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# Albumin And Zinc Content Of Snakehead Fish *(Channa striata)* Extract And Its Role In Health

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***Abstract*** One of the nutritional problems of hospitalized patients is hypoalbuminemia. Hospitality malnutrition data in Indonesia shows that 45% -50% of patients suffer from hypoalbuminemia, some of whom are at life-threatening level. In an effort to help patients with hypoalbuminemia is albumin administration in form of Human Serum Albumin (HSA), which until recently is still an expensive choice. Snakehead fish *(Channa striata)* extract has been introduced and significantly proven to increase levels of albumin in hypoalbuminemia and to accelerate the process of wound healing in postoperative patients. This paper aims to describe the nutrients profile of Channa striata extract and their role in health.
Snakehead is one of native freshwater fish that is widely available in many tropical regions such as Asia and Africa, and has been shown to have high nutrition and health benefits. Snakehead extract contains abundant of albumin (2.17 ± 0.14g/100mL) which is the largest fraction (64.61%) of protein. This is sufficient to provide albumin for highly demanded such as hypoalbuminemia and post-surgical patients, and growing children. Snakehead extract is a potential source of albumin as per 100 mL it contains 3.36± 0.29 g protein, 2.17± 0.14 g albumin, 0.77± 0.66 g total fat ; Total Glucose 0.07 ± 0.02 g, Zinc 3.34 ± 0.8 mg; Cu 2.34 ± 0.98 mg and 0.20 ± 0.09 mg Fe.

Key-Words: *snakehead fish, Channa striata extract, albumin, hypoalbuminemia, Zn, wound*

## 1. Introduction

"A balanced diet is the key to good nutrition" clearly suggests a way to achieve good nutrition through varying foods in the sufficient amount and quality. The shift of diet from traditional to more western-style that tends to have high-fat, low sugar and protein and fiber content in the large cities, causes imbalance intake of nutrients . A book entitles "You are what you eat" highlights the importance of foods selection, the amount as well as the frequency of consuming them. Foods people eat indeed have direct effects on their health [1].

Increase in social and economic status of community may have negative effect on meeting of recommended dietary allowance (RDA) when a sedentary life style is at the same time practiced. This is very likely to be the trigger for the onset of diseases caused by over nutrition and degenerative disorders such as diabetes mellitus (DM), hypertension, heart disease, cancer, and other health problems [2].

One of the common nutritional problems among in-hospital patients is hypoalbuminemia. Data on hospital malnutrition in Indonesia shows that 45% -50% of patients experienced hypoalbuminemia, some of whom are at severe level. The hypoalbuminea causes 90% of hospitalized patient to have longer stay in hospital as compared to those with good nutritional status [3]. An effort to treat hypoalbuminemia is administration of Human Serum Albumin (HSA), which until recently is still an expensive choice.

Fish is an animal food that contains proteins of good quality due to complete content of essential amino acids. Fish can be extracted to obtain plasma protein (sarcoplasmic) containing albumin and other nutrient which has potency to improve hypoalbuminemia condition [4,5]. Fish extract that are most used currently is obtained from snakehead fish (Channa striata). The snakehead extract may be used as both human serum albumin substitute and pharmaceutical ingredients [6].

Snakehead fish extract significantly increases levels of albumin in hypoalbuminemia and accelerate the process of wound healing in post-operative patients [7, 8, 9, 10, 11]. The potential of the extract in tissue synthesis, wound healing, and inhibiting free radical production are important in regenerative medicine as well as anti-aging agent. This topic is recently largely discussed, including in "The 7th Asia Pacific Conference on Anti-Aging and Regenerative Medicine", in Bali October 2008.

Beside extract, in form of cream the snakehead has capability to improve skin tensile strength. The process by which this occurs resembles to the fourth phase of the final step of normal wound healing. The presence of granulation tissue increases wound tensile strength. The detail mechanism of wound healing process, however, still needs further research [12, 13]. This paper is a review of the nutritional values contained in the extract of snakehead fish and its role in health.

