Haruan *Channa Striatus*: Malaysia's Wonder and Functional Food

Abdull Manan Mat Jais[1], Ismail Elysha Nur[2], Ishak Reezal[3]*

[1]Abmanan Biomedical Sdn. Bhd., Universiti Putra Malaysia-MTDC Technology Centre, 43400 UPM Serdang, Selangor, Malaysia.
Email: abdullmanan_matjais@yahoo.com
[2]Department of Biomedical Science, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.
Email: elysha@upm.edu.my
[3]Universiti Kuala Lumpur, Institute of Medical Science Technology, A1-1, Jln TKS 1, Taman Kajang Sentral, 43000 Kajang, Selangor, Malaysia.
Email: reezal@unikl.edu.my

Abstract

Introduction: Malaysia's freshwater biodiversity includes the carnivorous snakehead *Channa striatus* (Haruan), traditionally consumed to accelerate postpartum recovery. This review synthesizes compositional, preclinical and clinical evidence supporting Haruan as a protein-rich functional food and source of bioactive extracts for wound healing and musculoskeletal applications. **Objective:** Wild Haruan contain high protein (up to 78.3%) and 17 amino acids including, aspartic acid, glutamic acid, glycine, leucine, isoleucine and histidine; linked to tissue repair and anti-inflammatory mechanisms. Mechanistic studies implicate peptides, essential fatty acids and growth-promoting factors as candidate bioactive constituents. **Findings:** Solvent-free Pressurized In-Water Extraction (PIWE) yields Haruan Manan (HM), a standardized extract incorporated into Haruan Biomedical Products (HBP) including a 5% topical cream. The Certificate of Analysis (COA) confirms heavy metals within permissible limits, and Ames testing indicates non-mutagenicity. Human studies include a randomized Lower Segment Cesarean trial (oral HM 500 mg/day), a CABG cohort (mixed wound and Quality of Life outcomes), a Phase-I topical safety evaluation (5% HM), and a three-arm knee osteoarthritis randomized controlled trial (500 and 1000 mg/day; WOMAC function improvement). Development pathways include oral supplements (capsules and tablets), topical dermatological formulations and Halal-certified collagen or gelatin ingredients for the nutraceutical and biomedical markets. **Conclusion:** Collectively, these data support continued translational development of *C. striatus* HM/HBP, bridging traditional practice and evidence-based medicine. However, larger multicenter for randomized controlled trials, standardized extract characterization, and targeted safety monitoring such as hemostatic parameters are needed to confirm efficacy and ensure regulatory readiness.

Keywords: *Channa* Striatus, Wound Healing, Nutraceuticals, Haruan Manan, Ethnopharmacology.

Introduction

Flora, fauna, microbes, all other living and non-living beings are created as nature supplying necessities, providing every aspect, requirement of human being. [1] Malaysia, a small equatorial nation of approximately 330,803 square kilometers and just over 33 million inhabitants, supports one of the world's richest tropical rainforest and freshwater ecosystem, where complex riverine, wetland and flood plain systems sustain exceptionally high levels of species richness and ecological function. Within these freshwater networks, the snakehead *Channa striatus (C. striatus)* is a conspicuous fish species whose morphology, air-breathing physiology and behavioral ecology enable persistence in low-oxygen and slow-flowing habitats which is a characteristic of Peninsular Malaysia and Bornean wetland landscapes (Figure 1).

As both consumer of fish and invertebrates, and a source of animal protein for local communities, *C. striatus* occupies an important trophic and socio-economic niche in Malaysian inland fisheries and small-scale aquaculture systems.[2] Beyond its nutritional value, *C. striatus* has a long history of ethnomedical use. Experiential records and traditional practices in Malay communities report oral and topical applications of fresh fish and tissue

Access This Article Online

Quick Response Code:

Website: www.jnsbm.org

DOI: https://doi.org/10.5281/zenodo.19550675

Address for Correspondence: Universiti Kuala Lumpur, Institute of Medical Science Technology, A1-1, Jln TKS 1, Taman Kajang Sentral, 43000 Kajang, Selangor, Malaysia
Email: reezal@unikl.edu.my

