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## Short Communication

# Physicochemical properties and composition of Snakehead fish (*Channa striatus*) whole fillet powder prepared with pre-filleting freezing treatments

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**Abstract**

*Channa striatus* ("*haruan*") fish destined for fillet preparation was subjected to two freezing treatments, freezing with distilled water (FW) or freezing directly without distilled water (DF). Fish that was freshly processed without freezing served as control (C). Fillet yield (%) was in the range 33.8% to 35.3% and the highest yield was recorded in FW samples. Whole Fillet Powder (WFP) was prepared from the fillets through low temperature vacuum oven drying (50°C) and its composition and physicochemical properties were assessed. There was no significant difference in moisture and protein contents of all samples ($p > 0.05$). All WFP were generally dark in colour with whiteness indices ranging from 55.23 - 63.98. The redness ($a^*$) values were 4.33, 11.12, 8.83 whilst the yellowness ($b^*$) were 19.31, 23.04, 21.20 for C, WFP-FW and WFP-DF respectively. WFPs were generally high in histidine, arginine, threonine and tyrosine when compared to egg whites and these (except histidine) and other amino acids (serine, glycine, methionine and phenylalanine) were significantly higher ($p < 0.05$) in WFP-FW compared to other samples. Overall, freezing treatments affected the composition and physicochemical properties of WFPs.



## Introduction

Belonging to the family of Channidae, "*haruan*" is a fish that is widely consumed throughout South-East Asia, China and India for its biomedical properties (Mat Jais, 2007). *Haruan* has been known to have reputable positive effects on wound healing (Wee, 1982; Baie and Sheikh, 2000), pain reduction (Burstein *et al*., 2000) as well as anti-inflammatory attributes (Somchit *et al.*, 2004) due to its high levels of arachidonic acid and key amino acids such as aspartic acid, glycine and glutamic acid (Zuraini *et al*., 2006) that are also the key ingredient for polypeptide formation which is responsible for growth and wound healing (Heimann, 1982; Chyun *et al*., 1984). To date, products made from *haruan* are only available in liquid form, which is for consumption purposes or in cream form, which is for external use for skin treatment only. Liquid form of *haruan* extracts frequently poses problems of limited shelf life, physicochemical instability and restricted mobility due to presence of heavy weighted water (Hui *et al*., 2010).

*Haruan* are known to secrete mucus upon subjected to stress as a protection coat between the environment and the fish (Mat Jais *et al.*, 1998). This barrier makes the fish very slippery and hard to handle, affecting the fillet yield. When the fish is placed in a plastic bag filled with distilled water at a certain ratio at low ambient temperature ( $\geq 0$°C), the fish secretes slimes into the distilled water (Mat Jais *et al.*, 1998; Hui *et al*., 2010). The migration of slime may have occurred due to the differences in concentration of solutes because during freezing, ice crystal forms and solute concentration changes as water freezes out resulting in dehydration of fish tissues (Shenouda, 1980; Careche *et al*., 1999). Interestingly, if slime secretion can be induced by freezing the fish first in water before filleting, this will ease handling during processing of fillet into whole fillet powder. Nevertheless, the composition and physical properties of the powder prepared from fish that are frozen with or without water needs evaluating.

As far as we know, the studies on handling of *haruan* prior to filleting and also the evaluation of *haruan* powder are scarce. The objective of this study was to evaluate the effects of pre-treating the fish with different freezing conditions on fillet yield, composition and physicochemical properties of the whole fillet powder (WFP).

## Materials and Methods

Thirty live commercial *Haruan* fish (*Channa striatus*) were acquired from a local hypermarket (ten

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for control, C; ten for freezing with distilled water, FW; and ten for directly freezing without distilled water, DF). Only fishes weighing between 250 g to 450 g were used. Fishes were killed on the spot using ice (Rahim *et al*., 2009).

*Freezing pre-treatment*

Two types of freezing conditions were used. The fishes were frozen with distilled water (FW), frozen directly without water (DF) or freshly processed without freezing (control, C). All fishes were weighed and measured individually and their weights and total length were recorded.

In FW samples, each fish was placed into a clear plastic bag, filled with equal weight of distilled water and sealed with a commercial portable sealer machine and placed in -20ºC freezer for approximately 8 h. This was then transferred to a refrigerator (4 - 6ºC) to thaw overnight. For DF samples, the steps were similar to that of FW except that no distilled water was added before putting the fish in the freezer.

