putih daripada aktiviti tangkapan (1,701 TM) dan akuakultur (2,393 TM) adalah hampir sama. Dalam tempoh 18 tahun, dapat dilihat pola pengeluaran yang mendatar daripada sektor perikanan tangkapan. Bagi akuakultur pula, pengeluaran dilihat meningkat perlahan-lahan dari tahun 2000 ke 2007, terus meningkat dengan lebih ketara dari 2007-2014. Pengeluaran kekal stabil dari 2014-2017 dan turun dengan agak mendadak pada tahun 2018. Pengeluaran ikan siakap putih tertinggi adalah pada tahun tahun 2021 iaitu sebanyak 34,186 TM manakala pengeluaran terendah adalah pada tahun 2000 iaitu sebanyak 2,393 TM. Perbezaan ini adalah disebabkan oleh pertambahan dalam bilangan kolam dan sangkar yang beroperasi iaitu daripada sekitar 8,554 pada tahun 2000 kepada 132,924 pada tahun 2014. Negeri pengeluar utama ikan siakap putih adalah Pulau Pinang (14,154 TM) diikuti dengan Perak (3,429 TM), Kedah (2,427 TM) dan Kelantan (1,042 TM) (Rajah 9).



Rajah 8: Pengeluaran ikan siakap putih daripada aktiviti perikanan tangkapan dan akuakultur di Malaysia dari tahun 2001-2021



Rajah 9: Pengeluaran ikan siakap putih mengikut negeri di Malaysia pada tahun 2020

6.3 Pengeluaran benih

Benih yang mencukupi dan berkualiti penting untuk kelastarian projek akuakultur. Dianggarkan bagi penghasilan 1.0 tan metrik ikan siakap putih putih memerlukan 2,500 - 3,000 ekor benih yang bersaiz 7.5 - 10.0 cm. Pada tahun 2020, negeri Terengganu merupakan pengeluar benih siakap putih terbesar di Malaysia iaitu sebanyak 11,220,000 ekor diikuti dengan Pulau Pinang dan Kelantan.

Penyelidikan & pembangunan ikan siakap putih di Malaysia

Jadual 8 -12 menyenaraikan sebilangan besar kertas-kertas penyelidikan berkaitan ikan siakap putih yang telah diterbitkan dalam skop - skop yang tertentu. Senarai tesis berkaitan ikan siakap putih oleh penyelidik - penyelidik dari Malaysia pula disenaraikan dalam Jadual 13. Daripada maklumat yang disenaraikan, dapat disimpulkan bahawa kajian mengenai penyakit khususnya, genetik dan akuakultur siakap putih telah banyak dijalankan di Malaysia.

Jadual 8: Penyelidikan dan pembangunan dalam pembiakan, pembenihan dan ternakan ikan siakap putih

Bil	Tajuk	Rujukan
1.	Effect of stocking density on growth and survival of seabass (*Lates calcarifer*) in ponds.	Khamis & Hanafi (1986)
2.	Seabass (*Lates calcarifer*) larvae and fry production in Malaysia.	Ali (1987a)
3.	Status of seabass (*Lates calcarifer*) culture in Malaysia.	Ali (1987b)
4.	Seabass (*Lates calcarifer*) spawning in tanks in Malaysia.	Hussin (1987a)
5.	Seabass (*Lates calcarifer*) cage culture research in Malaysia.	Hussin (1987b)
6.	Aquaculture of coral reef fishes in Peninsular Malaysia.	Hussin & Ali (1996)
7.	Effects of hatchery rearing on Asian seabass, *Lates calcarifer*, in Sabah, Malaysia.	Mustafa et al. (2007)
7.	Benefits and problems in caged rearing of *Lates calcarifer*, *Oreochromis niloticus* and *Pangasius sutchi*: The case of entrepreneurs in Pekan, Pahang.	Idris et al. (2012)
9.	Identifying problems among seabass brackish-water cage entrepreneurs in Malaysia.	Idris et al. (2013)
10.	Experiment on the stocking density in rearing seabass (*Lates calcarifer*) from 0 day to 15 days old at PPIUL Tg. Demong, Besut, Terengganu.	Munir (2013)
11.	Effects of different light intensities on fry growth, survival and cannibalism control of Asian seabass (*Lates calcarifer*).	Masli et al. (2014)
12.	Performances of first generation (F_1) Asian seabass (*Lates calcarifer*) by selective breeding.	Nik-Sin (2015)
13.	A stochastic frontier analysis of technical efficiency of fish cage culture in Peninsular Malaysia.	Islam et al. (2016)
14.	Productive efficiency and capacity utilization of seabass grow-out culture in peninsular Malaysia.	Aripin et al. (2020)
15.	Costs of management practices of Asian seabass (*Lates calcarifer* Bloch, 1790) cage culture in Malaysia using stochastic model that includes uncertainty in mortality.	Norhariani et al. (2019)
16.	Towards systematic breeding of Asian seabass, *Lates calcarifer* (Bloch, 1790), in Malaysia: Status, challenges and prospects for future development.	Shaharah et al. (2022)