Submitted: 19th December, 2025 **Received:** 02nd January, 2026
Accepted: 17th February, 2026 **Published:** 22nd February, 2026

How to Cite This Article: Jais A M M, Nur I E, Reezal I. Haruan *Channa Striatus*: Malaysia's Wonder and Functional Food. J Nat Sc Biol Med 2026;17(1):30-36

extracts to accelerate postpartum recovery following normal birth and Caesarean deliveries, and promote healing of surgical and traumatic wounds and related infections.[3] These culturally embedded practices have driven interdisciplinary interest in the species, prompting biochemical and pharmacological investigations that seek to identify putative bioactive constituents such as growth factors, peptides and lipid mediators in muscle, mucus and organ tissues that may plausibly contribute to observed wound-healing effects.[4] Given the dual importance of *C. striatus* for biodiversity, food security and traditional healthcare, there is a persuasive need for integrated research that combines ecological field, sustainable management, and translational biomedical studies to validate the efficacy in order to ensure safety, whilst providing conservation guide for sustainable-use strategies. Such an evidence-based approach will both conserve Malaysia's unique freshwater biota and responsibly translate traditional knowledge into validated health interventions.

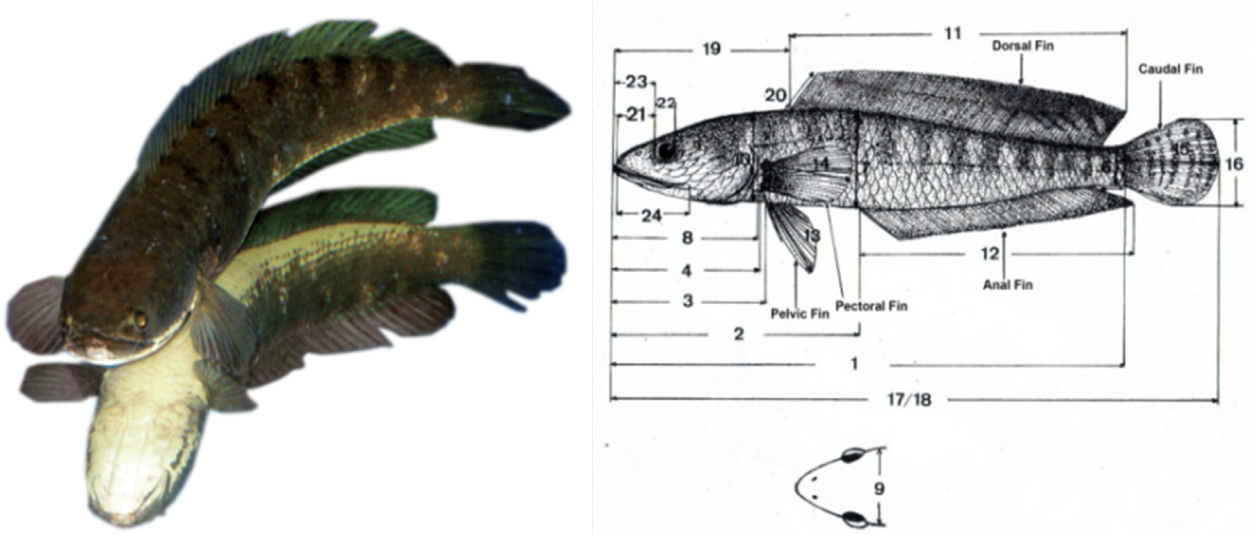

Figure 1: An Adult Wild Haruan *Channa Striatus* Caught in Malaysian's Water, and its External Morphology Measurement of the Fish.

