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REVIEW ; FISH SKIN COLLAGEN

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ABSTRACT

The purpose of this review article is to explain the potential of fish skin as a collagen raw material, collagen extraction methods, and collagen application. Based on the proximate composition, the skin of several types of fish has the potential to be used as raw material for collagen. Collagen isolation consists of several stages including pretreatment, collagen extraction (enzymatic and chemical methods) and *finishing*. Yield and characteristics of fish skin collagen are influenced by the type of fish, extraction method, extraction technique and concentration and immersion time. The use of fish skin collagen extract includes for the food, cosmetics and pharmaceutical industries.

KeyWords

Yield, Method, Application, Extraction, Cosmetics

1. INTRODUCTION

One type of waste produced from the fish fillet industry is fish skin. Currently, the economic value of fish skin is still low because it has not been processed into products with high added value (Junianto et al., 2006). According to Nurhidayah et al., (2019) this fish skin can be used as a source of collagen raw material by extracting it.

Fish skin that contains collagen with a yield value that varies between 11-63% depending on the type of fish, the extracting material, and the collagen extraction technique (Nurhayati et al., 2013). This very high yield allows fish skin to become very potential as a raw material for collagen. Currently commercial collagen is sourced from cow and pig skin.

Raw materials from pig are not allowed for Muslims and Jews, while the use of cow bones and skin is a problem for Hindus and raises concerns because of the issue of mad cow disease (Nurhayati et al., 2013). So that the use of fish waste as a source of collagen can reduce processing industry waste as well as an alternative raw material for collagen (Nurhidayah et al., 2019). This review article aims to explain the potential of fish skin as a collagen raw material, collagen extraction methods, and collagen application.

2. FISH SKIN

The skin is a byproduct of slaughtering animals in the form of organs during the skinning process. Fish skin generally consists of two main layers, namely epidermis and dermis. The dermis layer is a thick enough binding tissue and contains a number of collagen fibers (Azizah 2013).

According to Judoamijoyo (1974) approximately 80% of the dry matter of the skin is made up of a wide variety of proteins and is very complex in composition. Protein in the skin can be divided into two major groups, namely (1) proteins classified as protein fibers include collagen, keratin and elastin; (2) proteins classified as globular proteins include albumin and globulin.

Animal skin is woven from animal bodies formed from living cells, the basic structure of animal skin consists of woven protein fibers called collagen fibers, which are components that function as a reinforcing framework (Setiawati 2009). The skin content of several types of fish is presented in table 1.

Table 1. Skin Content of Several Types of Fish

Parameter	Types of fish		
	Oreochromis niloticus	*Pangasius* sp.	*Caesio cuning*
Water content (%)	69,6	65,59	68,5
Ash content (%)	2,5	0,19	0,74
Protein content (%)	26,9	30,28	27,73
Fat content (%)	0,7	2,69	1,17

Source : Rusli (2004) ; Suptijah et al*.,* (2018) ; Astiana et al., (2016)

3. FISH SKIN COLLAGEN ISOLATION

The pretreatment process is a process that greatly affects the purity of the collagen isolated, the time efficiency, and the cost of collagen isolation (Li et al., 2018). The pre-treatment process consists of selecting materials, cleaning, degreasing, reducing, demineralizing and washing. The pre-treatment process aims to increase the yield and quality of collagen (Prasetyo et al*.*, 2004).

The next step is collagen extraction, the method commonly used is the acid or enzymatic method using pepsin (Devi et al., 2017). According to Alhana et al., (2015) stated that collagen can be extracted chemically or a combination of enzymatic and chemical (acid / base). The acid process is used for raw materials with little cross-linking, for example fish skins (Karim & Bhat 2009). Acid or base solvents commonly used for collagen extraction are HCl, CH_3COOH and NaOH (Prasetyo et al., 2004).

The next process is finishing the collagen extract which aims to produce collagen products in the form of powder. The finishing stage consists of filtering by separating the collagen that has been extracted from rafinate, evaporation by evaporating water on the collagen and drying by cooling the collagen at room temperature (Prasetyo et al., 2004).