Jadual 9: Penyelidikan dan pembangunan dalam makanan ikan siakap putih

Bil	Tajuk	Rujukan
1.	The inclusion of palm kernel meal as a feed ingredient in the diet of juvenile seabass (*Lates calcarifer*) and its effect on the growth performance.	Suhaimee et al. (2005)
2.	Investigation of highly unsaturated fatty acid metabolism in the Asian seabass, *Lates calcarifer.*	Mohd-Yusof et al. (2010)
3.	The effect of partial replacement of dietary fishmeal with fermented prawn waste liquor on juvenile seabass growth.	Nor et al. (2011)
4.	Palm oil based-diet enhances growth performance of Asian seabass (*Lates calcarifer*, Centropomidae) juveniles.	Shapawi et al. (2011)
5.	Dietary fish oil replacement with palm or poultry oil increases fillet oxidative stability and decreases liver glutathione peroxidase activity in barramundi (*Lates calcarifer*).	Wan Ahmad et al. (2013)
6.	Improving dietary red seaweed *Kappaphycus alvarezii* (Doty) Doty ex. P. Silva meal utilization in Asian seabass *Lates calcarifer.*	Shapawi et al. (2015)
7.	Response of Asian seabass, *Lates calcarifer* juvenile fed with different seaweed-based diets.	Shapawi & Zamry (2016)
8.	Efficacy of insect larval meal to replace fish meal in juvenile barramundi, *Lates calcarifer* reared in freshwater.	Katya et al. (2017)
9.	Effects of dietary inclusion of Spirulina meal on growth and hematological parameters of cultured Asian seabass, *Lates calcarifer.*	Tan et al. (2017)

10.	Copepod supplementation as a live food improved growth and survival of Asian seabass *Lates calcarifer* larvae.	Rasdi & Qin (2018)
11.	Dietary administration of astaxanthin improves feed utilization, growth performance and survival of Asian seabass, *Lates calcarifer* (Bloch, 1790).	Lim et al. (2019)
12.	Hunger classification of *Lates calcarifer* by means of an automated feeder and image processing.	Razman et al. (2019)
13.	Enhanced growth performance, haemato-biochemical and immune parameters of Asian seabass, *Lates calcarifer* (Bloch,1790) fed dietary supplementation with *Polygonum chinense.*	Razak et al. (2019)
14.	Bioprocessed poultry by-product meals on growth, gut health and fatty acid synthesis of juvenile barramundi, *Lates calcarifer* (Bloch).	Siddik et al. (2019)
15.	Evaluation of Enterobacter sp. Strain G87 as potential probiont against *Vibrio harveyi* infection in artemia nauplii and Asian sea bass *(Lates calcarifer)* larvae.	Zakaria et al. (2019)
16.	Brown seaweed *Sargassum polycystum* as dietary supplement exhibits prebiotic potentials in Asian seabass *Lates calcarifer* fingerlings.	Nazarudin et al. (2020)
17.	Data on growth performance, glucose concentration and testosterone level of Asian seabass, *Lates calcarifer* juveniles fed with exogenous melatonin at different concentration.	Rani et al. (2022)
18.	Effects of fermented lemon peel supplementation in diet on growth, immune responses and intestinal morphology of Asian seabass, *Lates calcarifer.*	Zhuo et al. (2021)
19.	Palm oil-based enriched diets for the rotifer, *Brachionus plicatilis*, improved the growth of Asian seabass (*Lates calcarifer*) larvae.	Safiin et al. (2021)
20.	Successful co-feeding of Asian seabass, *Lates calcarifer* larvae with palm oil-based microdiets and live feeds.	Safiin et al. (2022)

Jadual 10: Penyelidikan dan pembangunan dalam genetik ikan siakap putih

Bil	Tajuk	Rujukan
1.	Isolation and characterization of microsatellite DNA loci In seabass, *Lates calcarifer* Bloch.	Sim & Othman (2005)
2.	Assessment of genetic variability to determine the quality of organic cultured Asian seabass, *Lates calcarifer* using RAPD marker: a case study.	Kamarudin et al. (2008)
3.	Genetic variation of *Lates calcarifer* in Peninsular Malaysia based on the cytochrome b gene.	Norfatimah et al. (2009)
4.	Genetic variation and population structure of Asian seabass (*Lates calcarifer*) in the Asia-Pacific region.	Yue et al. (2009)
5.	Molecular cloning and phylogenetic characterization of a putative Asian seabass (*Lates calcarifer)* serum amyloid A.	Mohd-Adnan et al. (2010)
6.	Characterization of the functional domain of β2-microglobulin from the Asian Seabass, *Lates calcarifer.*	Mohd-Padil et al. (2010)
7.	A standard panel of microsatellites for Asian seabass (*Lates calcarifer*).	Zhu et al. (2010)
8.	Phylogenetic characterization and the expression of recombinant C-reactive protein from the Asian seabass (*Lates calcarifer*).	Mohamed-Jawad et al. (2012)
9.	Molecular characterization of hepcidin in the Asian seabass (*Lates calcarifer*) provides insights into its role in innate immune response.	Lee et al. (2012)
10.	Evidence for female-biased dispersal in the protandrous hermaphroditic Asian seabass, *Lates calcarifer.*	Yue et al. (2012)
11.	Isolation and characterization of novel microsatellite loci for Asian seabass, *Lates calcarifer* from genome sequence survey database.	Abdul Rahman et al. (2014)
12.	Molecular characterisation and expression analysis of cathepsin D from the Asian seabass *Lates calcarifer.*	Azizan et al. (2014)
13.	Gene expression profiling in organic cultured seabass (*Lates calcarifer*) during purging process.	Abdul Wahid et al. (2015)
14.	Analysis of genetic diversity in five captive population of Asian seabass (*Lates calcarifer*) for selective breeding in Malaysia.	Bakri & Esa (2021)
15.	Genetic variation in the Asian seabass (*Lates calcarifer* Bloch, 1790) from Wallacea region estimated using random amplified polymorphic DNA (RAPD) markers.	Malina et al. (2021)