Channa Striatus Local Habitat and Characteristics

Haruan fish is a local name in Malaysia and scientifically identified as *Channa striatus* or *Channa striata*.[5] It is also known as snakehead fish and an indigenous based on Restriction Fragment Long Polymorphism or RFLP.[6] The fish is occasionally changing its total whole body to dark-muddy color without clear white-bottom and stripes as shown in Figure 1. For that reason, the external physical characteristics, measurement or morphology become necessary as a guide in identifying and confirming the species. In Malaysia alone, there are seven other species in the family Channidae namely; Toman, *Channa micropeltes*; Bujuk, *Channa lucius*; and Black Haruan, *Channa melanosoma*.[7] All of the fish have a fairly similar body shape, but both *C. micropeltes* and *C. lucius* appeared with a clear striking unique pattern externally. On the other hand, *C. melanosoma* is similar in shape and dark almost black whole body can easily be mistaken for *C. striatus*.[8] It is therefore highly recommended that a random inspection should be made as the Standard Operating Procedure (SOP) on fishes either caught in wild or supplied by any aquaculture contract farmers.[9] Furthermore, if necessary and in doubt, a laboratory analysis can be conducted in order to confirm the species based on biochemical profiling and nucleotide sequencing which have been identified as genetic marker and deposited at GenBank, USA.[10]

There are thirty different Haruan species in the family distributed throughout East, Mainland Asia and South East Asia or ASEAN Countries.[9] Few of these species, including *C. striatus* are restaurant menu in Malaysia and other ASEAN countries. The fish is also a popular game fish among freshwater anglers and capable of moving out crawling into more suitable cleaner water body, and would bored into the mud during dry seasons.[4] Haruan preys on other fishes, birds, frogs and reptiles in shallow, slow-moving small water body such as ponds, small lakes, river tributaries and man-made canal or agricultural establishment including paddy fields. This fish nature signified good parental care otherwise solitary with secured descend resting, shelter and hiding by dead wood, bushes and holes in water edges.[11]

The Potential and Benefits of *Channa Striatus*

Haruan fish fillet is tender and could easily be incorporated into simple traditional or modern cooking such as fried rice, rice porridge, noodles, curry or soup.[8] Even until today, many communities either in rural, sub-urban or

urban area are still observing and practicing their valuable cultural heritage passed down to the next generation in their dietary and cuisine. This practice is closely associated to knowledge and experiences from one generation to another either localized or influenced by others, before it became an ethnopharmacology belief.[8] This is the case with *C. striatus* where the fish has become an undisputed traditional remedy throughout Malaysia although the fish is not a popular protein source. Some species of the Channidae family are ornamental, and few are consumed as functional food that provides good quality protein in helping various health issues.[8]

Through extensive research and development on *C. striatus* over many years, a comprehensive biological data about the fish has been established describing its natural habitat, specific environmental physiology where wild Haruan is caught, and the specific parameters as references.[12] These references are highly recommended when working with wild Haruan species in order to ensure authenticity and originality of the raw material as required by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which is also known as the Washington Convention, 1973. This ecological data collection is helping to ensure that Haruan is not in the red-list of the International Union for Conservation of Nature (IUCN) as likely endangered and to become extinct. The data is a referral that can be used and translated as guide into farming condition and yielding as standardized raw material for the extraction to become biotherapy, bioactive and active pharmaceutical ingredient (API). The main physical parameters of *C. striatus* species are presented in Table 1.

Table 1: Physical Characteristic and Water Quality of Haruan *Channa Striatus* Caught in the Wild.

	Physical Characteristics	Measurement
i)	Temperature	23 - 28°C
ii)	Dissolved-Oxygen	1 - 4.1 ppm
iii)	Conductivity (ability or power to conduct or transmit heat, electricity, or sound)	0.1 - 1.3 Siemens per meter (S/m or $mScm^{-1}$)
iv)	Turbidity: Clarity, cloudiness or haziness of water (This is associated to concentration of suspended particles in water that might block light penetration, and productivity)	2 - 20 ppm or nephelometric turbidity units (NTU)
v)	pH	6 - 7.5
vi)	Salinity	0 - 10 ppm

Other important and relevant parameters from *C. striatus* includes the Total Dissolved Solids (TDS), Redox Potential or Oxidation-Reduction Potential (ORP) that measure the water ability to oxidize contaminants, where the higher the ORP means the greater number of oxidizing agents is available. Ion concentration analysis and water hardness (amount of dissolved calcium and magnesium) analysis completes the important information about the fish. Haruan normally inhabits in smaller shallow pond, lake or slow running rivers tributaries with plenty of aquatic plants and dead woods as shelter and hiding place. Interestingly, the water where Haruan was caught have the chemical compositions of ammonia, phosphate, sulphate, chlorine, calcium, magnesium and sodium, well below the permissible toxic level to human.[13]

