

# **Chemically Treated Chicken Feather Meal for Fish Feed**

---

## **ABSTRACT**

The increasing demand and consumption of chicken meat from year to year makes the waste produced also increase, especially chicken feathers. One of the physical waste utilization of chicken feathers is handicrafts that use chicken feathers such as dream catchers. The utilization of chicken feather waste as a feed ingredient is still relatively rare because chicken feathers have crude protein which includes structural protein called keratin. Therefore, it is necessary to process it first so that the keratin in the chicken feather can be degraded properly. The purpose of this review is to provide an overview of the chemical processing of chicken feathers and its application as one of the raw materials that make up fish feed.

*Keywords: chicken feather, chemistry, growth, processing*

## **1. INTRODUCTION**

Chicken feathers are waste from chicken slaughterhouses. Along with the increasing chicken population and slaughter rate, chicken feather waste continues to grow from year to year. The potential availability of chicken feathers from slaughterhouse waste in Indonesia is around 4-5% of live weight. Broiler production per year reaches 2 billion birds with an average harvest weight of 1.5 kg/head. From this, it can be estimated that the total broiler feather waste reaches 120.00 tons/year or the equivalent of chicken feather meal of around 36.000 tons/year[1].According to BPS (2023) every year the number of chicken slaughter increases, in 2018 it was 3.137.707.479 heads and in 2019 it increased to 3.169.805.127 heads [2]. Until now, a small portion of chicken feathers are only used as upholstery filler, plant fertilizer, crafts or decorations, shuttlecocks and feather duster [3].Most others are simply dumped in landfills, polluting the surrounding environment. Generally, producers of chicken feather waste deal with it by burning or burying the feathers, which will lead to new problems of soil and air pollution [4].

Chicken feathers are included in the waste that has the potential to be utilized because it has a very high protein content of around 80 - 90% [5]. According to Zerdani et al. (2004) chicken feathers contain about 1.2% fat, about 86% dry content and about 1.3% ash content [6]. Chicken feathers contain keratinized bonds that are difficult to dissolve in water, so the natural form of unprocessed chicken feather meal has low nutritional value. Therefore, if chicken feathers are to be used as feed raw materials, it is necessary to process them first. According to Puastuti (2007), the methods of processing chicken feathers are divided into four types: physical using high temperature and pressure, enzymatic, microbiological with fermentation and chemical with acids, bases or carbonation. In principle, processing of chicken feathers aims to weaken or break the bonds in keratin through hydrolysis [7]. Of the

several processing methods, chemical processing with acids or bases (NaOH, HCl) is a more efficient processing because the processing method is easy and also cheap[1].Therefore, it is necessary to conduct a literature study (review) in order to provide a clear picture of chicken feathers and their practical utilization through chemical processing. It is hoped that the review article on chicken feather processing can be a suggestion and also input for stakeholders in managing livestock waste for fish feed ingredients.

## 2. METHODS

The method used is descriptive by conducting literature review studies in various research journals such as SAINTEKS journals, Tropical Aquaculture Science, Journal of Aquaculture Management and Technology and so on. The type of literature that will be reviewed is research journals related to the use of local ingredients in feed both as substitutes and as additional ingredients in feed for the growth and survival of fish. The subject of the test animals to be discussed is specific to various types of fish. The results of the search for related journals were grouped according to the topic and obtained journals as the main reference. Furthermore, it is analyzed and reviewed according to each subtopic.

## 3. RESULT AND DISCUSSION

### 3.1 Chicken Feather Composition

Feathers are part of the skin, formed from a controlled growth process through the activity of biological cells from the body's outermost tissue or epidermis [8]. Part of the chicken feather consists of down and the other half is the feather core which is a feather sheath that has a hollow tube structure. Part of the feather contains proteins that are difficult to dissolve and have a very strong structure in the form of keratin. Keratin is a fibrous protein that contains a lot of sulfur and is usually found in nails, hair, and feathers and other results from the hardening of epidermal tissue [9].

Chicken feathers are included in the waste that has the potential to be utilized because it has a very high protein content of around 80-90% [5]. According to Zerdani et al. (2004) chicken feathers contain about 1.2% fat, about 86% dry content and about 1.3% ash content [6]. The nutrient content contained in chicken feather meal is in Table 1.