Jadual 11: Penyelidikan dan pembangunan dalam penyakit ikan siakap putih

Bil	Tajuk	Rujukan
1.	Parasite fauna of seabass, *Lates calcarifer* Bloch, from Thailand and from floating cage culture in Penang, Malaysia.	Leong & Wong, (1986)
2.	Bacteriosis associated with epizootic in the giant sea perch, *Lates calcarifer*, and the estuarine grouper, *Epinephelus tauvina*, cage cultured in Malaysia.	Nash et al. (1987)
3.	Parasites of healthy and diseased juvenile grouper (*Epinephelus malabaricus* Bloch & Schneider) and seabass (*Lates calcarifer* Bloch) in floating cages in Penang, Malaysia.	Leong & Wong (1990)
4.	A comparative study of *Vibrio* infections in healthy and diseased marine finfishes cultured in floating cages near Penang, Malaysia.	Wong & Leong 1990)
5.	A redescription of *Pseudorhabdosynochus latesi* (Tripathi 1955) and description of *Diplectanum penangi* n. sp. from *Lates calcarifer* cultured in floating cages in Malaysia and Thailand.	Liang & Leong (1991)
6.	Multiple bacteriosis, with special reference to spoilage bacterium *Shewanella putrefaciens*, in cage-cultured barramundi perch in Malaysia.	Subasinghe & Shariff (1992)
7.	Description of a new blood-fluke, *Cruoricola lates* n. g., n. sp. (Digenea: Sanguinicolidae), from sea-bass *Lates calcarifer (*Bloch, 1790) (Centropomidae).	Herbert et al. (1994)
8.	*Pseudorhabdosynochus monosquamodiscusi* n. sp. (Monogenea: Diplectanidae) from *Lates calcarifer* cultured in floating cages in Malaysia.	Balasuriya & Leong (1995)
9.	Life cycle of *Pseudorhabdosynochus monosquamodiscusi* (Monogenea: Diplectanidae) on cage-cultured barramundi perch, *Lates calcarifer.*	Balasuriya & Leong (1995)
10.	Histopathology of cultured seabass (*Lates calcarifer*) (Centropomidae) Infected with Cruoricola lates (Treamatoda: Sanguinicolidae) from Pulau Ketam, Malaysia.	Herbert et al. (1995)
11.	Blood parasites of Malaysian fish.	Shaharom (1999)
12.	Digenetic trematodes found in marine fish of Port Dickson, Malaysia.	Kolandasamy & Shaharom (1999)
13.	Pathogenic *Vibrio* isolates from cultured seabass (*Lates calcarifer*), groupers (*Epinephelus* spp.) and red snappers (*Lutjanus* spp.).	Palanisamy et al. (2002)
14.	Preliminary study on genetic distance of *Vibrio parahaemolyticus* isolates from diseased fish and shrimp brackishwaterpPonds by Random Amplified Polymorphic DNA (RAPD) in Malaysia.	Najiah et al. (2003)
15.	The internal transcribed spacer (ribosomal DNA) of fish protozoan, *Cryptocaryon irritans*, isolated from cultured seabass, *Lates calcarifer*, in Penang waters.	Kua (2008)
16.	Study on morphology and infection of *Lernanthropus latis* (Yamaguti, 1963) and their biological control in *Lates calcarifer* culture.	Sabri & Shaharom (2008)
17.	Antibiogram and heavy metal resistance pattern of Aeromonas spp. isolated from Asian seabass (*Lates calcarifer*) hatchery.	Seong et al. (2009)
18.	Fabrication *of Lates calcarifer* cDNA microarray slide.	Kiat et al. (2009)
19.	Records of Caligus (Crustacea: Copepoda: Caligidae) from marine fish cultured in floating cages in Malaysia with a redescription of the male of *Caligus longipedis* Bassett-Smith, 1898.	Maran et al. (2009)
20.	Identification of immune-related genes by analysis of spleen expressed sequence tags from the Asian seabass, *Lates calcarifer.*	Mohd-Yusof et al. (2009)
21.	Molecular and antigenicity characterisation of *Vibrio* sp. isolates from Asian seabass (*Lates calcarifer*).	Abiddin & Yusoff (2010)
22.	Life cycle of the marine leech (*Zeylanicobdella arugamensis*) isolated from sea bass (*Lates calcarifer*) under laboratory conditions.	Kua et al. (2010)
23.	Mass mortality of hatchery-produced larvae of Asian seabass, *Lates calcarifer* (Bloch), associated with viral nervous necrosis in Sabah, Malaysia.	Ransangan & Manin, (2010)
24.	Development and validation of Enzyme-Linked Immunosorbent Assay (ELISA) vitellogenin in *Lates calcarifer.*	Fazielawanie et al (2011)
25.	Development and partial characterization of new marine cell line from brain of Asian sea bass *Lates calcarifer* for virus isolation.	Hasoon et al. (2011)
26.	Infestation of gill copepod *Lernanthropus latis* (Copepoda: Lernanthropidae) and its effect on cage-cultured Asian seabass *Lates calcarifer.*	Kua et al. (2011)
27.	Experimental evidence of horizontal transmission of Betanodavirus in hatchery-produced Asian seabass, *Lates calcarifer* and brown-marbled grouper, *Epinephelus fuscoguttatus* fingerling.	Manin & Rangsangan (2011)

