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Therapeutic Potential of the Haruan (*Channa striatus*): From Food to Medicinal Uses

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ABSTRACT

The haruan (*Channa striatus*) is an indigenous, predatory freshwater fish of Malaysia. It is a common food fish among the local populace with traditionally identified pharmacological benefits in treating wound and pain and in boosting energy of the sick. *Channa striatus* is also a subject of renewed interest in Malaysian folk medicine in the search for a better cure for diseases and ailments. Amino acids and fatty acids, found in high concentrations in the fish, might have contributed to its pharmacological properties. Important amino acids of the fish include glycine, lysine and arginine, while its fatty acids are arachidonic acid, palmitic acid and docosahexaenoic acid. They appear to effect their influence through the formation of several types of bioactive molecules. Extracts of the fish are produced from whole fish, roe, mucus and skin of the fish. This review updates research findings on potential uses of *Channa striatus*, beyond the traditional prescription as a wound healer, pain reliever and energy booster to include its properties as a ACE-inhibitor, anti-depressant and neuroregenerative agent. The fish appears to have wide-ranging medical uses and should be studied more intensively to unearth its other properties and mechanisms of action.

Keywords: Functional food, haruan, *Channa striatus*, traditional medicine, zoo therapeutics

INTRODUCTION

Channa striatus, or snakehead murrel, is an obligate air-breathing freshwater fish which inhabits all types of water bodies from small ditches to ricefields, rivers and lakes across tropical and subtropical Asian countries from Pakistan and India to Southeast Asia and Southern China (Mohsin & Ambak, 1983; Hossain, Latifah & Rahman, 2008). It belongs to the Channidae family which has been around from 50 million years ago with an origin purportedly from the ancient Himalayan valley (Madeleine, 2004). About 30 species are reported worldwide from this family, and seven are found in Malaysia (Lee & Ng, 1994) including C*hanna bankanensis*, *Channa gachua*, *Channa lucius*, *Channa marulioides*, *Channa melasoma*, *Channa micropeltes*, and C*hanna striatus*.

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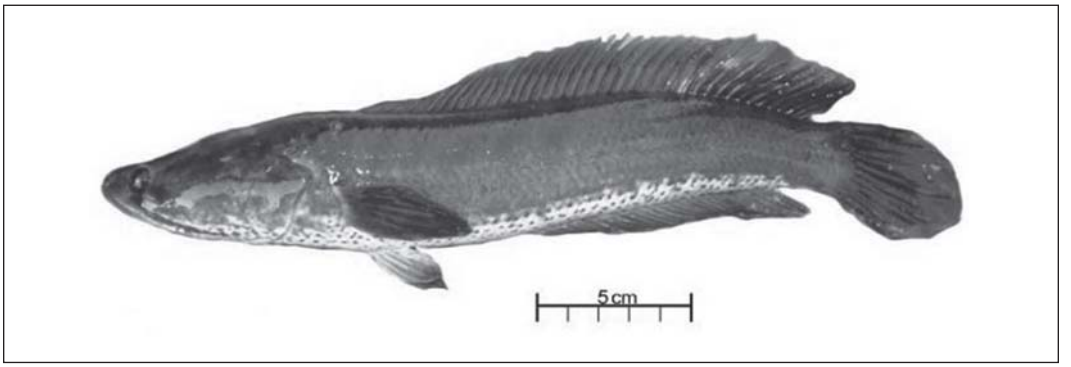

Figure 1: An adult haruan typically measures 15-30cm in length from head to tail.

In Peninsular Malaysia, three main stocks of wild *Channa striatus* have been described in North-West Penang, North-East Kelantan and South Johor corridors. (Mat Jais *et al*., 2009) *Channa striatus* has a reputation of being an aggressive predatory fish which survives on aquatic animals such as fish and frogs as well as small terrestrial rodents and birds. It is known to be an excellent survivor and a top predator preferring shallow, slow moving waters with temperatures between 20-30°C, a good level of dissolved oxygen and low turbidity.

