

# Amino acid and proximate composition of fish bone gelatin from different warm-water species: A comparative study

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**Abstract.** Research on fish bone gelatin has been increased in the last decade. The quality of gelatin depends on its physicochemical properties. Fish bone gelatin from warm-water fishes has a superior amino acid composition than cold-water fishes. The composition of amino acid can determine the strength and stability of gelatin. Thus, it is important to analyze the composition of amino acid as well as proximate composition for potential gelatin material. The warm water fish species used in this study were Grass carp, Pangasius catfish, Catfish, Lizard fish, Tiger-toothed croaker, Pink perch, Red snapper, Brown spotted grouper, and King weakfish. There were five dominant amino acid in fish bone gelatin including glycine (21.2-36.7%), proline (8.7-11.7%), hydroxyproline (5.3-9.6%), alanine (8.48-12.9%), and glutamic acid (7.23-10.15%). Different warm-water species has some differences in amino acid composition. The proximate composition showed that fishbone gelatin from Pangasius catfish has the highest protein content. The water composition of all fishbone gelatin was well suited to the standard. Meanwhile, based on ash content, only gelatin from gelatin Pangasius catfish met the standard for food industries.

## 1. Introduction

Gelatin has been widely used in food, pharmaceutical and cosmetic industries. Gelatin is mainly used to improve the gelation, water binding, foaming, emulsifying, elasticity and viscosity of food products. Furthermore, gelatin is applicable for encapsulation and edible film formation purposes, making it interesting for the biomaterial-based packaging, as well as photographic industries [1]. Nevertheless, commercial gelatin from the mammals such as pig skins, cattle hides, and cattle bones are unacceptable by some religions like as Judaism, Hinduism, and Islam. Therefore, the seeking of an alternative source of gelatin has been increasing in the last decade. The waste from the fish processing is potential source of gelatin. More than 30% fish weight comes from skin and bones [2]. The skins sometimes are still used in the further processing, but the bones are often discarded. Thus, utilization of fish bone as a source of gelatin can minimize waste as well as add value for this particular fishery products.

The indicator of fish bone gelatin production can be analysed both qualitatively and quantitatively. The quality of gelatin is mostly determined by physicochemical properties. It is expected to have the same quality as well as the commercial gelatin. The physicochemical characteristics of fish bone gelatin are gel strength, stability, visco-elasticity, amino acid and proximate composition. In the previous study, it is stated that fish bone gelatin from warm-water fishes has a superior amino acid



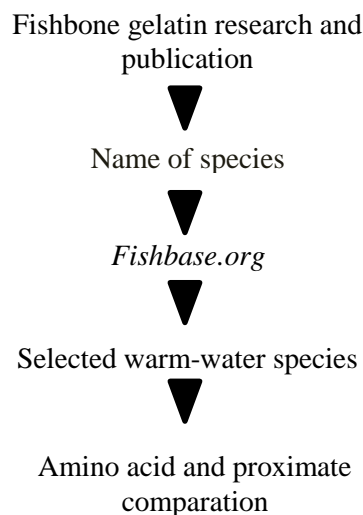
than that cold-water fishes. It gives effect to the stability and gel strength of fishbone gelatin [3]. Moreover, Gomez-Guillen et al. stated that fish bone gelatin from warm-water fish has better thermo-stability and rheology than cold-water fish [4]. Wang and Regenstein stated that there are positive correlations between composition of amino acid hydroxyproline (Hyp) and gel strength [5]. High content of amino acids (Hyp+Proline) have been improve the rheological (viscoelasticity and gel strength) and stability of fish gelatin meanwhile glycine is important for gel strength [6]. The chemical quality of gelatin can also be indicated by proximate composition.

Protein is the most abundant compound in collagenous material, thus, it represents the maximum yield of gelatin extraction [7] In addition to protein content, ash and water in collagenous material contribute to the quality of gelatin, as the maximum level of ash and water for food application are 2.6% [8] and 15% [9], respectively. About 6-8% of water content leads to the hygroscopic gelatinous material. Meanwhile, 13% of water content leads to the reduction size of particle, since the glass transition temperature of gelatin is about 64 °C [10].