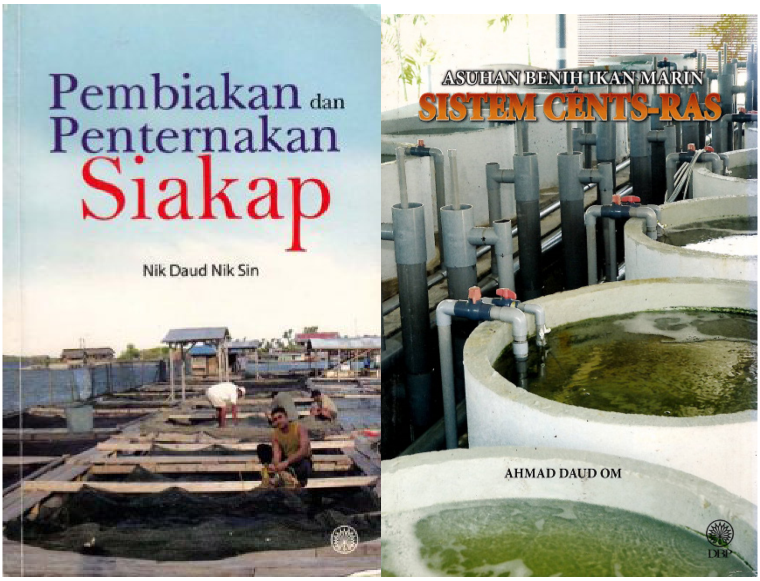
28.	Identification of *Vibrio harveyi* isolated from diseased Asian seabass *Lates calcarifer* by use of 16S Ribosomal DNA sequencing.	Ransangan & Mustafa, (2009)
29.	*Cryptocaryon irritans* infection induces the acute phase response in *Lates calcarifer*: A transcriptomic perspective.	Khoo et al. (2012)
30.	Infestation of gill copepod *Lernanthropus latis* (Copepoda: Lernanthropidae) and its effect on cage-cultured Asian sea bass *Lates calcarifer.*	Kua et al (2012)
31.	Caligidae infestation in Asian seabass, *Lates calcarifer*, Bloch 1790 cultured at different salinity in Malaysia.	Muhd Faizul et al. (2012)
32.	Characterization of *Edwardsiella tarda* isolated from Asian seabass, *Lates calcarifer*.	Nadirah et al. (2012)
33.	Characterization and experimental infection of *Vibrio harveyi* isolated from diseased Asian seabass (*Lates calcarifer*).	Ransangan et al. (2012)
34.	Dietary effects of garlic (*Allium sativum*) on haemato-immunological parameters, survival, growth, and disease resistance against *Vibrio harveyi* infection in Asian seabass, *Lates calcarifer* (Bloch).	Talpur & Ikhwanuddin, (2012)
35.	Expression profile of immune-related genes in *Lates calcarifer* infected by *Cryptocaryon irritans.*	Mohd Shaharuddin et al. (2013)
36.	*Azadirachta indica* (neem) leaf dietary effects on the immunity response and disease resistance of Asian seabass, *Lates calcarifer* challenged with *Vibrio harveyi.*	Talpur & Ikhwanuddin, (2013)
37.	Nutritional effects of ginger (*Zingiber officinale* Roscoe) on immune response of Asian sea bass, Lates calcarifer (Bloch) and disease resistance against *Vibrio harveyi*	Talpur et al. (2013)
38.	Isolation and partial characterization of Asian sea bass (Lates calcarifer) vitellogenin.	Fazielawanie et al. (2013)
39.	Description of *Goussia kuehae* n. sp. (Apicomplexa: Eimeriidae) infecting the Asian seabass, *Lates calcarifer* (Bloch) (Perciformes: Latidae), cultured in Malaysian fish farms.	Székaly et al. (2013)
40.	The life cycle of the parasitic crustacean, *Lernanthropus latis* Yamaguti, 1954 (Copepoda: Lernanthropidae), on marine-cultured fish, *Lates calcarifer*, from Setiu Wetland, Terengganu.	Abdul Khalid & Shaharom (2014)
41.	*Mentha piperita* (Peppermint) as feed additive enhanced growth performance, survival, immune response and disease resistance of Asian seabass, *Lates calcarifer* (Bloch) against *Vibrio harveyi* infection.	Talpur (2014)
42.	Pathogenicity of *Aeromonas hydrophila* isolated from the Malaysian sea against coral (*Turbinaria* sp.) and seabass (*Lates calcarifer*).	Hamid et al. (2016)
43.	Estimating the cost of Vibrisosis in the Asian seabass (*Lates calcarifer*) cage culture in Malaysia.	Al-Adlan & Nor (2017)
44.	*In vitro* antimicrobial activity of betel, *Piper betle* leaf extract against *Vibrio alginolyticus* isolated from Asian seabass, *Lates calcarifer.*	Othman et al. (2018)
45.	First report of *Achlya oblongata* Infection in freshwater-reared Asian seabass *Lates calcarifer.*	Lau et al. (2018)
46.	A case of gill copepod (*Lernanthropus latis*) infestation in an Asian seabass (*Lates calcarifer*) net-caged culture in Kelantan.	Ng & Ong (2018)
47.	Use of neem oil (*Azadirachta indica*) to control caligid copepod infestation on Asian seabass (*Lates calcarifer*).	Khoa et al. (2019a)
48.	The life cycle of *Caligus minimus* on seabass (*Lates calcarifer*) from floating cage culture.	Khoa et al. (2019b)
49.	Effect of alkalinity on fecundity of *Caligus minimus* parasitizing on seabass (*Lates calcarifer*) in laboratory condition.	Nguyen et al. (2019)
50	Efficacy of bath vaccination with a live attenuated *Vibrio harveyi* against vibriosis in Asian seabass fingerling, *Lates calcarifer*.	Chin et al. (2020a)
51.	Effects of skin abrasion in immersion challenge with *Vibrio harveyi* in Asian seabass *Lates calcarifer* fingerlings.	Chin et al. (2020b)
52.	Evaluation of different functional antioxidant groups and protein responses in Asian seabass (*Lates calcarifer* Bloch, 1970) as an early indication of fish health in aquaculture farms.	Hassan et al. (2020)
53.	First evidence of scale drop disease virus in farmed Asian seabass (*Lates calcarifer*) in Malaysia.	Nurliyana et al. (2020)
54.	Characterization of *Enterococcus hirae* isolated from the intestine of seabass (*Lates calcarifer*) as a new potential probiotic against pathogenic Vibrios.	Masduki et al. (2020)
55.	Henneguya (Cnidaria: Myxosporea: Myxobolidae) infections of cultured barramundi, *Lates calcarifer* (Perciformes: Latidae) in an estuarine wetlands system of Malaysia: description of *Henneguya setiuensis* n. sp., *Henneguya voronini* n. sp. and *Henneguya calcarifer* n. sp..	Borkhanuddin et al. (2020)