TRADITIONAL USES

Channa striatus is commonly consumed as a food fish. In Malaysia, freshwater fish consumption provides an important source of protein constituting up to 70% of total protein requirements (Osman, Suriah & Law, 2001) and is also recognised as a source of omega-3 fatty acids (Ng, 2006). *Channa striatus* features prominently in the local diet among the Malays, the Orang Asli of Peninsular Malaysia (Haemamalar, Zalilah & Neng, 2010) and tribal communities in East Malaysia (Kodoh, Mojiol & Lintangah, 2009).

Channa striatus is also highly valued for its medicinal properties. Of the many types of fishes in Malaysia, only the Malaysian channidae (including *Channa micropeltes, Channa striatus* and *Channa gachua*), the mudskipper, *Periophtalmus* spp., and the freshwater eel, *Monopterus albus* (Abdullah *et al*., 2010) are known to be used in traditional Malay medicine. Other Southeast Asian communities like the Thais, Vietnamese and Cambodians as well as the Chinese also use *Channa striatus* in the treatment of diseases.

The popularityof C*hanna striatus* as a therapeutic agent is related to folk belief in its efficacy in treating wounds, relieving pain and boosting energy in the sick and elderly. Mothers recuperating from normal or Caesarean delivery (Barakbah, 2007) and patients recovering from surgical operations are routinely and customarily advised to eat meals containing *Channa striatus*. Among the Malays, such meals come in the form of curried, spiced, fried or roasted fish, playing the role of functional foods which provide health benefit beyond basic nutrition. Other forms such as broth or a tonic of *Channa striatus* extracts are quite popular. The energy-restoring properties of *Channa striatus* are also recognised in Malay society who consume it for recovery from minor to major illnesses as well as a diet supplement for elderly people.

Table 1. Important amino acids and fatty acids in different sources of *Channa striatus* extract (from various sources cited in the text).

	Fillet	*Roe*	*Mucus*
Amino acids	Glycine Glutamic acid Arginine Aspartic acid	(No study)	(No study)
Fatty acids	Eicosapentaenoic acid (EPA) Docosahexaenoic acid (DHA) Palmitic acid Oleic acid Stearic acid Arachidonic acid	Eicosapentaenoic acid (EPA) Docosahexaenoic acid (DHA) Arachidonic acid Hexadecanoic acid Oleic Linoleic	Oleic acid Linoleic acid

MEDICINAL EFFECTS

The medicinal effects of *Channa striatus* are attributed to two major components, the amino acids and the fatty acids.

Amino acids

The earliest documented study on the amino acid profile of *Channa striatus* was conducted in 1994 (Mat Jais, McCulloch & Croft, 1994) on filleted *Channa striatus* extract. The study found the extract to be rich in glycine, a non-essential amino acid. This result has been confirmed by more recent studies (Dahlan-Daud *et al*., 2010).

Other non-essential amino acids that appear to be in abundance in *Channa striatus* extracts include amino acids such as glutamic acids (Gam, Leow & Baie, 2006; Ahmad *et al*., 2005), arginine (Witte & Barbul, 2002), and aspartic acid (Ahmad *et al*., 2005). These amino acids are important in influencing the sense of pain and in healing wounds.

A study on protein content of mucus of *Channa striatus* (Wei, Xavier & Marimuthu, 2010) showed that variation exists in different extraction types. Crude extract appears to contain the highest amount of protein (0.589 mg / ml) followed by the aqueous (0.291 mg / ml) and acidic extracts (0.291 mg / ml). The study, however, did not analyse detailed amino acid composition of *Channa striatus* mucus.

Fatty acids

The first reported study of *Channa striatus* lipid profiles done in 1993 (Endinkeau & Kiew, 1993) showed a high level of fat (11-17%) of wet weight and a high level of unsaturated: saturated ratio (1.2-2.3) and low omega-3 in general. Fat or lipid content in *Channa striatus* remains a matter of contention as some studies found a high amount of total fat in the range of 5.7 - 11.9% (Ahmad *et al*., 2005) and up to 35.93% (Zakaria *et al*., 2007) while others found a low level at 3.25% (Abdul Rahman *et al*., 1995), 0.99% (Karapanagiotidis *et al*., 2010) and 1.47% (Chedoloh, Karrila & Pakdeechanuan, 2011) of total body weight. The ability of *Channa striatus* to produce unsaturated fatty acids such as eicosapentaenoic acid (EPA) and decosahexaenoic acid (DHA) (Jaya Ram *et al*., 2011) in high amounts (Abdul Rahman