*Filleting*

Each fish was rinsed under running tap water prior to filleting. To maximize yield with minimum amount of bones during filleting, fish was cut lengthwise along the back bone from the neck all the way to the tail (Zakaria *et al.*, 2007). Skins were then removed and only fish flesh were put on ice to maintain freshness of the fillets. Fillets were cleaned with distilled water, patted dry with kitchen towel and placed in a pre-weighed container. Weights of fillet harvested were recorded. Fillet yield was calculated based on the formula below (Powell *et al*., 2008):

$$\text{Fillet Yield \%} = \frac{WH}{WW} \times 100 \qquad (1)$$

where, WH represents weight of fillets harvested in g and WW represents weight of whole fish in g.

*Preparation of whole fillet powders (WFP)*

Fish fillets were minced using a food cutter (HOBART, model 84145 Food Cutter, USA). Minced fillets of 200 g were collected and spread into a thin and even layer on a piece of grease proof paper followed by drying in a vacuum oven (Louka *et al*., 2004). Minced spread was placed onto a stainless steel wire grid cooling rack and into a vacuum oven (BINDER GmbH, model VD53, Germany) set to temperature of approximately 50ºC for 24 h. The dried product was then blended in a commercial kitchen blender to form whole fillet powder (WFP). WFP was stored in an air tight container and kept in a fridge (4ºC) until further analysis.

*Proximate analysis*

Proximate analysis was performed according to Association of the Official Analytical Chemists (AOAC, 1998) standard methods. Moisture and ash content was determined using AOAC method 930.15 and 935.42 (AOAC, 1998) respectively. Protein content was determined using Nitrogen Determination by Kjeldahl method from AOAC method 981.10 (AOAC, 1998). Conversion factor used to calculate crude protein content was 6.25. To determine crude fat of samples, AOAC method 920.39 (AOAC, 1998); Soxhlet extraction with diethyl ether was used.

*Measurement of colour*

The colour of WFP samples was determined using a Konica Minolta Spectrophotometer (Minolta Co. Ltd, model CM-3500d, Japan) together with Spectramagic software at Illumination D65. Calibration was performed using a Zero calibration box followed by a white calibration plate and results were reported as $L^*$, $a^*$ and $b^*$. Whiteness of sample was calculated using the following equation (Park *et al*., 2004):

$$WI = 100 - [(100-L^*)^2 + a^{*2} + b^{*2}]^{0.5} \qquad (2)$$

where, WI represents Whiteness Index, $L^*$ represents lightness, $a^*$ represents redness and $b^*$ represents yellowness.

*Amino acid analysis*

Amino acid composition was determined by acid hydrolysis according to methods of Gan (2008). Dried samples of 0.1 g were carefully weighed into tubes and hydrolysed in 5 mL of 6 N hydrochloric acid at 110°C for 24 h. Hydrolysates were added to 400 µL of 50 µm/mL AABA (L-α-amino-n-butyric, as internal standard). Deionised water (ELGA LabWater, UK) was utilized to top up the sample to 100 mL. Filtration was then conducted using Whatman No. 1 filter paper (Whatman, UK) followed by a 0.22-µm PTFE membrane filters (Millipore, USA) prior to derivatisation. Filtrates of 10 µL were added to 70 µL borate buffer and 20 µL AccQ.Flour ™ reagent (AQC: 6-aminoquinolyl-N-hydroxysuccinimidyl carbamate) for derivatisation of 1 min at RT and subsequently 10 min at 55°C water bath. Hydrolysates of 10 µL were injected into a column of an automated amino acid analyzer L-8500 (Hitachi, Japan). Net height of each peak representing individual amino acid produced by chart recorder of analyzer were measured, calculated

and recorded. Values of amino acid were reported as g / 100 g of sample.

*Statistical analysis*

Mean values obtained from fillet yield, proximate analysis, colour and amino acid composition for each sample were subjected to One-Way ANOVA using SPSS Statistics for Windows, Version 17 (SPSS Inc. Released 2008, Chicago) followed by Post Hoc and Bonferroni descriptive test. This is to evaluate for any statistical significant differences ($p < 0.05$) among the samples prepared from the different pre-filleting treatment of the fish.