56.	Elucidating the efficacy of vaccination against Vibriosis in *Lates calcarifer* using two recombinant protein vaccines containing the outer membrane protein K (r-OmpK) of *Vibrio alginolyticus* and the DNA chaperone J (r-DnaJ) of *Vibrio harveyi.*	Silvaraj et al. (2020)
57.	Vaccine efficacy of a newly developed feed-based whole-cell polyvalent vaccine against Vibriosis, Streptococcosis and Motile Aeromonad Septicemia in Asian seabass, *Lates calcarifer.*	Mohamad et al. (2021)
58.	Detection and resistance profile of *Vibrio alginolyticus* isolated from farmed Asian seabass (*Lates calcarifer*) in Terengganu, Malaysia.	Zin et al. (2021)
59.	Dietary astaxanthin augments disease resistance of Asian seabass, *Lates calcarifer* (Bloch, 1790), against *Vibrio alginolyticus* infection.	Lim et al. (2021)
60.	Transcriptome analysis of immune response in recombinant cell vaccine expressing OmpK vaccinated juvenile seabass (*Lates calcarifer*) head kidney against *Vibrio harveyi* infection.	Silvaraj et al. (2021)
61.	Diversity, relative abundance and functional genes of intestinal microbiota of tiger grouper (*Epinephelus fuscoguttatus*) and Asian seabass (*Lates calcarifer*) reared in a semi-closed hatchery in dry and wet seasons.	Sutra et al. (2021)

Jadual 12: Skop Penyelidikan dan pembangunan lain berkaitan ikan siakap putih

Bil	Tajuk	Rujukan
1.	Effects of salinity and pre-exposure on acute cadmium toxicity to seabass, *Lates calcarifer.*	Shazili (1995)
2.	The influence of fish cage aquaculture on pelagic carbon flow and water chemistry in tidally dominated mangrove estuaries of peninsular Malaysia.	Alongi et al. (2003)
3.	Modified atmosphere storage of barramundi (*Lates calcarifer*) fillets.	Siah & Ariff (2002)
4.	Effect of potassium sorbate dips on refrigerated storage of modified atmosphere packed barramundi (*Lates calcarifer*) fillets.	Siah & Ariff (2003)
5.	Structure and development of free neuromasts in barramundi, *Lates calcarifer* (Bloch).	Mukai et al. (2007)
6.	Identification and analysis of a prepro-chicken gonadotropin releasing hormone II (preprocGnRH-II) precursor in the Asian seabass, *Lates calcarifer*, based on an EST-based assessment of its brain transcriptome.	Tan et al. (2008)
7.	Feasibility study of a recirculation aquaculture system.	Bijo (2007)
8.	Biogenic amine changes in barramundi *(Lates calcarifer)* slices stored at 0 °C and 4 °C.	Bakar et al. (2010)
9.	Methylmercury in marine fish from Malaysian waters and its relationship to total mercury content.	Hajeb et al. (2010)
10.	Characterization of the functional domain of β2-microglobulin from the Asian seabass, *Lates calcarifer.*	Mohd-Padil et al. (2010)
11.	Bacterial flora from a healthy freshwater Asian seabass (*Lates calcarifer*) fingerling hatchery with emphasis on their antimicrobial and heavy metal resistance pattern.	Lee et al. (2010)
12.	Tissue culture isolation, electro microscopic caharacterization and PCR detection of a Betanodavirus isolated from diseased Asian seabass *Lates calcarifer.*	Mauida et al. (2010)
13.	Investigation of highly unsaturated fatty acid metabolism in the Asian seabass, *Lates calcarifer.*	Mohd Yusof et al. (2010)
14.	Assessment of cadmium (Cd) and lead (Pb) levels in commercial marine fish organs between wet markets and supermarkets in Klang Valley, Malaysia.	Nor Hasyimah et al. (2011)
15.	Antibiogram and heavy metal resistance pattern of *Salmonella* spp. isolated from wild Asian seabass (*Lates calcarifer*) from Tok Bali, Kelantan, Malaysia.	Wei & Wee (2011)
16.	Ontogenetic eye development and related behavioural changes in larvae and juveniles of barramundi *Lates calcarifer* (Bloch).	Yahaya et al. (2011)
17.	Assessment of concentrations of toxic elements in aquaculture food products in Malaysia.	Mok et al. (2012)
18.	Elements content in otolith as pollution indicator for cultured seabass (*Lates calcarifer*) of Malaysia.	Sarimin & Mohamed, (2012)
19.	Laboratory experiment on bioaccumulation of {sup 109}Cd and {sup 134}Cs in white seabass.	Mohamed et al. (2012)
20.	Batch phytoremediation of aquaculture wastewater of Silver Barramundi (*Lates calcarifer*) utilizing green microalgae; *Chlorella* sp..	Ahmad et al. (2013)
21.	Properties of collagen from barramundi (*Lates calcarifer*) skin.	Jamilah et al. (2013)
22.	Benefits and problems in caged rearing of *Lates calcarifer*, *Oreochromis niloticus* and *Pangasius sutchi*: The case of entrepreneurs in Pekan, Pahang.	Idris et al. (2013)
23.	Different element/Ca ratios in the Otolith of culture seabass in Malaysia and relationship to salinity.	Sarimin & Mohamed, (2013)