et al., 1995) partly explains the efficiency of the fish as a wound healing agent. Some of the most abundant fatty acids in *Channa striatus* are C16 (palmitic acid), C22:6 (DHA), C18:1 (oleic acid) and C18:0 (stearic acid) (Ahmad *et al*., 2005; Zakaria *et al*., 2007; Dahlan-Daud *et al*., 2010). As C16 (palmitic acid) was also prominent in the absence of some fatty acids in a study that used aqueous extract of *Channa striatus* (Zakaria *et al*., 2007), this leads to the suggestion that C16 could play some role in the observable anti-nociceptive effect of the *Channa striatus* extract.

High amounts of arachidonic acid, which has functions in the anti-nociceptive pathways, were found in many studies (Ahmad *et al*., 2005; Zuraini *et al*., 2006; Mat Jais *et al.*, 1994; Abdul Rahman *et al.*, 1995; Chedoloh *et al.*, 2011); they were detectable in polar lipids but not traceable in neutral lipids (Suloma *et al.*, 2008).

Another important fatty acid in *channa striatus* is the DHA, found from about 13% (Zuraini *et al.*, 2006; Chedoloh *et al.*, 2011) up to 17.09% (Suloma *et al.*, 2008) of total fatty acid content. The DHA appears to be present in all types of *channa striatus* extractions except for the haruan traditional extract (HTE); HTE lacks both DHA and EPA (Dahlan-Daud *et al.*, 2010). Although the amount of omega-3 in *Channa striatus* when compared with other freshwater fishes is rather low (Suloma *et al*., 2008), it is a major source of omega-3 for the local populace (Ng, 2006)

Alternative *Channa striatus* fatty acid sources apart from the fillets have also been considered. This includes the roe (Mat Jais *et al*., 1998; Prabakhara Rao *et al*., 2010) and mucus (Mat Jais *et al*., 1998) of *Channa striatus.* This enables the harvesting of optimum amounts of relevant medicinal compositions of *Channa striatus* without sacrificing the fish.

An analysis of *Channa striatus* mucus showed mainly unsaturated fatty acid (oleic acid (C18:1) and linoleic acid (C18:2)) which were in higher quantity than in the roe (Mat Jais *et al*., 1998). The roe of *Channa striatus* in freeze-dried form contained oleic acid at 58.56% and linoleic acid at 26.08% that is reduced to 45.76% and 20.94% in non-freeze-dried form (Mat Jais *et al.*, 1998). Non-freeze-dried roe also contains large amounts of arachidonic acid which was totally absent in the freeze-dried sample, leading to the conclusion that arachidonic acid might have been destroyed during the process of freeze-drying (Hui *et al.*, 2010). Other important saturated fatty acid in the roe include hexa-decanoic acid (16:0) while among the unsaturated fatty acids found in the roe are eicosapentaenoic (20:5, EPA) and docosa-hexaenoic acid (22:6, DHA) (Prabakhara Rao, 2010)

With more evidence-based scientific experiments supporting the ever-popular *Channa striatus,* the fish has retained its status as a prominent local, natural remedy. A survey in 2003 (Ministry of Health, 2003) which looked at public attitude towards supplementary foods found that the use of *Channa striatus*-based supplements remain positive. Its use hinges on several factors, the most important of which are self-belief (76.32%), increased vitality (36.84%) and beautification purposes (2.63%). About 7% of respondents in the survey had also been recommended by modern medical practitioners to use *Channa striatus*, hence demonstrating the faith in the effectiveness of *Channa striatus* across ociety.