The objective of this study was to compare the amino acids and proximate compositions of fish bone gelatin from warm-water fish species. This study may give additional information regarding the correlation between amino acids and proximate composition toward physicochemistry properties of fishbone gelatin which can be used for further studies.

## 2. Research workflow and result

Three consecutive research steps were conducted for this study : (1) selection of related research publications, (2) clusterization upon warm-water fish species and (3) comparison analysis of both amino acid and proximate compositions (figure 1). The clusterization was important to specify the warm water fish species used in this study, since numerous fish species has been used for the production of gelatin. Warm water fish species were choosen and clarified based on the data available on *fishbase.org*



**Figure 1.** Research workflow.

### 2.1. Warm-water fish

The warm-water species were used in this study were Grass carp (*Ctenopharyngodon idella*), Pangasius catfish (*Pangasius sutchi*) [8], Catfish (*Clarias gariepinus*) [6], Lizard fish (*Saurida* spp.) [11], Tiger-toothed croaker (*Otolithes ruber*) and Pink perch (*Nemipterus japonicus*), Red snapper (*Lutjanus campechanus*), Brown spotted grouper (*Epinephelus chlorostigma*), and King weakfish (*Macrodon ancylodon*) [10,12,13].

## 2.2. Amino acid composition

There are five dominant amino acids in fish bone gelatin including glycine (21.2-36.7%), proline (8.7-11.7%), hydroxyproline (5.3-9.6%), alanine (8.48-12.9%), and glutamic acid (7.23-10.15%) (table 1).

**Table 1.** Amino acid composition of fishbone gelatin from warm-water fish.

Amino acid (%) /Species	Code	Grass carp <sup>[5]</sup>	Pangasius catfish <sup>[1]</sup>	Catfish <sup>[2]</sup> 1	Lizard fish <sup>[7]</sup>	King Weakfish <sup>[6]</sup>	Comercial Gelatin <sup>[1]</sup>
Alanin	Ala	12.9	8.48	9.1	9.1	9.75	7.73
Arginin	Arg	5	8.11	6	5.36	7.25	7.01
Aspartic acid	Asp	4.7	4.62	6.5	5.36	0	4.97
Asparagin	Asn	0	0	0	0	5.35	0
Cysteine	Cys	0	0	0	0	0	0
Glutamic acid	Glu	7.7	8.16	9.1	7.23	10.15	6.19
Glycine	Gly	36.7	25.02	21.2	30.34	24.42	42.71
Histidine	His	0.5	0.8	-	0.9	0.92	1.02
Hydroxyproline	Hyp	7	5.97	5.3	8.13	9.6	6.49
Isoleucine	Ile	1	1.33	1.5	0.85	1.73	1.35
Leucine	Leu	2.1	2.23	2.5	1.9	2.54	2.42
Lysine	Lys	2.5	3.13	3.5	2.1	3.25	3.11
Methionine	Met	1.3	10.83	7.7	1.35	1.85	6.43
Phenylalanin	Phe	1.3	1.7	2.9	1.4	1.9	1.63
Proline	Pro	8.7	11.4	9	11.7	10.25	11.09
Serine	Ser	3.9	3.08	3.8	3.4	3.25	2.87
Threonine	Thr	2.5	2.45	3.9	1.53	2.82	1.43
Tyrosine	Tyr	0.4	0.53	0.6	0.3	0.75	0.4
Valine	Val	1.8	2.19	2.5	1.84	1.6	2.08
Hydroxylisin	Hyl	0	0	0	0	0.85	0
<b>Total</b>		100	100	100	100	100	100
Hydroxyproline Proline	Hyp+Pro	15.7	17.37	14.3	19.83	19.85	17.58

## 2.3. Proximate composition

**Table 2.** Proximate composition (%) of fishbone gelatin from warm-water fish and commercial gelatin.

Proximate properties (%) /species	Pangasius catfish <sup>[1]</sup>	Catfish <sup>[2]</sup>	Lizard fish <sup>[7]</sup>	Tiger- toothed croaker <sup>[3]</sup>	Pink perch <sup>[3]</sup>	Red snapper <sup>[4]</sup>	Brown spotted grouper <sup>[4]</sup>	King Weak- fish <sup>[6]</sup>	Commercial Gelatin <sup>[3,4,9]</sup>
Water	9.2	11.43	8.27	10.33	8.56	6.24	4.1	9.9	< 15
Protein	87.3	81.75	81.89	82.5	69.49	78.56	82.36	82.3	86.1*
Ash	2.6	5.6	11.17	2.7	2.8	10.32	6.58	3.8	< 2.6
Lipid	0.96	0.95	0.01	0.52	0.32	5.16	3.92	-	-