24.	Characterization of exopolysaccharides produced by *Bacillus cereus* and *Brachybacterium* sp. isolated from Asian seabass (*Lates calcarifer*).	Orsod et al. (2012)
25.	Assessment activity of 210Po and 210Pb in the edible tissues of cultured seabass (*Lates calcarifer*) at Peninsular Malaysia.	Zakaria et al. (2013a)
26.	Natural radioisotopes of polonium and lead in the edible muscle of cultured seabass (*Lates calcarifer*).	Zakaria et al. (2013b)
27.	Sr/Ca, Mg/Ca and Ba/Ca ratios in the otolith of seabass in Peninsular Malaysia as salinity influence marker.	Sarimin & Mohamed, (2014)
28.	Effect of three different cooking methods on proximate and mineral composition of Asian seabass (*Lates calcarifer*, Bloch).	Marimuthu et al. (2014)
29.	Cholinesterase-based biosensor using *Lates calcarifer* (Asian Seabass) brain for detection of heavy metals.	Hayat et al. (2015)
30.	Toxicological studies of Irgarol-1051 and its effects on fatty acid composition of Asian seabass, *Lates calcarifer.*	Ali et al. (2015)
31.	The use of *Lates calcarifer* as a biomarker for heavy metals detection.	Hayat et al. (2016)
32.	Isolation and characterization of microplastics abundance in *Lates calcarifer* from Setiu Wetlands, Malaysia.	Ibrahim et al. (2017)
33.	Characterisation of cholinesterase from kidney tissue of Asian seabass (*Lates calcarifer*) and its inhibition in presence of metal ions.	Hayat et al. (2017)
34.	Comparative study on spoilage and pathogenic bacteria in selected commercial marine and freshwater fishes.	Jalal et al. (2017)
35.	Ichthyofauna of Sungai Merbok Mangrove Forest Reserve, northwest Peninsular Malaysia, and its adjacent marine waters.	Abidin et al. (2021)
36.	The impacts of monsoon and dry seasons on physical water quality changes and farmed Asian seabass *Lates calcarifer* (Bloch, 1790) mortality at Sri Tujuh lagoon, Tumpat, Kelantan, Malaysia.	Abdullah et al. (2018)
37.	Antibiogram and heavy metal resistance pattern of *Flavobacterium* spp. Isolated From Asian seabass (*Lates calcarifer*) hatchery.	Lee & Wee (2018)
38.	Bisphenol A and alkylphenols concentrations in selected mariculture fish species from Pulau Kukup, Johor, Malaysia.	Ismail et al. (2018)
39.	Bioaccumulation of heavy metals in maricultured fish, *Lates calcarifer* (Barramudi), *Lutjanus campechanus* (red snapper) and *Lutjanus griseus* (grey snapper).	Sobihah et al. (2018)
40.	Fish scales as a bioindicator of potential marine pollutants and carcinogens in Asian seabass and red tilapia within the coastal waters of Pahang, Malaysia.	Rahman et al. (2018)
41.	The Identification of hunger behaviour of *Lates calcarifer* through the Integration of image processing technique and support vector machine.	Taha et al. (2018a)
42.	The classification of hunger behaviour of *Lates calcarifer* through the integration of image processing technique and k-Nearest Neighbour learning algorithm.	Taha et al. (2018b)
43.	Hunger classification of *Lates calcarifer* by means of an automated feeder and image processing.	Razman et al. (2019)
44.	Level of zinc and lead in freshwater fishes in Balok River, Pahang, Malaysia.	Rohalin et al. (2019)
45.	Accumulation of heavy metals in farmed *Lates calcarifer* of a Tropical Coastal Lagoon.	Tengku Nur Alia et al. (2019)
46.	Comparative study of raw and cooked farmed seabass (*Lates calcarifer*) in relation to metal content and its estimated human health risk.	Alia et al. (2020)
47.	Estimating the economic loss due to Vibriosis in net-cage cultured Asian seabass (*Lates calcarifer*): Evidence from the East Coast of Peninsular Malaysia.	Mohd Yazid et al. (2021)
48.	Prevalence and antimicrobial resistance of *Escherichia coli*, *Salmonella* and *Vibrio* derived from farm-raised red hybrid tilapia (*Oreochromis* spp.) and Asian seabass (*Lates calcarifer*, Bloch 1970) on the West Coast of Peninsular Malaysia.	Dewi et al. (2022)