The active ingredient in *Channa striatus* is not clear but is thought to be molecules of peptide origin, possibly a glycoprotein, polypeptide or polysaccharide, whose nature can be either a water-soluble polar compound, or a fat-soluble non-polar compound, acting alone or in synergy and interdependent on each other (Zakaria *et al*., 2004 (a)). As lipase seems to exert a positive, enhancing influence in *Channa striatus'* anti-nociceptive property, it is suggested that lipid is involved either as a carrier to the bioactive molecule or as a component of the bioactive molecule itself (Zakaria *et al*., 2004

(b)). Four major fractions representing four different molecules or types of bioactive compounds have been identified. Ranging from as low as 5000 to 30000 dalton in size in the aqueous extract of *Channa striatus* (Zakaria *et al*., 2006), they are thought to be implicated in affecting at least four types of the non-opioid receptors (muscarinic, GABA, a-adrenergic and sero-tonergic) (Zakaria *et al*., 2005 (a)) and the L-arginine / NO / cGMP pathways (Zakaria *et al*., 2005 (b); Raffa & Pergolizzi, 2010)) Similar fractions were found with the water-based haruan traditional extract (HTE) of the fish (Dahlan-Daud *et al.*, 2010).

POST-PARTUM & ENERGY BOOSTER MEAL

Despite the assumed prominent use of *Channa striatus* as post-partum meal, there has been a lack of studies looking at current attitude of post-partum mothers towards *Channa striatus* as a medicinal fish. Only one public health study (Koon, Peng & Karim, 2005) done among Chinese respondents in a Kuala Lumpur maternity hospital involved questions on the consumption of *Channa striatus.* The study is limited in that it did not consider cross-racial attitudes and is restricted to a small segment of an urban Malaysian sample. A comprehensive study that looks into the current food beliefs among post-partum mothers in rural and urban settings in Malaysia and other parts of Asia at the turn of a new globalised century would not only contribute to a greater understanding of public health and its practices, but also would be useful to uncover the hitherto unknown benefits of traditional foods.

WOUND HEALING

The effectiveness *Channa striatus* as a wound healing agent is thought to be influenced by the high level of specific amino acids, like glycine, and fatty acids, such as arachidonic acid, believed to be involved in the promotion of wound healing by the initiation of a series of reactions involving remodeling of collagen, re-epithelialisation of wound and induction of wound contraction.

The encouraging wound-healing properties of *Channa striatus* extract are substantiated by the observation that it is able to affect the tensile strength of the post-operation wound better than established cetrimide cream (Baie & Sheikh, 2000 (a)), inducing more rapid wound contraction (Baie & Sheikh, 2000 (b)) and positively influencing the fibroplastic phase of wound healing with a marked increase in glycosaaminoglycans. Re-epithelialisation of wound healing is also accelerated under the influence of topical application of *Channa striatus* (Mustafa, 2005) with the benefit of rapid cleansing of wound, thus leaving only minimal scarring.

Several forms of formulations have thus far being tested to refine the wound healing effect. Incorporation of *Channa striatus* into palm-oil creams could yield best wound healing results when olein (DFPL 65) is used as stabilisers (Sheikh, Baie & Khan, 2005). The DFPL is the most refined form among the different grades of Malaysian palm oleins and contains B-carotenes and tocopherols, two substances which also have wound healing properties. Several types of aerosol formulations of C*hanna striatus* have also been formulated. These include aerosol formulations with hydroxylpropyl methylcellulose as polymer and glycerine as plasticisers (Febriyenti, Noor & Baie, 2008), aerosol formulations incorporated with fusidic acid (Febriyenti, Noor & Baie, 2010) and a water-based extract of *Channa striatus* (Laila *et al*., 2011). These aerosol formulations allow an increased rate of wound healing while providing more practical, effective and safe practical application to incision and burn wounds.

Channa striatus extracts also have the ability to cause proliferation of mesenchymal cells and maintain sufficient cell viability

for use as a biochemical agent and promoter of healing (Abdul Wahid, Syamsiah & Mat Jais, 2009) which is not limited to dermal wounds but possibly involving other types of organs too.