This carnivorous fish is territorial and monogamous with good-parental-care and preys mainly on aquatic fauna that provides all dietary nutrients needed, thus making *C. striatus* as one of the best source for functional food.[14] This is indeed an important information in formulating diet, or pellets for Haruan in farming activities, where the fish at all stages of its life needs at least 40% protein in daily consumption, especially in a mass commercial scale production without compromising the quality. The whole ecosystem complements the genetic information of Haruan with a stock identification of parentage for breeding and where the fish is found to having 44 chromosomes.[15] In addition, the RFLP measurement and nucleotide sequences with the accession number JF826031-JF826036 as marker for the local wild *C. striatus* confirmed the indigenous status of the species to Malaysia, and it is one of the key findings reported previously.[16]

Proximate analysis on wild *C. striatus* indicated a high protein content of up to 78.32±0.23%, low-fat of 2.08±0.08%, Vitamin A at 0.27±0.01%, and have almost all nutritional as well as dietary minerals of Mg, Cu, Fe, Mn, Ni, Pb, Zn, and Ca at a concentration much lower than toxic level recommended to human. The medicinal value of Haruan is contributed by a good profile of 17 amino acids which some are essentials, and this includes as aspartic acid, glutamic, glycine, leucine, isoleucine and histidine.[5] The fatty acids detected are the Omega-6 arachidonic acid AA 20:4ω6, and Omega-3, Docosahexaenoic acid DHA 22:6ω3,[17] and antioxidant content.[18]

Development and Commercialization of *Channa Striatus* based Products

Combination of all the biochemical components makes *C. striatus* unique and ideal for wound treatment, by providing necessary elements for healing, repair and growth.[19] Preclinical and early clinical studies consistently report multiple bioactivities for *C. striatus* extracts relevant to wound healing and recovery. Anti-nociceptive effects were demonstrated in murine models using abdominal-constriction and other nociception tests. The extracts produced strong, dose-dependent inhibition of nociceptive responses and enhanced morphine analgesia, and this activity was not reversed by naloxone, indicating a non-opioid mechanism; the activity remained sizeable across a broad pH range and showed partial heat stability (mucus extract inhibition reduced from 88.4% at 0°C, to 61.1% at 80-

100°C).[20] The extracts also stimulate platelet aggregation and produce marked changes on thromboelastography (TEG), notably shortening clot initiation (reaction time) and accelerating clot formation kinetics, together with alterations in measures of clot strength. These consistent, highly significant TEG shifts indicate a pro-hemostatic effect that plausibly contributes to faster haemostasis observed in wound-healing models.[21] Anti-inflammatory activity is supported across multiple *in vitro* and *in vivo* models (gastric-ulcer, dermatitis and osteoarthritis models), with extracts reducing pro-inflammatory cytokines and markers of NF-κB signalling in treated tissues.[22] Antimicrobial testing of fillet and mucus preparations shows inhibitory activity against a range of pathogens, including *Helicobacter pylori*, *Escherichia coli*, *Salmonella* spp. and *Staphylococcus aureus*, by agar-diffusion and MIC methods,[23] and preliminary antifungal inhibition has been reported for several filamentous species in screening assays.[24] Neurobehavioral studies demonstrate antidepressant-like and neurotrophic effects. Lipid and aqueous extracts reversed chronic-stress induced behavioral deficits in rats (chronic unpredictable mild stress models) and significantly reduced immobility in forced-swim and sucrose-preference tests (dose range from 125-500 mg/kg; significance levels of $p<0.05$ to $p<0.001$), accompanied by restoration of hippocampal/prefrontal monoamines, increased BDNF, and reductions in IL-6 and NF-κB.[25]