**Table 1. Nutritional content of chicken feather meal**

No	Content	Chicken Feather Flour [10]	Chicken Feather Flour [11]
1.	Dry Material	93,3	91,96
2.	Crude Fiber	0,9	-
3.	Protein	85,8	83,74
4.	Fat	7,21	3,81
5.	Ash	3,5	2,76
6.	Ca	1,19	0,17
7.	P	0,68	0,13
8.	DE (kcal/kg)	3.000	3.952

In Table 1, it can be seen that the dry matter content of chicken feathers is quite high (91.96-93.3%), making it a potential solid waste that can be utilized for fish feed ingredients. Moreover, it has a fairly high protein content (83.74-85.80%). However, the type of chicken feather protein is dominated by structural protein called keratin. According to Saravanan & Dhurai (2012) the protein content of chicken feathers consists of 91% keratin protein, 1% lipid and 8% water [12]. Keratin in chicken feathers is mostly composed of the amino acids

cysteine, glutamine, proline, serine glycine, alanine, serine, cysteine and valine, as well as small amounts of lysine, methionine and tryptophan [13]. According to Kim & Patterson (2000) chicken feathers contain the minerals calcium 0.19%, phosphorus 0.04%, potassium 0.15%, and sodium 0.15% [14]. The amino acid composition in feather meal is similar to the amino acid composition in fish meal. Broiler feather meal has a variety of amino acids such as, 5.28% lysine, 2.91% arginine, 4.28% glycine, 2.04% histidine, 4.70% isoleucine, 2.11% methionine, 6.67% phenylalanine and 6.44% valine [15]. Meanwhile, according to Prado et al. (2016) the amino acids contained in fishmeal consist of: 8.83 mg lysine, 4.56 mg arginine, 5.82 mg glycine, 1.84 mg histidine, 4.21 mg isoleucine, 1.39 mg methionine, 4.79 mg phenylalanine and 5.24 mg valine [16]. This shows that feather meal has great potential to be developed as an alternative ingredient to fishmeal.

### 3.2 Chemical Improvement of Chicken Feather Quality

The natural form of unprocessed chicken feather meal has low nutritional value. Therefore, if chicken feathers are to be used as feed raw materials, it is necessary to process them first. According to Puastuti (2007), chicken feather processing methods are divided into four types, namely physical using high temperature and pressure, enzymatic, microbiological with fermentation and chemical with acids, bases or carbonation [7]. In principle, processing of chicken feathers aims to weaken or break the bonds in keratin through hydrolysis.

The four processing methods produce different digestibility and biological value of chicken feather hydrolysate. Microbiological processing produces good results but the processing is less effective because the necessary microbes are difficult to find and require expensive costs and for physical processing by heating will result in protein damage. Meanwhile, chemical processing is considered more effective and economical because it does not damage the protein in chicken feathers. Chemical processing also produces more natural chicken feather flour and can reduce damaged amino acids [17].

**Table 2. Chemical Processing of Chicken Feathers**

Processing	Treatment	Results	Reference
Chemical with HCl	The treatments consisted of 4 HCl concentrations (0, 6, 12 and 24%) and 3 hydrolysis times (2, 4, and 6 days).	The processing technique with 12% HCl and hydrolysis time of 4 days produced an optimal Hydrolysate of Chicken Feathers as a protein source in terms of the digestibility of Dry matter, Organic matter, solubility of Dry matter and fermentation products tested in vitro.	[18]
Physical Combination using autoclave and Chemical using 1 M HCl and 1M NaOH	The treatment consisted of four conditions including P0 (control), P1 [20% 1 M NaOH + autoclave (21 Psi)], P2 [20% 1 M HCl + autoclave (21 psi)] and P3 [10% 1 M NaOH + 10% 1 M HCl + autoclave (21 psi)].	The hydrolysis process using a combination of chemical [20% 1 M NaOH] and physical (autoclaving) processes (P1) was the best hydrolysis treatment.	[19]

Physical combination using autoclave at 2.5*10 <sup>5</sup> Pa with temperature 121°C for 30 minutes and Chemical using NaOH.	The first experiment consisted of the control treatment, 2, 12, 24 hours with 1.0 M NaOH. The second experiment consisted of the following treatments (1) Raw chicken feathers were autoclaved (2) Raw chicken feathers were soaked in 0.5% NaOH solution for 24 hours, then autoclaved.	Long-term treatment (24 and 12 hours) with NaOH increased feather solubility but resulted in lower protein retention, while NaOH addition followed by autoclaving resulted in higher protein content and increased in vitro pepsin digestibility.	[20]
Kimiawi dengan HCl dan NaOH	The treatments carried out, namely: H-1: without hydrolysis, H-2: 1 M - NaOH 20%, H-3: 1 M - HCl 20%, H-4: 1 M - NaOH 10% + 1 M - HCl 10%	Chemical hydrolysis process using H-2 1M-NaOH 20% treatment is the best hydrolysis process compared to other treatments.	[15]
Chemical using H <sub>2</sub> SO <sub>4</sub> , HCl, HNO <sub>3</sub> and H <sub>3</sub> PO <sub>4</sub> .	Treatment with 10% of each acid namely H <sub>2</sub> SO <sub>4</sub> , HCl, HNO <sub>3</sub> and H <sub>3</sub> PO <sub>4</sub> .	Feathers hydrolyzed with HNO <sub>3</sub> had the highest protein content (83.63%) compared to feather meal treated with other acids, followed by feather meal treated with HCL (82.40%).	[21]
Chemical with NaOH	Base hydrolysis with concentrations of 5%, 7.5% and 10% NaOH solution (1:6 ratio) and hydrolyzed for 4 hours at 80°C using a hot plate and with the help of a magnetic stirrer at 1000 rpm.	Chicken feather hydrolysate with 5% NaOH solvent concentration showed optimum results with a yield of 70.24%, total protein 62.66%, total free amino acids 39.126% and protein molecular mass by SLS method showed the result of 4.31 kDa.	[22]