4. FISH SKIN COLLAGEN

Collagen is a fibrous protein that provides flexibility and strength to tissues and bones and is essential for a variety of other tissues, including skin and tendons (Stephanie et al., 2016). Collagen is the major structural component of white connective tissue which accounts for nearly 30% of the total protein in the tissues of vertebrates and invertebrates (Junianto et al., 2006). Collagen is a type of protein found in connective tissue. This protein has a triple helical structure and consists of 25% glycine and 25% more proline and hydroxy, but does not contain cysteine, cystine and tryptophan (Nauli et al., 2015). Collagen produced from fish skin has different yields depending on the extraction method and extraction technique (Devi et al., 2017), types of fish (Nurhayati et al., 2013) and fish body parts (Romadhon et al., 2019). According to Astiana et al., (2016) factors that can cause differences in yields are the protein content in fish skin and the conditions during pretreatment and different extraction. The yield of skin collagen from several types of fish is presented in table 2.

Table 2. The Yield of Skin Collagen from Several Types of Fish

Types of Fish	Yield (%)	Extraction method
Oreochromis niloticus	5,96	Acid (CH_3OOH) 0,75 M
Pangasius sp.	12,15	Acid (CH_3OOH) 0,05 M
Caesio cuning	5,79	Acid (CH_3OOH) 0,3 M
Makaira indica	4,77	Acid (CH_3OOH) 0,9 M

Source : Putra et al., (2013) ; Suptijah et al., (2018) ; Astiana et al., (2016) ; Raymundus et al., (2020)

5. FISH SKIN COLLAGEN CHARACTERISTICS

5.1 Color

Collagen color is an important parameter to determine collagen quality because it can affect the color of the final product that is added with collagen (Romadhon et al., 2019). The skin collagen whiteness values of several types of fish are presented in table 3.

Table 3. Value of Skin Collagen Whiteness of Several Types of Fish

Types of Fish	*Whiteness* (%)
Oreochromis niloticus	48,31
Channa striata	66.67
Raja kenojei	88,4

Pastinachus solocirostris	72,48

Source : Romadhon et al., (2019) ; Wulandari et al., (2015) ; Shon et al., (2011) ; Nur'aenah et al., (2013)

The difference in collagen color is influenced by the amount of pigment present in the raw material where the pigment can be released during the acid / alkaline immersion process (Alhana et al., 2015). The low degree of whiteness in fish skin collagen is thought to be less than optimal in the pretreatment process so that the pigments in the skin have not been completely eliminated (Wulandari et al., 2015). Soaking with an acid or alkaline solution causes a development on the skin so that the pigment in the fish skin will be easily eliminated (Jaswir et al., 2011).

The dark color of collagen cannot be completely removed because fish skin contains pigments (Muyonga et al., 2004). An effective method for eliminating pigments from fish skin is pretreatment with organic acid solutions (Shon et al. 2011). In general, the color of collagen has no effect on functional properties, but the white color of collagen is more desirable because it is easier to use without having to add dyes to the final product (Wulandari et al. 2015).

5.2 pH

The pH value greatly affects the solubility of collagen. Collagen will dissolve easily in acidic pH conditions. Collagen from fish skin shows higher solubility at pH> 6, this is because collagen from the skin has a low degree of crosslinking (Devi et al., 2017). The pH value of skin collagen from several types of fish is presented in table 4.

Table 4. The pH Value of Skin Collagen from Several Types of Fish

Types of Fish	pH Value	Extraction Method
Oreochromis niloticus	4,38	Acid (CH_3OOH) 0,75 M
Pangasius sp.	5,34	Acid (CH_3OOH) 0,05 M
Makaira indica	4,6	Acid (CH_3OOH) 0,7 M

Source : Romadhon et al., (2019) ; Suptijah et al., (2018) ; Astiana et al., (2016)

The low collagen pH value is thought to be due to the incomplete neutralization process (Romadhon et al., 2019). The neutralization process that is carried out will affect the final pH of collagen, because in addition to reducing the residual acid or alkaline solution due to immersion, it is also possible to result from the water used to neutralize the collagen (Suptijah et al., 2018). The difference in the pH value of collagen can also be caused by differences in the type and concentration of acids or bases used in the solution used, both acidic or alkaline and the neutralizing process (Tabarestani et al., 2010). The combination of acid and alkaline processes tends to produce a pH close to neutral (Zhou & Regenstein 2005).