## Results and Discussion

*Influence of freezing treatments on slime*

Slime or mucus is made up of watery substances and high-molecular-weight, gel-forming macromolecules that makes the fish slippery to touch and thus difficult to handle (Shephard, 1994). It was not practical to measure the degree of sliminess of the fish, however based on observations on the surface appearance of the fish, there appears to be a difference in slime excretion by the fish after freezing (Figure 2). Arranged in the order from slimiest to the least slimy was DF>C>FW. FW samples appeared to be the least slimy and were the easiest to handle. This similar observation has been reported by Hui et al. (2010) where *Haruan* that was incubated in a fridge with distilled water had reduced amount of slimes, and were easier to handle.

The frozen fishes were processed into fillet. There was no significant difference ($p > 0.05$) in the yield of control and DF fillet (around 34%; Figure 1). However, FW samples displayed a significantly higher ($p < 0.05$) fillet yield (35.73%) compared to other samples. Even though this looks marginal, it is possible to relate the higher yield of FW fillet to the reduced sliminess of the fish right after freezing. This reduced in sliminess occurs because all or most of the slimes has been secreted out and into the distilled water.

*Proximate composition*

The proximate composition of WFP is shown in Table 1. There was no significant difference ($p > 0.05$) in the water content between the three samples that ranged from 6.86% to 7.00%. The crude protein content for WFP-C was the lowest (87.93%) while WFP-DF and WFP-FW showed no significant difference ($p > 0.05$) but with very high percentage of more than 90%. Lipid content showed a vast range ranging from 2.89% in DF samples all the way to 8.54% in C samples. Lastly, results for crude ash showed result that ranges from 4.75% to 5.16%.

Table 1. Proximate composition[1] of whole fillet powder (WFP) prepared from *Channa striatus* in percentage (%)

| Sample | Moisture (% WB) | Protein (% DB) | Lipid (% DB) | Ash (% DB) |
|---|---|---|---|---|
| WFP-C | 6.86 ± 0.64[a] | 87.93 ± 0.19[b] | 8.54 ± 0.28[a] | 4.82 ± 0.17[a] |
| WFP-FW | 7.00 ± 0.04[a] | 92.89 ± 0.36[a] | 2.98 ± 0.91[b] | 5.16 ± 0.13[a] |
| WFP-DF | 6.91 ± 0.07[a] | 94.78 ± 0.98[a] | 2.89 ± 0.14[b] | 4.75 ± 0.14[b] |

Notes: WB, wet basis; DB, dry basis; C, without freezing; FW, after freezing with distilled water; DF, after freezing directly without distilled water. Carbohydrate was not determined.
[1] Values are means ± SD of three separate determinations. Means with the same superscript letter in each column are not significantly different ($p > 0.05$).

Table 2. Colour $L^*a^*b^*$ values[1] of whole fillet powder (WFP) prepared from *Channa striatus*

| Sample | CIE Colour Parameter | | | Whiteness Index (WI) |
|---|---|---|---|---|
| | *L** | *a** | *b** | |
| WFP-C | 69.91 ± 0.32[a] | 4.33 ± 0.17[c] | 19.31 ± 0.25[c] | 63.98 ± 0.40[a] |
| WFP-FW | 61.65 ± 0.18[b] | 11.12 ± 0.22[a] | 23.04 ± 0.17[a] | 53.90 ± 0.19[b] |
| WFP-DF | 61.58 ± 0.42[b] | 8.83 ± 0.17[b] | 21.20 ± 0.19[b] | 55.23 ± 0.32[c] |

Notes: $L^*$, lightness; $a^*$ redness; $b^*$, yellowness. C, without freezing; FW, after freezing with distilled water; DF, after freezing directly without distilled water. a: highest, c: lowest.
[1] Values are means ± SD of three separate determinations. Means with the same superscript letter in each column are not significantly different ($p > 0.05$).

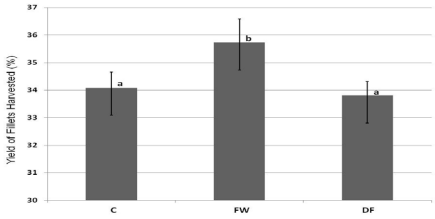


Figure 1. Mean fillet yield ± SD of *Channa striatus* for each pre-treatment (n = 10). Means with the same superscript letter are not significantly different ($p > 0.05$). C, without freezing; FW, after freezing with distilled water; DF, after freezing directly without distilled water.