\*) Bovine gelatin [14]

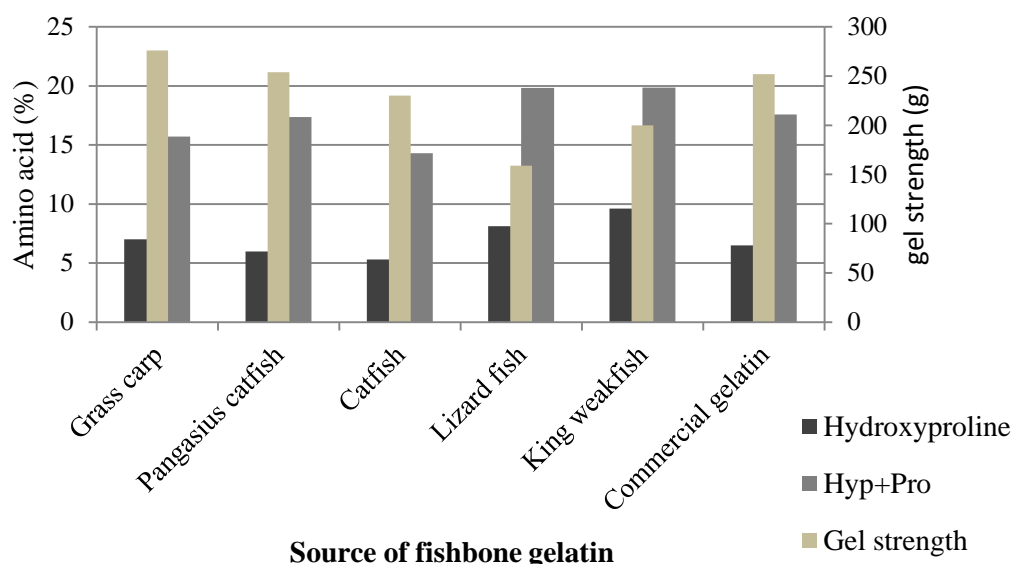
## 3. Discussion

From this study, it is likely that amino acid compositions varied in each warm-water species. Importantly, we noticed that Glycine (Gly) was the highest content of amino acid in most of the fishbone gelatin. Methionine was relatively high in fishbone gelatin of Pangasius catfish and Catfish, but it was found in low concentration in Grass carp, Lizard fish and King Weakfish. Histidine was

occurred in low level in most of the fish species and almost un-detectable in catfish. Interestingly, Hydroxyproline of Tiger toothed croaker was occurred within 7.51% and Pink perch 7.41%.

Based on the proximate compositis, fishbone gelatin from *Pangasius catfish* has the highest protein content (table 2). The protein content, however, is not quite necessary for new gelatin discoveries, since gelatin itself is considered as highly-abundant protein material. On the other hand, high protein would be important for an optimum extraction step [15]. The water composition in all fish bone gelatin from warm-water fish suited to the standard. Judging from water content alone, the gelatin from Red snapper and Brown spotted-grouper were considered as hygroscopic gelatin. Based on ash content, amongst the warm water fish tested, only gelatin from *Pangasius catfish* met the standard of that commercial gelatin for food application.

Based on our study, King weakfish and Lizard fish have the highest hydroxyproline and amino acid compositions among others, contrarily to their corresponding gel strength value (figure 2). Thus, previous reports regarding the correlation between the content of amino acids, particularly, hydroxyproline with gel can not be fully accepted. However, it has been reported the gel strength value can be influenced by the composition of several amino acids, extraction method and molecular weight distribution [6, 16, 17].



**Figure 2.** Hydroxyproline and amino acid composition (%) and gel strength (g) of fishbone gelatin from warm-water species.

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