The in-water extracts termed as Haruan Manan (HM) demonstrated anti-inflammation, and anti-ulcers activity,[26] as well as helping those suffering from diabetic and cardiovascular complications.[27] Similarly, HM and other products containing Haruan's extract was shown to be effective for human applications based on wound healing progress post lower segment caesarean section (LSCS) on mothers after giving birth. Clinical evidence for *C. striatus* extracts in humans comprises a small number of randomized trials that report promising but heterogeneous results. In a randomized, double-blind, placebo-controlled postpartum study, oral *C. striatus* dose of 500 mg/day for 6 weeks produced significantly faster uterine involution versus placebo as assessed by serial sonographic anteroposterior uterine dimensions (between-group time effect: F=3.93, p=0.013) with plane-specific differences reported p<0.05 and p<0.001).[28] In a large CABG cohort, daily dose of *C. striatus* (500 mg/day) yielded non-significant differences for most objective wound (ASEPSIS score) and pain endpoints (pain Visual Analogue Scale (VAS), p=0.290), with only a single significant improvement.[29] A phase-I dermal safety study of a 5% *C. striatus* cream reported a low patch-test positivity rate and only mild, transient application reactions (2.4%), supporting short-term topical tolerability.[30] Additionally, a three-arm, double-blind trial in knee osteoarthritis found that oral *C. striatus* at 500 mg and 1000 mg/day for 6 months produced statistically significant improvements in WOMAC stiffness and function domains versus placebo (p<0.05), without serious safety indications.[31] Safety data are generally reassuring but preclinical haemostatic effects reported elsewhere warrant inclusion of coagulation monitoring and exclusion criteria in future trials. Taken together, these studies justify larger, multi-centred, well-powered randomized controlled trials with standardized extract characterisation, and pre-specified primary endpoints, together with rigorous adherence and safety monitoring for efficacy and safety.

HM is the key outcome from extensive drug discovery research and development on Haruan *C. striatus* (Figure 2). HM was obtained through a standardized proprietary Standard Operating Procedure (SOP) using a Pressurized In-Water Extraction (PIWE) procedure, a modified of the earlier Haruan Traditional Extract (HTE) methodology that was patented under Utility Innovation (UI138245A) for preparation of Haruan *C. striatus* extracts with pharmaceutical functions. Both protocols have successfully extracted out, sustained and maintained similar biochemical composition to a living Haruan,[32] and the whole extraction process was achieved without using any toxic organic solvent such as chloroform, methanol or ethanol. The yield from the extraction process was obtained in two forms, which is liquid and solid with equipotent biomedical properties.[33]

Figure 2: Extraction Process Flowchart from Fresh Haruan to Fillet, And Two forms of Solid and Liquid Extracts that was used to Develop HM Haruan based Personal Care Products (Shower gel, body lotion and cream).

Subsequently, HM and derivative Haruan Biomedical Products (HBP) were manufactured and released only after the batch Certificate of Analysis (COA) confirms that heavy-metal contents (Arsenic, Lead, Cadmium and Mercury) were below permissible human limits. The HM ingredient has been incorporated into a non-steroidal, aqueous-based

topical cream containing 5% HM, which demonstrated an approximately 60% diffusion rate in *in vitro* skin permeation assays.[34] In addition to the cream formulation, HM has been processed into both spray-dried powder and solid extract forms, thereby broadening its potential applications in oral, topical, and biomedical product development. Physical characterization showed the spray-dried extract had a median particle size of approximately 30 µm, and the solid fraction of about 80 µm. An electron-beam cross-linking procedure yielded nanoparticles form of HM of about 0.2 µm (200 nm).[35] All extracts and finished formulations were non-mutagenic in a reverse-mutation Ames testing, and met routine safety panel specifications. Stability testing described in the product report indicates that the active molecular constituents withstand high thermal challenge (stability of up to 100°C), resist enzymatic degradation by amylase, lipase and protease, and remain stable across extreme pH conditions. The final report combines the chemical safety release of COA, particle sizing and functional stability data prior to the clinical evaluation.

In addition, the bones from Haruan's organic waste has garnered increasing interest in recent years as possible raw materials for Halal collagen and gelatin in order to fulfil the demands of Muslim population across the world, and to replace doubtful Halal status collagen and gelatin coming from bovine and birds source.[36] This will definitely add on to the potential of *C. striatus* extracts and widening the scope of Haruan healthcare industry. *C. striatus* fish is definitely a promising future candidate as raw material for natural-based product either for therapeutic purposes, or biotherapy, or as functional food.