When compared to reported proximate composition of dried fillets of other fresh water fish such as dried grass carp (Wu *et al*., 2008) and catfish (Chukwu *et al*., 2009), moisture content for all WFPs were lower. However, the difference in drying time and the temperature used by the various authors could have caused the differences in moisture content. All crude protein contents of WFPs were considerably high and were higher than that of the reported protein content for dried grass carp fillets and catfish which was approximately 87.1% and 67.21% respectively suggesting *Haruan* as a good source of protein. However, when compared to reported proximate composition of raw wild Channa striatus flesh (Zuraini *et al.*, 2006), moisture and fat content were lower but protein and ash content were higher. Changes in moisture were induced by oven drying resulting in higher protein levels in WFPs than in raw fish as reported by previous studies (Gall *et al.*, 1983; Gokoglu *et al.*, 2003).

*Colour*

When observed qualitatively, all samples were light reddish-brown in colour. Upon further

Table 3. Amino acid composition of whole fillet powder (WFP) prepared from *Channa striatus* and adult and infants' suggested essential amino acid intake. All data were expressed in g of amino acid per 100 g of protein

| Amino acid | Composition of samples | | | | Suggested Intake | |
|---|---|---|---|---|---|---|
| | WFP-C | WFP-FW | WFP-DF | Egg albumin[2] | EAA[5] | EAA[6] |
| Aspartic acid | 8.59 ± 0.68[a] | 6.44 ± 0.03[b] | 9.09 ± 0.42[a] | 9.20 | NA | NA |
| Serine | 4.79 ± 0.09[b] | 5.26 ± 0.04[a] | 4.81 ± 0.10[b] | 8.50[3] | NA | NA |
| Glutamic Acid | 13.31 ± 0.68[a] | 10.77 ± 0.09[b] | 13.85 ± 0.43[a] | 15.70 | NA | NA |
| Glycine | 1.17 ± 0.56[b] | 3.45 ± 0.04[a] | 1.00 ± 0.19[b] | 3.20 | NA | NA |
| Histidine[4] | 7.74 ± 0.77[a] | 8.01 ± 0.06[a] | 7.13 ± 0.23[a] | 2.41 | 1.6 | 2.6 |
| Arginine | 8.68 ± 1.15[b] | 10.74 ± 0.15[a] | 8.19 ± 0.13[b] | 5.90 | NA | NA |
| Threonine[4] | 5.19 ± 0.19[b] | 6.39 ± 0.07[a] | 4.98 ± 0.09[b] | 4.00 | 0.9 | 4.3 |
| Alanine | 5.60 ± 0.22[b] | 4.45 ± 0.03[a] | 5.75 ± 0.13[b] | 5.70 | NA | NA |
| Proline | 3.63 ± 0.12[a] | 3.36 ± 0.03[b] | 3.67 ± 0.08[a] | 3.80 | NA | NA |
| Methionine[4] | 3.51 ± 0.20[b] | 4.29 ± 0.03[a] | 3.35 ± 0.19[b] | 5.40 | 1.7[7] | 4.2[7] |
| Cystein | 0.95 ± 0.23[a] | 0.73 ± 0.40[a] | 0.82 ± 0.47[a] | - | NA | NA |
| Phenylalanine[4] | 5.27 ± 0.25[b] | 6.64 ± 0.01[a] | 5.24 ± 0.14[b] | 7.50 | NA | NA |
| Tyrosine | 4.53 ± 0.14[b] | 6.10 ± 0.04[a] | 4.62 ± 0.14[b] | 3.75 | NA | NA |
| Valine[4] | 5.23 ± 0.10[a] | 4.94 ± 0.02[b] | 5.33 ± 0.05[a] | 8.80 | 1.3 | 5.5 |
| Lysine[4] | 8.36 ± 0.71[a] | 5.49 ± 0.04[b] | 8.54 ± 0.23[a] | 6.40 | 1.6 | 6.6 |
| Isoleucine[4] | 4.82 ± 0.12[a] | 4.66 ± 0.01[ab] | 4.92 ± 0.10[ac] | 7.10 | 1.3 | 4.6 |
| Leucine[4] | 8.65 ± 0.19[a] | 8.26 ± 0.03[bc] | 8.78 ± 0.13[ad] | 9.90 | 1.9 | 9.3 |