## 2. Review of References

### 2.1. Biological Characteristic of Snakehead

Snakehead is a type of freshwater fish that nutritionally of high values. The fish is native to tropical regions such as Asia and Africa [14]. The fish can be easily found in various open waters in Indonesia, mainly in the island of Java, Sumatra, Kalimantan, Sulawesi, Bali, Lombok, Singkep, Flores, Ambon and Maluku under a various local names [15]. The local names for snakehead include Kutuk (in Java), Kocolan (in Betawi), Aruan or Haruan (in Malaysia and Banjarmasin). In English it is known as the common snakehead, snakehead murrel, chevron snakehead, or striped snakehead. The scientific name is Channa striata, the fish is identified as the following:

| | |
|---|---|
| Kingdom | : Animalial |
| Phylum | : Chordate |
| Class | : Actinopterygii |
| Order | : Perciformes |
| Family | : Channidae |
| Genus | : Channa |
| Species | : **C. striata** |

Snakehead fish which is a carnivore and also a predator has not been widely cultivated. It is nearly spherical in shape, lengthy and more compressed as getting to the back. The back part of the fish is convex, while the stomach is quite flat with head like those of a snake. The fish is dark green on the back and cream or white on abdomen, and has a wide long anal fin, semicircular tail fins, and broad with rounded pectoral fin. The snakehead also has a dorsal fin and hard spines inside. The fish can reach a length of 90-110 cm [16]. Snakehead morphology is depicted in Figure 1.

**Figure 1.** Snakehead/Channa striata

Snakehead usually lives in estuaries or lakes, and may inhabit dirty water, ditches, rice fields, ponds, and even abnormally is able to withstand the drought. This fish can survive in the dry season by burying themselves in the mud, breathe in anaerobic way and may jump to dry land. As a predator and a carnivore in nature the fish preys on small fish, frog, young turtle and even duckling that are around [17]. The predatory behavior of the fish is investigated in which various sizes of six snakehead fishes were put in an aquarium with fish of large, medium and small in it as prey [18]. The snakehead fishes scrambled to prey on small fish first, then the medium and ultimately the large size of the fishes. The peak time of eating was in the morning and evening and in just 45-50 seconds the prepared preys run out. Then, it appeared that some of the snakehead fishes were in fight each other by attacking the head, mouth and fin areas and this even ended up with body cavities creation. After 2 to 3 days later on amazingly they still survived.

Snakehead and similar fishes, have recently received attention from researchers. Acidic mucus extracts of the fish has the ability to fight bacterial activity and to inhibit the growth of several human pathogenic bacteria such as *Klebsiella pneumoniae, Pseudomonas aeruginosa* and *Bacillus subtilis* [19]. This suggests that the extracts may have potential antimicrobial agents both in human and fish. Nitric oxide may play a role in inhibiting the occurrence of pigment aggregation on the melanophores in Indian Snakehead teleost, Channa punctatus, induced by extra-cellular calcium (+2) at each concentration level [20].

The fish provides good source of albumin for people who has low albumin serum or injuries, burns or has been in post-operative condition. In rural areas, the snakefish is traditionally administered to boys who are just after having circumcised to accelerate healing process. The fish is first steamed to obtain the extract, and this extract is then used as an extra menu for the patients. The administration is positively correlated to elevated levels of plasma albumin and postoperative wound healing [21].

## 2.2. Nutrient content of Snakehead extract

Snakehead contains higher protein than that of similar fishes as listed in Table 1.

**Table 1.** Protein Content of Snakehead and Other fishes [22]

| Fish | Protein (g%) |
|---|---|
| Patin | 17.0 |
| Snakehead | 16.2 |
| Gold fish | 16.0 |
| Sepat (trichogaster trichopterus) | 15.2 |
| Baung | 15.1 |
| Belida | 14.7 |
| Eel | 14.6 |
| Rabbit fish | 14.5 |
| Tongkol | 13.7 |
| Teri | 10.3 |

The basic principle of making snakehead extract is the extraction of plasma proteins of the fish. Albumin is heat sensitive protein therefore techniques and temperature during extraction should be properly controlled. A proper process produces white to yellowish extract, less sediment, and typical sharp fishy odor. This pungent flavor may be reduced by adding spices. A typical process of making snakehead extract is presented in Figure 2.

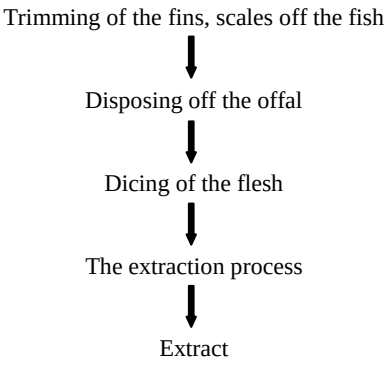


**Figure 2.** A typical process of making snakehead extract

Snakehead extract contains proteins with albumin being the major fraction, fat, glucose and some minerals Zn, Cu, and Fe as presented in Table 2.