Conclusion

Haruan *C. striatus* is an indigenous Malaysian species that forms part of the nation's megabiodiversity. Its continuous consumption and practice in traditional medicine, particularly as a remedy for wound healing among postpartum mothers, underscores its long-standing ethnopharmacological value. Extensive preclinical investigations in *in vitro* and *in vivo* models, alongside emerging clinical trials, have validated its therapeutic activities. Classified as a functional food, *C. striatus* facilitates rapid recovery by contributing to the four key physiological processes of wound healing: tissue repair, pain reduction, anti-inflammatory activity, and antibacterial defence. Its rich biochemical composition, encompassing high protein content, antioxidants, and essential dietary minerals, positions it as a versatile nutraceutical ingredient capable of promoting health across age groups and genders.[37] Importantly, the translational potential of *C. striatus* is increasingly recognized, with its bioactive extracts advancing into diverse commercial formats including tablets, capsules, Halal-certified collagen, and gelatin. Such innovations align with global demand for evidence-based natural products, offering a dual role as both functional food and biomedical resource. By bridging traditional ethnomedicine with modern product development, *C. striatus* is poised to expand Malaysia's footprint in the nutraceutical and biomedical industries, establishing itself as a valuable resource for therapeutic and commercial applications.

Acknowledgement

The authors gratefully acknowledge Abmanan Biomedical Sdn. Bhd., Malaysia for their contribution and usage of materials in order to complete this study, and Universiti Kuala Lumpur for the support provided.

References

1. Quora. Six Fundamental Human Needs We Need To Meet To Live Our Best Lives. Forbes. Feb 5, 2018. Accessed Feb 5, 2023, Available from: https://www.forbes.com/sites/quora/2018/02/05/six-fundamental-human-needs-we-need-to-meet-to-live-our-best-lives.
2. Martin K. Channa striata. Animal Diversity Web. 2017. Accessed Jun 26, 2023, Available from: http://www.animaldiversity.org/accounts/Channa_striata.
3. Mat Jais AM. Pharmacognosy and pharmacology of Haruan (Channa striatus), a medicinal fish with wound healing properties. Bol Latinoam Caribe Plant Med Aromat. 2007; 6(3): 52-60. Available from: https://www.redalyc.org/pdf/856/85660303.pdf.
4. Mat Jais AM, Azemi AK, Rahim MHA, et al. Snakehead fish, Haruan (Channa striata): Emerging potential for nutraceuticals, active pharmaceutical ingredients (API) and biomedical applications. Bangladesh Journal of Fisheries. 2020; 32(1): 165-72. doi: https://doi.org/10.52168/bjf.2020.32.18.
5. Mat Jais AM, Prasat K, Croft KD. Distribution, environmental physiology and genetic variability of Haruan Channa striatus. Malaysian Fisheries Journal. 2001; 2(1): 192-97.
6. Rahman MA, Molla M, Sarker MK, Chowdhury SH, Shaikh MM. Snakehead Fish (Channa striata) and Its Biochemical Properties for Therapeutics and Health Benefits. SF J Biotechnol Biomed Eng. 2018; 1(1): 1005. Available from: https://scienceforecastoa.com/Articles/SJBBE-V1-E1-1005.pdf.
7. Mat Jais AM, Fung R, Bosi E, Platell C, McCauley R, Croft K. Preliminary Evidence on the Potential of Haruan. Malaysian Applied Biology. 1998; 27: 50-51.
8. AquaInfo. Channa striata – Striped Snakehead – Common Snakehead – Chevron Snakehead. Accessed Sep 3, 2022, Available from: https://aquainfo.org/channa-striata-striped-snakehead.
9. Mohd Khatib MA, Mat Jais AM. A Brief Overview of the Integrated Fish Farming of Three Commercially Popular Fish Species (Snakehead, Tilapia and Catfish) in Malaysia. Malaysian Journal of Applied Sciences. 2021; 6(2): 105-12. doi: https://doi.org/10.37231/myjas.2021.6.2.301.
10. Rahim MH, Ismail P, Alias R, Muhammad N, Mat Jais AM. PCR-RFLP analysis of mitochondrial DNA cytochrome b gene among Haruan (Channa striatus) in Malaysia. Gene. 2012; 494(1): 1-10. doi: https://doi.org/10.1016/j.gene.2011.12.015.