Buku-buku berkaitan ikan siakap putih yang diterbitkan di Malaysia

Jadual 13: Tesis berkaitan siakap putih oleh penyelidik Malaysia

Bil	Tajuk	Tahun	Peringkat	IPTA	Pengarang
1.	Ketoksikan ammonia terhadap juvenil ikan siakap putih *Lates calcarifer.*	1992	Sarjana	UPM	Hussin Mat Ali
2.	A sanguinicolid blood fluke in sea bass (*Lates calcarifer* bloch) in coastal Peninsular Malaysia.	1992	Sarjana	UPM	B.W Herbert
3.	Some ecological and pathological studies of gill monogeneans in floating cage cultured seabass *Lates calcarifer* (Bloch).	1994	PhD	USM	Balasuriya L.K.S.W
4.	Effects of environmental factors on Vibriosis In seabass (*Lates calcarifer* Bloch) at a floating cage culture farm.	1995	Sarjana	UPM	Premala Arulampalam
5.	Identification of *Vibrio* spp. from cultured *seabass Lates calcarifer* and their antibiogram relationship with plasmid profiles.	1998	Sarjana	UPM	Chan Soo Mun
6.	The use of protein from palm kernel meal in diets of seabass (*Lates calcarifer*).	2005	Sarjana	UTM	Mohammed Suhaimee Abd. Manaf
7.	Pembuatan vaksin rendaman untuk melawan serangan patogen akuakultur, *Vibrio harveyi.*	2008	Sarjana Muda	UMS	Noor Hanis bt Abu Halim
8.	Genetic variability and differentiation of feral and cultured populations of Asian sea bass (*Lates calcarifer*) in Malaysia inferred by microsatellites.	2008	Sarjana	USM	Lai Choay Hoong
9.	Profil hormon steroid di dalam plasma induk Siakap putih, *Lates calcarifer* (Bloch, 1790) yang diternak dan kaitannya dengan kematangan gonad dan tempoh pusingan pembiakan.	2009	Sarjana	USM	Che Zulkifli b Che Ismail
10.	Kajian bioremediasi rumpai laut merah (*Gracilaria changii*) ke atas bahan buangan ternakan ikan tilapia Nile (*Oreochromis niloticus*) dan ikan siakap putih Asia (*Lates calcarifer).*	2011	Sarjana	USM	Adibi Rahiman Md Nor
11.	Aplikasi penanda DNA mikrosatelit dan DNA mitokondria dalam program pembiakan ikan siakap putih, *Lates calcarifer.*	2011	Sarjana	USM	Roziana Mat Khairuddin

12.	A genetic linkage map of Asian seabass *Lates calcarifer* using DNA microsatellite markers in application to Quantitative Trait Loci (QTL).	2012	Sarjana	USM	Mohd Shahril Firdaus bin Ab Razak
13.	Molecular cloning, phylogenetic analysis and expression of two immune related genes, serum amyloid A and C-reactive protein from Asian seabass, *Lates calcarifer*.	2012	PhD	UKM	Laith Abdul Hassan Mohammed Jawed Alobaidi
14.	Diseases of Asian seabass (or barramundi), *Lates calcarifer* Bloch.	2012	PhD	Murdoch University, Australia	Susan Gibson-Kueh
15.	Characterization and physicochemical properties of collagen extracted from Barramundin (*Lates calcarifer*) skin.	2012	Sarjana	UPM	Umi Hartina Mohamad Razali
16.	Morphological and phylogenetic analysis of *Caligus* spp isolated from *Lates calcarifer* cultured in floating net cages in Malaysia.	2013	Sarjana	UM	Muhd Faizul Helmi Ahamad Hasmi
17.	Optimization of antioxidant properties from chemically prepared fish skin protein hydrolysate produced from Barramundi (*Lates calcarifer*).	2013	Sajana	UIAM	Noor Yuslida binti Hazahari
18.	Performance of an automated temperature and salinity control system for fish rearing.	2014	Sarjana	UPM	Nur Lailina Mahtar
19.	Comparative study on selected species of aquaculture production in Malaysia under different agro-food incentives schemes.	2014	PhD	UPM	Sara Ravan Ramzani
20.	Isolation of beneficial bacteria and feed incorporated with beneficial bacteria on growth performance of Asian Sea bass (*Lates calcarifer*) fingerling.	2015	Sarjana	UPM	Tarry, Wendy Ferrina
21.	Resistant starch from underutilised legumes as prebiotic and its effect on the growth of *Danio rerio* and *Lates calcarifer.*	2018	PhD	University of Nottingham Malaysia Campus	Ivan Kar Mun Chiew
22.	An economic study of seabass production in Peninsular Malaysia.	2020	PhD	Queensland University of Technology, Australia	Mohd Ammarr Mohd Aripin

Penutup

Secara umumnya maklumat dan data-data yang dipersembahkan di dalam ensiklopedia mini ini menunjukkan industri ternakan ikan siakap putih di Malaysia telah lama bertapak dengan banyak penyelidikan dan pembangunan telah dilaksanakan. Di samping itu ikan siakap putih mempunyai permintaan yang tinggi sebagai makanan berkhasiat untuk manusia dan mempunyai potensi yang sangat baik di masa hadapan. Negara seperti Indonesia terus memacu pengeluaran ikan siakap putih dengan pesat dengan penggunaan teknologi novel seperti IOT dan penambahbaikan produktiviti.