**Table 2.** Nutritional Composition of Channa striata Extract in 100 milliliters [5]

| Nutrient | Value |
|---|---|
| Protein (g) | 3,36 ± 0,29 |
| Albumin (g) | 2,17 ± 0,14 |
| Total fat (g) | 0,77 ± 0,66 |
| Total glucose (g) | 0,07 ± 0,02 |
| Zn (mg) | 3,34 ± 0,8 |
| Cu (mg) | 2,34 ± 0,98 |
| Fe (mg) | 0,20 ± 0,09 |

Snakehead albumin content is comparable to that of other food sources of albumin such as egg. albumin content of snakehead and some foods are presented in Table 3.

**Table 3.** Albumin Content of Some Food Sources

| Food | Albumin (%TP) [10] | Protein (%)[23] |
|---|---|---|
| Soybean | 10 | 40.4 |
| Groundnut | 15 | 27.9 |
| Rice (dehulled) | 21 | 7.8 |
| Rice (milled) | 10.8 | 8.4 |
| Sticky white rice (dehulled) | 20.2 | 7.4 |
| Wheat flour | 14.7 | 9.0 |
| White egg (oval and conal) | 73 | 10.8 |
| Snakehead fish | 2.17 | 16.2 |

Snakehead protein compos of essential amino acid-amino acids required by the body. Amino acids in the protein composition snakehead and other fish can be seen in Table 4 and 5.

**Table 4.** Amino Acid Profile of Snakehead [5]

| Amino Acid | Content (mg/g) |
|---|---|
| Arginine | 360 |
| Phenylalanine | 230 |
| Histidine | 130 |
| Isoleucine | 320 |
| Leucine | 470 |
| Lysine | 560 |
| Methionine | 180 |
| Cysteine | 70 |
| Threonine | 280 |
| Tyrosine | 190 |
| Tryptophan | 60 |
| Valine | 330 |

**Table 5.** Snakehead, Egg White, and Soybean Amino Acid Contents

| | Egg White (g/100g)[24] | Snakehead (µg/mg)[5] | Soybean (g/16 N)[24] |
|---|---|---|---|
| Phenylalanine | 0.69 | 0.750 | 4.9 |
| Isoleucine | 0.70 | 0.838 | 4.5 |
| Leucine | 0.95 | 1.496 | 7.8 |
| Methionine | 0.42 | 0.081 | 1.3 |
| Valine | 0.84 | 0.866 | 4.8 |
| Threonine | 0.48 | 0.834 | 3.9 |
| Lysine | 0.65 | 1.702 | 6.4 |
| Histidine | 0.23 | 0.415 | -- |
| Aspartic | 0.85 | 1.734 | -- |
| Glutamic | 1.52 | 3.093 | -- |
| Alanine | 0.65 | 1.007 | -- |
| Proline | 0.41 | 0.519 | -- |
| Arginine | 0.63 | 1.102 | -- |
| Serine | 0.75 | 0.675 | -- |
| Glycine | 0.40 | 0.728 | -- |
| Cysteine | 0.26 | 0.016 | 1.3 |
| Tyrosine | 0.45 | 0.538 | 3.1 |

As for fish protein in common, snakehead protein contains three types proteins, namely soluble protein (which is easily removed by extraction), connective tissue stromal proteins, and sarcoplasmic contractile proteins which is a fluid that exists between myofibril [25]. Sarcoplasmic protein or known as myogin includes albumin, myoalbumin, myoprotein, globulin-X and myostromin. Albumin, myoprotein, and myoalbumin have is highly water soluble. Whereas myostromin and globulin is not soluble in water but in weak acid or base solution. This protein is soluble in water and salt solutions of low ionic strength (salt concentration 0.5%), and can be coagulated with high temperatures (90$^{o}$C). Sarcoplasmic protein content varies among different species and

even between types of red flesh and white flesh. White fleshy fish contains sarcoplasmic protein higher than that of red fleshy fish [21].
Snakehead extract is also rich in zinc. Although some food contains higher zinc that snakehead do, zinc content of snakehead is still relatively high as compared to common food sources. The zinc content of some foods is shown in Table 6.

**Table 6.** Zn Content of Snakehead and Other Foods (mg/100g) [**5,22*]

| Food | Zinc Content | Source |
|---|---|---|
| Channa striata extract | 3.34** | Santoso, 2009 |
| Channa striata | 0.4* | Mahmud, et al., 2009 |
| Tuna | 1.6* | Mahmud, et al., 2009 |
| Chicken egg | 1.5* | Mahmud, et al., 2009 |
| Duck eggs | 1.8* | Mahmud, et al., 2009 |

## 2.3. Role of Snakehead Extract in Health

Hypoalbuminemia is related to the following three common causes: lack of raw materials for protein synthesis (amino acids from foods), liver disorder, and loss of albumin through a disposal or excretion [26]. Health food producer has begun to take advantages of snakehead for the production of several healthy foods, such as ice cream, pudding, porridge, fish nuggets, meatballs and jelly candies. Consumption of these products may increase nutrients intake to meet the body's need for albumin and other nutritional substances as recommended.