11. Hadi NHA, Ooi FK, Kadir AA, Ahmad NS. In vivo effects of Channa striatus on humans and animals: a systematic review. International Food Research Journal. 2021; 28(3): 407-22. doi: https://doi.org/10.47836/ifrj.28.3.01.
12. Mohsin AK, Ambak MA. Freshwater Fishes of Peninsular Malaysia. Kuala Lumpur: Univer-siti Pertanian Malaysia Press; 1983.
13. Mat Jais AM, Dambisya YM, Lee TL. Antinociceptive activity of Channa striatus (haruan) extracts in mice. J Ethnopharmacol. 1997; 57(2): 125-30. doi: https://doi.org/10.1016/s0378-8741(97)00057-3.
14. Mohd SM, Abdul Manan MJ. Therapeutic potential of the haruan (Channa striatus): from food to medicinal uses. Malays J Nutr. 2012; 18(1): 125-36. Available from: https://maljnutr.org.my/publication/18-1/l.pdf.
15. Samidjan I, Rachmawati D. Engineering culture using natural filter differences based on microsatelite to improve the quality of Snakehead (Channa striata). IOP Conf Ser Earth Environ Sci. 2020; 530(1): 012034. doi: https://doi.org/10.1088/1755-1315/530/1/012034.
16. Haniffa MA, Sheela PA, Kavitha K, Mat Jais AM. Salutary value of haruan, the striped snakehead Channa striatus - a review. Asian Pac J Trop Biomed. 2014; 4(Suppl 1): S8-s15. doi: https://doi.org/10.12980/apjtb.4.2014c1015.
17. Zuraini A, Somchit MN, Solihah MH, et al. Fatty acid and amino acid composition of three local Malaysian Channa spp. fish. Food Chem. 2006; 97(4): 674-78. doi: https://doi.org/10.1016/j.foodchem.2005.04.031.
18. Dahlan-Daud CK, Mat Jais AM, Ahmad Z, Akim AM, Adam A. Amino and fatty acid compositions in Haruan traditional extract (HTE). Bol Latinoam Caribe Plant Med Aromat. 2010; 9(5): 414-29. Available from: https://www.redalyc.org/pdf/856/85615225012.pdf.
19. Mat Jais AM. Molecular Size of the Bio-active Components from Haruan Channa striatus Extract. Journal of applied Sciences. 2007; 7(15): 2198-99. doi: https://doi.org/10.3923/jas.2007.2198.2199.
20. Zakaria ZA, Mat Jais AM, Goh YM, Sulaiman MR, Somchit MN. Amino acid and fatty acid composition of an aqueous extract of Channa striatus (Haruan) that exhibits antinociceptive activity. Clin Exp Pharmacol Physiol. 2007; 34(3): 198-204. doi: https://doi.org/10.1111/j.1440-1681.2007.04572.x.
21. Wahono OW, Suparyatmo JB, Ariningrum D. The Effects of the Supplementation with Snakehead Fish and Sea Cucumber Extracts on Platelet-Derived Growth Factor in Post-Operative Patients. Indonesian Journal of Clinical Pathology and Medical Laboratory. 2020; 26(3): 350-55. doi: https://doi.org/10.24293/ijcpml.v26i3.1541.
22. Ali Khan MS, Mat Jais AM, Hussain J, et al. Gastroprotective Effect of Freeze Dried Stripped Snakehead Fish (Channa striata Bloch.) Aqueous Extract against Aspirin Induced Ulcerogenesis in Pylorus Ligated Rats. ISRN Pharmacol. 2014; 2014: 327606. doi: https://doi.org/10.1155/2014/327606.
23. Permana SA, Hartono H, Purwanto B, Indarto D. The Efficacy of Albumin Channa Striata Extract Administration in Stabilizing PAI-1 and Platelet Levels in Septic Patients: A Randomized Control Trial Study. Open Access Maced J Med Sci. 2022; 10(B): 2313-18. doi: https://doi.org/10.3889/oamjms.2022.10453.
24. Mat Jais AM, Zakaria ZA, Luo A, Song YX. Antifungal Activity of Channa striatus (Haruan) Crude Extracts. International Journal of Tropical Medicine. 2008; 3(3): 43-48. doi: https://doi.org/10.36478/ijtmed.2008.43.48.