ANTI-PAIN

The anti-nociceptive property of *Channa striatus* is thought to be due to its glycine and arachidonic acid constituents which are known to be involved in the anti-nociceptive pathway (Kapoor *et al*., 2006). Extracts of *Channa striatus* have superior anti-nociceptive properties compared to other extracts from other channidae (Mohd Hasan, 2005) and work in a concentration-dependent manner (Zakaria, 2005) in a wide range of temperatures and pH (Dambisya *et al*., 1999). The extracts also enhance the activity of other anti-nociceptive agents such as morphine (Mat Jais, Dambisya & Lee, 1997) suggesting a possible interaction with the μ-opioid receptor.

ANTI-INFLAMMATORY & ANTI-PYRETIC

The anti-inflammatory effect of *Channa striatus* extracts in both acute and chronic inflammation appears to be better than that of other channidae (Somchit *et al.*, 2004; Mohd Hasan, 2005). A further test on this property was done using aqueous and lipid-based extracts of *Channa striatus* (Zakaria *et al*., 2008). Given the possible anti-inflammatory property of *Channa striatus* extract, its use in treating diseases with an inflammatory component has been explored in the amelioration of osteoarthritis (Michelle, Shanti & Loqman, 2004; al-Saffar, Ganabadi & Fakuraz, 2011; al-Saffar *et al.*, 2011). They found evidence which signifies reduction of soft tissue swelling and synovial inflammation and significant improvement in the density of PGP 9.5-immunoreactive nerve fibres in the synovial membrane of the osteoarthritis joints in rats. Thus, *Channa striatus* may have a role in the treatment of joint diseases with a clearer inflammatory component such as rheumatoid arthritis.

The anti-inflammatory property may also be the reason behind the observable anti-pyretic activity of the aqueous extract (Zakaria *et al.*, 2008) This anti-pyretic activity, however, is absent in the lipid-based extracts which suggest that the anti-pyretic compound may have been a polar based, water soluble substance.

ANTI-OXIDANTS

Fish is one of the recognised sources of anti-oxidants. Among freshwater fishes, *Channa striatus* appears to have a medium level of anti-oxidant activities (Lokman, 2006) possibly contributed by some of the major amino acids and fatty acids which it contains. (Dahlan-Daud *et al.*, 2010) The anti-oxidants present in *Channa striatus* are most likely to be lipophilic antioxidants which represent powerful defence tools particularly against omega-3 oxidation.

ANTI- FUNGAL & ANTI-BACTERIAL

Most *Channa striatus* fillet extracts have no antibacterial function. Several exceptions include an ethanol extract against *Staphyllococcus aureus* (Mat Jais *et al*., 2008) and an acidic extract against *Klebsiella pneumoniae, Pseudomonas aeruginosa* and *Bacillus subtilis* (Wei *et al*., 2010). Skin mucus and intestinal mucus extract of *Channa striatus* on the other hand show antibacterial activity against *Aeromonas hydrophila* and *Pseudomonas aeruginosa* (Dhanaraj *et al*., 2009).

Anti-fungal activities of haruan extract have only been demonstrated by an ethanolic fillet extract against *Neurospora crassa, Aleurisma keratinophilum* and *Cordyceps militaris* (Mat Jais *et al*., 2008). The same extract also inhibits *Botrytis pyramidalis* and *Paecilomyces fumosa-roseus* on a short-term basis.

CARDIOLOGICAL EFFECTS

Fish oil supplementation is now widely regarded as an effective preventative measure against cardiovascular problems. Italian researchers for example report that fish oil supplementation could be useful in preventing post-operative atrial fibrillation (Calo *et al*., 2005). In *Channa striatus*, the skin extract called shol fish skin extract (SFSE) has been found to contain potent active compound, cardiotoxic factor II (CTF-II) (Karmakar, Dasgupta & Gomes, 2002), with hypotensive effect and cardiotoxic property that influence the increase in cardiac marker enzyme creatine phosphokinase (CPK) and creatine phosphokinase-MB (CPK-MB) values (Karmakar *et al*., 2004)

Characterisation of protein hydrolysates from muscle and myofibrillar samples of *Channa striatus* showed different kinetic and preoteolytic activities (Ghassem *et al.*, 2011(a), and the result led to isolation of angiotensin converting enzyme (ACE) inhibitory peptides with high ACE-inhibitory activity, further supporting the use of *Channa striatus* as a functional food and preventative medicine in hypertensive patients (Ghassem *et al.*, 2011(b)).