Some important nutrients contained in snakehead extract, such as amino acids and fatty acids, play important roles in the synthesis of collagen fibers during wound healing process. Snakehead extract this regard has better performance as compared to centrimide which is more commonly used medication to treat wound. The glycine contained which is rich in arachidonic acids acts as a precursor of prostaglandins, whereas the poly unsaturated fatty acids promote prostaglandins synthesis and may increase tensile strength [12].

Inclusion of snakehead extract in hypoalbuminemia patient diets significantly increases serum albumin levels of the patient. Administration of snakehead extract obtained from 2kg snake heads daily for consecutives five days for hypoalbuminemia increases albumin level from 1.8 g/100ml to normal condition, > 3.5 g/100 ml [21].

Administration of snakehead extract for postoperative patients accelerates the process of tissue formation. Serum albumin levels significantly correlates to the rate of wound healing. Wound healing very likely requires protein, amongst other important substances, as a basis for the formation of collagen tissue. Studies show a significant association between serum albumin administration and the length of wound healing episode ($p = 0.001$). Albumin functions as binding and transport substance, osmotic pressure regulation, inhibition of platelet formation and anti-thrombosis, increasing cell permeability, and as antioxidants [27, 28].

Other research demonstrates that snakehead albumin powder is the more effective to heal wound of white wistar (Rattus novergicus) compared to powder obtained from goldfish (Cyprinus carpio), catfish (Clarias gariepinus) and milkfish (Chanos chanos) [21,6].

Hypoalbuminemia is commonly found in malnutrition, hunger and cases of gastrointestinal pathology in relation to the digestibility and protein absorption dysfunction. The low albumin level causes osmotic blood pressure to decrease, leading to seepage of fluid through blood vessels which may result in edema [29].

The protein content of snakehead extract is 3:37% and is comparable to cow's milk protein content (3.2%), but is lower than egg white protein (10.8%) [22]. The extract contains Zn of $3.43 \pm 0.28$ mg/100ml. As compared to Zn content of some foods, snakehead extract Zn is still higher (Table 5).

Zn deficiency is associated with changes in immune system such as decrease of B and T cells functions, hypersensitivity reactions, phagocytosis, and cytokine production. Zn deficiency also causes disruption of microbial destruction and wound healing process. Administration of Zn per oral effects on alkaline phosphatase level and accelerate the healing process of surgical wounds. This could be due to the fact that Zn plays important role in protein synthesis and in the cell multiplication. Human body consists of connective tissues made of protein, so as to establish and maintain the integrity of connective tissue is required Zn [30]. Zinc deficiency is also associated with impaired sense of taste. Children who have a low content of Zn in their hair have abnormalities in the sense of taste. This can be cured with zinc supplementation [31].

Cu contained in the extract of snakehead is an important mineral which relates to Fe because of similar in nature and its role. In the body, Cu is stored in the liver and in small amounts found in brain, bone marrow, spleen, heart, and kidney [32]. Cu plays very important role in several enzymes function, especially amine oxidase and pyridoxal phosphate. Cu is associated with the unification of collagen and elastin. Animals fed with Cu deficient diet is reported to experience heart muscle problem which may relate to the absence of unification of tissue collagen and elastin. Cu is also responsible for maintaining the integrity of myelin membranes, and

formation of bone and connective tissue, melanin in the skin and hair, and normal function of heart and reproductive organ. Cu deficiency may also associate with impaired immune response, reticule endothelial function and activity of phagocytes. This shows the interference of Cu on the superoxide dismutase (SOD) and cytochrome oxidase. Furthermore, Cu deficiency can lead to decreased antibody response to dependent T-antigen.

The requirement of Cu for children is 0.08 mg/kg body weight, and 0.03 mg Cu/kg for adult. Provision of 3 ml/kg body weight of snakehead fish extract daily contributes Cu intake of 3.28 mg and this meets Cu daily requirement. Thus snakehead extract may be classified into a good food source of Cu. However, the extract is not a good source of Fe, a 100ml of extract provides about 0.81mg. The same provision of extract will only supply 8.6% of recommended intake.