25. Mohd Shafri MA, Mat Jais AM, Kyu KM. Neuroregenerative property of haruan (Channa striatus spp.) traditional extract. Jurnal Intelek. 2011; 6(1): 77-83. Available from: https://ir.uitm.edu.my/id/eprint/32195.
26. Mohamad I, II, Abu Bakar S, Md Tohid SF, Mat Jais AM. Channa striatus cream down-regulates tumour necrosis factor (TNF)-alpha gene expression and alleviates chronic-like dermatitis in mouse model. J Ethnopharmacol. 2016; 194: 469-74. doi: https://doi.org/10.1016/j.jep.2016.10.033.
27. Azemi AK, Abd Rahim MH, Mamat SS, Mat Jais AM, Zakaria ZA. Antiulcer activity of methanol-chloroform extract of Channa striatus fillet. Pak J Pharm Sci. 2018; 31(1): 143-51. Available from: https://www.pjps.pk/uploads/pdfs/31/1/Paper-20.pdf.
28. Saleem AM, Taufik Hidayat M, Mat Jais AM, et al. Antidepressant-like effect of aqueous extract of Channa striatus fillet in mice models of depression. Eur Rev Med Pharmacol Sci. 2011; 15(7): 795-802. Available from: https://www.europeanreview.org/wp/wp-content/uploads/998.pdf.
29. Musa AF, Min CJ. Haruan Extract (Channa striatus) as an Effective Mediator in Promoting Wound Healing. In: Skin Grafts for Successful Wound Closure. IntechOpen; 2021. doi: https://doi.org/10.5772/intechopen.99207.
30. Kuppusamy M, Taib Tb, Johar A, Mat Jais AM. Topical Channa striatus 5% cream for inflammatory skin conditions: A phase I randomized double-blind, controlled trial. Iran J Dermatol. 2016; 19(3): 67-72. Available from: https://www.iranjd.ir/article_98278.html.
31. Abdul Kadir A, Abdul Kadir A, Abd Hamid R, et al. Evaluation of Chondroprotective Activity of Channa striatus in Rabbit Osteoarthritis Model. Biomed Res Int. 2019; 2019: 6979585. doi: https://doi.org/10.1155/2019/6979585.
32. Kumar R, Gokulakrishnan M, Debbarma J, Damle DK. Advances in captive breeding and seed rearing of striped murrel Channa striata, a high value food fish of Asia. Anim Reprod Sci. 2022; 238: 106957. doi: https://doi.org/10.1016/j.anireprosci.2022.106957.
33. Kwan SH, Ismail MN. Discovery of Channa Striata Extracts as Regenerative Medicine in Promoting Wound Healing and Scarless Skin Regeneration. Nat Prod J. 2021; 11(4): 430-37. doi: https://doi.org/10.2174/2210315510999200629205601.

34. Tungadi R, Hasan AM. The Effect of Penetrant Enhancer Combination towards the Diffusion Rate of Snakehead Fish (Ophiocephalus striatus) Cream in Vitro and Vivo. Int J Pharmtech Res. 2016; 9(6): 508-13. Available from: https://sphinxsai.com/2016/ph_vol9_no6/2/(508-513)V9N6PT.pdf.
35. Hui LY, Mat Jais AM, Krishnaiah D, et al. Encapsulization of Channa striatus Extract by Spray Drying Process. Journal of Applied Sciences. 2010; 10(21): 2499-507. doi: https://doi.org/10.3923/jas.2010.2499.2507.
36. Nurilmala M, Suryamarevita H, Husein Hizbullah H, Jacoeb AM, Ochiai Y. Fish skin as a biomaterial for halal collagen and gelatin. Saudi J Biol Sci. 2022; 29(2): 1100-10. doi: https://doi.org/10.1016/j.sjbs.2021.09.056.
37. Gebru T. Integrated Aquaculture with Special Reference to Fish Integration with Animal Husbandry to Enhance Production and Productivity. Journal of Agriculture and Aquaculture. 2021; 3(2): 1-6. Available from: https://www.researchgate.net/publication/360868752.