Di Malaysia, industri ini juga sedang diperkasakan untuk meningkatkan pengeluaran akuakultur negara. Pembangunan baka yang berkualiti (cepat besar, rintang penyakit) melalui teknik pembiakan terpilih untuk tujuan digunakan oleh pemain industri adalah salah satu pendekatan yang sedang dijalankan untuk meningkatkan pengeluaran komersial, memaksimumkan produktiviti dan keuntungan. Keberkesanan teknik ini bergantung kepada beberapa faktor sistematik iaitu mengetahui populasi asal, objektif dan strategi dalam pemilihan induk untuk proses pembenihan selanjutnya. Program penyelidikan dan pembangunan induk ikan siakap putih, termasuk penentuan variasi genetik, pemilihan induk, pengeluaran benih ikan, penternakan dan penilaian prestasi telah dimulakan di Institut Penyelidikan Tanjung Demong sejak tahun 2016 dan masih diteruskan dengan matlamat jangka panjang program untuk menghasilkan baka ikan ikan siakap putih yang cepat besar bagi tujuan kelestarian akuakultur ikan siakap putih di Malaysia.

Maklumat berkaitan penyelidikan dan pembangunan yang disenaraikan dalam buku ini, boleh digunakan oleh penyelidik-penyelidik atau pelajar di Malaysia sebagai panduan untuk tidak mengulangi kajian yang sama atau menyambung penyelidikan yang telah dijalankan agar lebih banyak pengetahuan baharu boleh dihasilkan.

Akhir sekali, adalah diharapkan ensiklopedia mini ini dapat melengkapi informasi sedia ada mengenai ikan siakap putih dalam satu naskah yang padat dan ringkas agar memudahkan semua pihak berkepentingan untuk membuat rujukan tentang sejarah, status, pola dan data pengeluaran, perkembangan penyelidikan dan pembangunan terkini serta potensi industri ikan siakap putih di Malaysia.

Rujukan

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Data pengeluaran ikan siakap putih daripada perikanan tangkapan dan akuakultut di Malaysia dari tahun 2001-2021 (Perangkaan Tahunan Perikanan Jabatan Perikanan).

Tahun	Pengeluaran (Tan Metrik)	
	Perikanan Tangkapan	Akuakultur
2001	1518	4061.2
2002	1440	4003.73
2003	1335	4210.93
2004	1749	4000.64
2005	1786	4191.25
2006	1760	5538.43
2007	1805	5679.18
2008	1514	11701.9
2009	1430	14229.82
2010	1357	20021.52
2011	1360	17606.82
2012	1499	20088.74
2013	1684	16981.4
2014	1823	30439.93
2015	1552	29132.37
2016	1556	15025.91
2017	2566	30236.59
2018	2632	21241.52
2019	2252	17263.61
2020	3322	23033.83
2021	3877	34186.73

Data pengeluaran ikan siakap putih dari pelbagai sistem ternakan air payau di Malaysia dari tahun 2001-2021 (Perangkaan Tahunan Perikanan, Jabatan Perikanan)

Tahun	Jumlah pengeluaran (Tan Metrik)			
	Kolam	Sangkar	Tangki	Kandang
2001	979.68	3081.52	-	-
2002	998.48	2964.21	-	-
2003	721.83	3489.10	-	-
2004	727.20	3273.44	-	-
2005	859.40	3331.85	-	-
2006	1302.28	4236.15	-	-
2007	1759.68	3919.50	-	-
2008	4447.50	7246.00	8.40	-
2009	6925.35	7270.40	34.08	-
2010	11919.58	7992.09	109.85	-
2011	10020.59	7345.33	240.90	-
2012	12284.65	7757.20	42.01	4.88
2013	10328.10	6649.56	3.74	-
2014	18214.11	12213.90	11.92	-
2015	14124.42	14997.18	10.58	0.20
2016	5141.68	9883.78	0.34	-
2017	19425.43	10661.09	150.07	-
2018	11559.13	9680.99	-	1.40
2019	8940.17	8316.21	1.22	6.01
2020	14500.20	8524.43	4.33	4.87
2021	25810.23	8371.49	3.04	1.96

Senarai hatceri yang mengeluarkan telur dan benih siakap putih di Malaysia

Bil	Nama hatceri	Lokasi	Maklumat tambahan
1.	HP Aquaculture Sdn. Bhd.	Alor Setar, Kedah	012-4089997
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3.	Paragon Aquatech Sdn. Bhd.	Kukup, Johor	07-2786668 Email: aragonaquatechsb@gmail.com
4.	F1 Aquaculture Sdn. Bhd.	Port Dickson, Negeri Sembilan	013-6025577
5.	SB Aqua Marine	Bachok, Kelantan	012-9698428 Email: sbaquamarinesdnbhd@gmail.com
6.	Ain Aquaculture Sdn. Bhd.	Lot 664 & 665 Tanjung Kuala Kampung Pulau Gajah,Pengkalan Chepa	012-9737494 Email: ain.aquaculture@yahoo.com
7.	Hineb Sdn. Bhd.	Besut, Terengganu	014-5463204
8.	Aliesya resources	Besut, Terengganu	013-9820708
9.	Trijoy Enterprise Sdn. Bhd.	Air Tawar 5, Felda Semenchu, Kota Tinggi, Johor Darul Takzim (MyGAP)	012-7138829
10.	Rambungan Marine Aquaculture	Lot 1, Sungai Rambungan Sampadi Lundu Sarawak (MyGAP)	019-8586536 Emel: sandylim1000@gmail.com
11.	Prima Bumisetia Sdn. Bhd.	Batu 7 Tanjung Payang silam, Lahad Datu Sabah (MyGAP)	0128137722 Timplytrading2003@yahoo.com
12.	GST Aquaculture (Batu Kawan) Sdn.Bhd.	Lot 272,Kolam Ikan Kampung Masjid Batu Kawan, Simpang Ampat 14100 Seberang Prai Selatan Pulau Pinang (MyGAP)	014-2460790; 04-5682277 Email: enquiry@gstgroup.com.my

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