HAEMOTOLOGICAL EFFECT

The CTF-II factor found in SFSE also has blood-modulating properties. This factor could induce adecrease in haemoglobin, total RBC, WBC, and platelet count (Karmakar *et al*., 2004).

NEUROLOGY& NEUROPHYSIOLOGY

The skin extract of *Channa striatus* (SFSE) could initiate apnoea and irreversible blockade of nerve-muscle preparation (Karmakar *et al.*, 2002) and influence the serotonergic receptor system hence its possible role as an anti-depressant (Saleem *et al.*, 2010; Saleem *et al*., 2011). It is also able to exert positive changes in the regenerative potential of neurons involved in traumatic injury as observed by neurite outgrowth and multipolarity of cells which took place in phaechromocytoma PC12 cells treated with haruan therapeutic extract (HTE) (Mohd Shafri, Mat Jais & Kyu, 2011). These findings

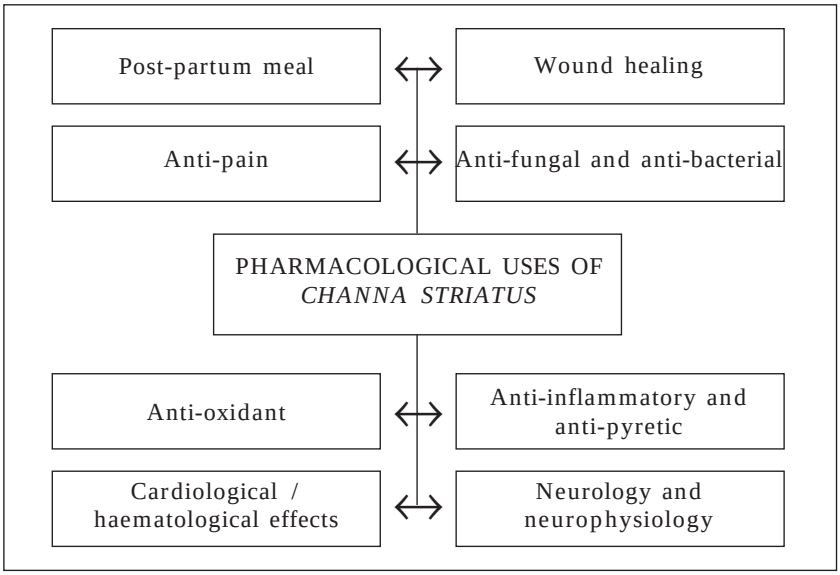

Figure 2: Pharmacological uses of *Channa striatus*

open up the possibility of using *Channa striatus* extract as a regenerative and restorative agent for treating damage to many types of organs.

OTHER USES

High demand for a special diet, increasing awareness about functional food and public concern over bovine spongiform encephalopathy (BSE) has led to increased demand for fish, which in turn has led to higher amounts of byproducts such as fish skin being created. To avoid wasteful disposal of fish skin, researchers are looking at effective and creative way to utilising this valuable source (Babji, Yusop & Ghassem, 2011). One is through the production of gelatin from freshwater fish such as *Channa striatus* which has been shown to be comparable to commercial gelatins made from cold water fishes and bovine skin (See *et al*., 2010). In fact, the quality of gelatin from freshwater fish is superior to those from coldwater fish and closely resemble bovine gelatin. Hence there is a potential for commercial use of freshwater fishes such as *Channa striatus* in various applications particularly pharmaceutical industries.

CONCLUSION

Channa striatus is a medicinal freshwater fish found in several Asian countries and used as medication to treat wounds, alleviate pain and boost energy. Scientific findings have given weight to its traditional uses by elucidating possible compounds that may give rise to the observable therapeutic effects and confirming these effects through *in vitro* as well as *in vivo* studies. C*hanna striatus* extract may also have a role in other non-traditional uses such as in treating neurological diseases and in inducing regenerative potential of organs and cells. Future work on this fish must maintain the dynamism in studies on *Channa striatus* extract that are not confined and limited to its previously known, traditional uses.

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