## 3. Discussion

In daily menu, fish serve as source of animal protein. Apart from protein, it biologically composes of carbohydrates, fats, vitamins, and enzymes [32]. Fish protein content varies between 16-20% [33]. Ironically, to date in some regions there are custom in which consuming animal dishes such as fish, eggs and meat after surgery is prohibited. It is even worse because people are advice to only eat rice with little salt and/or fried onion [34]. In the body protein is a component of cell structure, antibodies, and hormones and enzymes. The protein is required for cells to grow, to maintain cell membranes [35]. The protein which is required to this function is plasma protein. In blood plasma the amount of albumin varies between 3.5 to 5.5 g/dl, whereas globulin is only 1.5 to 3g/dl [36].

The major fraction of snakehead extract protein is albumin (64.61% of total protein). Snakehead extract albumin is relatively high (2.17 ± 0.14 g/100 ml), sufficient enough to use as ingredient to increase intake of both the growing children and patient undergoing wound healing treatments. Snakehead extract albumin is of higher quality than that of egg albumin. Provision of snakehead extract to patients with liver cirrhosis significantly increases serum albumin levels higher than administration of egg white [11]. Albumin contains many sulfhydryl groups (-SH) that can serve as radical binder and plays an important role in sepsis. Physiological solution of human serum albumin has been shown to inhibit free radical production by polymorph nuclear leukocytes. This binding capacity is related to the abundance of sulfhydryl groups (-SH) in the albumin [26].

Human Serum Albumin (HSA) is commonly used to treat patients with hypoalbuminemia. Based on data from Pharmalab Intersains Dipa (2004), albumin is yet a fairly expensive imported commodity. HAS costs ranging from $33 per 50 ml - 165 per100 ml. The price of packaging with 50 ml and 100 ml with a concentration of 5%, 20% and 25% ranges between A series of post-surgery patients needs 2 – 4 bottles of imported HSA. The prices of 600ml and 200mlg HSA are $202 and 175 respectively. This equals to 200 ml). Therefore, it is necessary to find a cheaper source of albumin but have the equal physiological potency as HAS [21].

Snakehead extract has been clinically tested on post-surgical patient with low albumin levels (1,8 g/dl) of General Hospital Dr. Syaiful Anwar Malang, East Java. Administration of snakehead extract obtained from 2kg fish daily increases albumin to normal level (3.5 to 5.5 g / dl) and the wound healed for 8 days without observable side effects. The study also indicates that diet of 15 eggs per day for 8 days gives similar albumin increase, however the cholesterol levels also elevates. This endangers health of patients with high cholesterol risk [37].

Both albumin and Zn are important for wound healing since the protein is able to bind Zn and transports it in the blood plasma [29]. Zn deficiency decreases wound healing process [38]. As these nutrients, and other vitamins, present in snakehead extract, the extract may trigger formation of Endothelial Progenitor Cell (EPC) and accelerate wound healing [7]. The presence of Zn in snakehead extract is likely to be key factor that plays role in wound healing and children appetite. Administration of snakehead extract to loss-appetite children has been shown to increase their appetite. As metaloenzim component, in the body Zn is required in almost all aspects of cellular metabolism. Zn is an essential mineral in the structure and function of cell membranes. Zn supplementation may limit membrane damage caused by free radicals during inflammation. Furthermore, Zn also involves in the immune system, ranging from defense systems by the skin to gene regulation in lymphocytes.

Human body contains Zn ranging from 1.4 to 2.3g, in the plasma Zn content is about 100 mg/100mL. The daily requirement of Zn for adult is 15 mg/day. Snakehead extract Zn content is 3.43mg/100mL, administration of 30mL/kg/day of the extract as part of diet has a contribution of 31.98% of recommended dietary intake. Thus, the extract is reasonably a good source of Zn.

Another important mineral found in snakehead extract is Cu. Deficiency of Cu is associated with impaired immune response, reticule endothelial function and activity of microbial cells phagocyte. Cu deficiency can also lead to decreased antibody response to T-dependent antigen.

The Cu daily requirements are 0.08mg/kg and 0.03mg/kg body weight for children and adult respectively.

## 4. Conclusion & Further Direction

1. Snakehead fish extract is a good source of important nutrients, especially albumin and Zn. Each 100mL of the extract contains 3.37 g protein, 2.17 g albumin, 0.77 g fat, 0.07 g glucose, 3.34 mg Zn, 2.34 mg Cu, and 0.20 mg Fe.
2. Snakehead fish extract has a good potential to increase serum albumin post-operative patients. It also has antioxidants capacity which reacts with free radicals and suppresses its production.
3. Increase of serum albumin is positively correlated to wound healing process.
4. Provision of 100mL snakehead extract provides 10% of daily protein and Fe requirements and 20% of Zn.

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