5.3 Proximate Composition

The chemical composition of collagen is a parameter of the effectiveness of the deproteinization, defatting, demineralization, and extraction processes in making collagen. Soaking in alkaline and acid solutions aims to remove non-collagen protein, as well as other components, namely fats and minerals (Suptijah et al., 2018). The proximate composition of skin collagen from several types of fish is presented in table 5.

Table 5. Proximate Composition of Skin Collagen from Several Types of Fish

Parameter	Types of Fish	
	Pangasius sp.	*Raja kenojei*
Water content (%)	6,55	7,01
Ash content (%)	1,8	3,38
Protein content (%)	64,74	86,4
Fat content (%)	8,85	0,35

Source : Suptijah et al., (2018) ; Shon et al., (2011)

The difference in collagen protein content can be influenced by the pretreatment process with the concentration and duration of soaking in an acid / base solution which is able to optimally remove non-collagen protein and other impurities (Wulandari et al., 2015). According to Jamilah et al., (2013) differences in protein content can be caused by differences in the extraction method used. The difference that does not meet the collagen quality standards can also be caused by the ineffective pretreatment process. Shon et al., (2011) stated that skin that has a high fat and ash content requires different purification techniques to produce high purity collagen products.

5.4 Amino acid

According to Ogawa et al., (2004) collagen contains large amounts of the amino acids proline, glycine, alanine, glutamic acid and hydroxyproline. his was also confirmed by Junianto et al., (2006) which states that the collagen molecule is roughly composed of twenty amino acids which have slightly different shapes depending on the source of the raw material. The main amino acids of collagen are the amino acids glycine, proline and hydroxyproline. The amino acid composition of skin collagen from several types of fish is presented in table 6.

Table 6. The Amino Acid Composition of Skin Collagen from Several Types of Fish.

Types of Fish.	Amino Acid Composition
Oreochromis niloticus	Glycine, alanine, glutamate
Pangasius sp.	Glycine, proline, alanine, arginine and glutamate
Caesio cuning	Glycine, alanine, and proline
Thunnus albacores	Glutamic acid, glycine, alanine, arginine and proline..

Source : Putra et al., (2013) ; Suptijah et al., (2018) ; Astiana et al., (2016) ; Kolanus et al., (2019)

Fish collagen has a lower amount of hydroxyproline and stability than the collagen of terrestrial vertebrates (Baily & Light 1989). The content of hydroxyproline varies depending on body temperature, ambient temperature and the type of fish. Fish that live at low temperatures have a lower content of hydroxyproline than fish that live at higher temperatures (Rigby 1968).

Type I collagen contains high amounts of the amino acids glycine, alanine, and proline, while the amino acids tyrosine and histidine are only present in small amounts and do not contain cystine (Nalinanon et al., 2011). The content of proline and hydroxyproline are amino acids that function in increasing collagen stability (Astiana et al., 2016). Tamilmozhi et al., (2013) stated that proline is an amino acid that is unique to collagen because it plays a role in maintaining the structural integrity of collagen. Collagen with a high amino acid content is very good for use as raw material in industry because it has high temperature stability (Jamilah et al., 2013).

6. BENEFITS OF FISH SKIN COLLAGENTS

The use of fish skin collagen extract includes the food, cosmetics and pharmaceutical industries (Romadhon et al., 2019). Collagen in the cosmetic sector acts as an active substance that can provide many benefits for the skin, such as a skin guarding agent, preventing wrinkles, increasing skin moisture, from free radicals, and maintaining skin elasticity (Stephanie et al., 2016). Collagen can maintain skin elasticity because collagen is a protein that can bind water (Nauli et al., 2015). Collagen can speed up the wound healing process because it is an excellent hemostatic agent. Collagen extract initiates collagen biosynthesis from within and activates fibroblast tissue, thereby increasing skin elasticity and moisture (Harris et al., 2016).

Conclusion

Based on the proximate composition, the skin of several types of fish has the potential to be used as raw material for collagen. Collagen isolation consists of several stages including pretreatment, collagen extraction (enzymatic and chemical methods) and finishing. Yield and characteristics of fish skin collagen are influenced by the type of fish, extraction method, extraction technique and concentration and immersion time. The use of fish skin collagen extract includes for the food, cosmetics and pharmaceutical industries

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