Notes: NA; not applicable. C, without freezing; FW, after freezing with distilled water; DF, after freezing directly without distilled water. Tryptophan was not determined.
[1] Values are means ± SD of three separate determinations. Means with the same superscript letter in each row are not significantly different ($p > 0.05$).
[2] Reported composition of egg albumin (Lewis *et al*., 1950). Result for cystein was not reported.
[3] Assay values was increased by 10% to compensate for destruction during acid hydrolysis.
[4] Essential Amino Acid (EAA).
[5] Suggested profile of essential amino acid required by an adult human by FAO/WHO (1990).
[6] Suggested profile of essential amino acid required by an infant by FAO/WHO/UNU (1985).
[7] Methionine + Cystein.

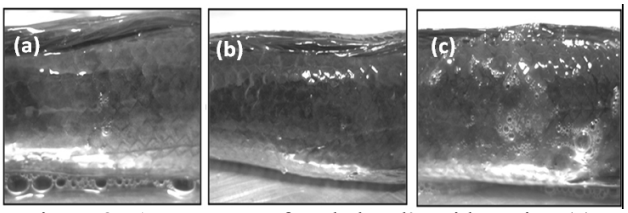


Figure 2. Appearance of snakehead's mid-section (a) C, without freezing, (b) FW, after freezing with distilled water; and (c) DF, after freezing directly without distilled water.

inspection through colourimetry (Table 2), WFP-C had the highest Whiteness Index (WI). As WI is directly related to $L^*$ (lightness), $a^*$ (redness) and $b^*$ (yellowness) values, similar trend was also observed for these readings. The freezing treatments yielded WFP that are darker, higher in redness and yellowness characteristics. WFP-FW was the reddest and most yellow in colour as compared to other samples. Also, previous findings demonstrated that there was a correlation between lipid content and $L^*$ value. Samples get whiter (higher $L^*$ value) as lipid content increases (Jo *et al*., 1999; Phillips *et al.*, 1995). Hence, WFP-C which had the highest lipid content, based on proximate results (Table 1) had the highest $L^*$ value (Table 2).

*Amino acid analysis*

Amino acids that have been shown to assist in wound healing include aspartic acid, glycine, glutamic acid, alanine, proline, arginine, serine, leucine, isoleucine and phenylalanine (Heimann, 1982; Zuraini *et al*., 2006). Since *Haruan* has been studied for its wound healing properties, the amino acid composition of WFP was analyzed. All WFPs were high in amino acids that are required for healing of wounds (Table 3). When compared gram for gram to reported amino acid levels of egg albumin (Lewis *et al*., 1950), some of the amino acids especially histidine, arginine and threonine showed higher levels than egg albumin. The amino acids levels of serine, glycine, arginine, threonine, tyrosine, methionine and phenylalanine were the highest in WFP-FW sample while no significant difference ($p > 0.05$) was found in all three levels of histidine and cysteine. Table 3 also compares the essential amino acid (EAA) content of the WFPs to the recommended requirements for adults (FAO/WHO, 1990) and infants (FAO/WHO/UNU, 1985). Values for EAA in all WFPs exceeded requirement for human adults (g of amino acid/ g of protein). However, with the exception of methionine, valine, lysine and leucine, values of EAA in WFPs did not meet the requirements for infants. Values for methionine in WFP-C and WFP-DF and lysine in WFP-FW were generally below the suggested recommendation for infants. Our findings imply the potential of WFPs as a source of EAA for adults but not for infants.

## Conclusion

Results obtained indicated that pre-freezing *Haruan* with distilled water yielded quality WFP samples in terms of yield, composition and physicochemical properties. Upon freezing the fish with distilled water, *Haruan* was less slimy and a higher mean fillet yield was observed. Compositions of protein, ash and amino acids contents of serine, glycine, arginine, threonine, methionine,

phenylalanine and tyrosine were the highest in WFP-FW samples. Also, lowest whiteness index but highest redness ($a^*$) and yellowness ($b^*$) has been noted.

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