Chemical processing using acid is one of the processes of processing chicken feathers. According to Puspitasari et al. (2019) processing of chicken feather waste by adding HCl or NaOH solution serves to facilitate the crushing process and lyses the keratin compound which is the main constituent of chicken feathers [23]. Based on SEM analysis conducted [15], there are differences in the structure of chicken feathers before and after chemical processing. The structure of unprocessed chicken feathers is still arranged in an orderly manner, while chicken feathers that have been processed have a significant change in structure such as elongated and irregular. This shows that there is a process of protein denaturation caused by the hydrolysis process so that the structure of chicken feathers changes. This denaturation process occurs due to the reaction of amino acids in keratin with the chemical solution used. This chemical process is able to loosen polypeptide and disulfide

bonds and dissolve the protective layer of wax found in feathers so that the feathers are brittle and easy to grind [24].

### 3.3 Use of chicken feathers in fish feed

Chicken feathers have benefits in aquaculture, one of which is for feed formulations in alternative feed substitutes. As in Table 3 below is an application of the utilization of chicken feather meal in feed formulations in aquaculture.

**Table 3. Use of chicken feather meal as a raw material for fish feed**

Processing	Organisms	Treatment in Feed	Results	Reference
Chemical with 12% HCl	Pomfret Fish ( <i>Colossoma macropomum</i> )	0,25,50,75 and 100% substitution with fishmeal.	The results showed that the addition of chicken feather meal up to 100% had no effect on survival rate, specific growth rate, feed conversion ratio, protein efficiency ratio, and protein retention but did have an effect on protein digestibility.	[1]
Chemical with HCl	Striped Catfish ( <i>Pangasius hypophthalmus</i> )	Fish meal substitution with different doses of chicken feather silage, namely A (0%), B (25%), C (50%), D (75%) and E (100%).	Substitution of fishmeal with 25% doses of chicken feather silage is the best dose for protein digestibility and growth of catfish.	[24]
Chemical with HCl	Catfish ( <i>Clarias gariepinus</i> )	Feeds were formulated to replace fish meal with feather meal at 0%, 25%, 50%, 75%, and 100% levels.	Replacement of fishmeal with feather meal improved growth and survival of <i>Clarias gariepinus</i> , especially at levels of 25% and 50% of feather meal.	[26]

Based on the results of the literature study in Table 3, there are only 3 recent publications of research on the use of chemically treated chicken feather meal in fish feed. The test fish used in the three studies were tilapia, catfish and catfish. The research was conducted by substituting fishmeal by chicken feather meal as much as 0%, 25%, 50%, 75% and 100% with maintenance media in the form of aquariums [1,25,26]. From the results of research that has been conducted, it is known that processed or partially hydrolyzed chicken feather meal at various levels in feed formulations can replace the role of fishmeal [27]. According to Nurhayati et al. (2017), feed utilization and growth rate of tilapia can increase with the addition of chicken feather meal and the best composition in the substitution of chicken

feather meal in artificial feed is 25% [28]. Meanwhile, according to Suryaningrum (2011), chicken feather meal can be utilized as an alternative raw material to replace fishmeal by 25-30% in tilapia feed formulations [27].

#### 4. CONCLUSION

Based on the description above, it can be concluded that chemically processed chicken feather meal has the potential to be used as an alternative to fishmeal and has been shown to affect fish growth and survival. Considering that the price of commercial feed continues to increase, the utilization of chicken feather meal as an alternative feed ingredient can be a solution to the problem of aquaculture production costs.

#### REFERENCES

1. Ekawati AW, Yuniarti A, Marsoedi. Chicken Feather Silage Meal As A Fish Meal Protein Source Replacement In Feed Formula Of Pomfret (*Colossoma macropomum*). *Res J Life Sci*. 2016;3(2):98-108. doi:10.21776/ub.rjls.2016.003.02.4
2. Badan Pusat Statistika. Broiler Population by Province. Badan Pusat Statistik. Published 2023. <https://www.bps.go.id/linkTableDinamis/view/id/1034>
3. Adiati U, Puastuti W. *Chicken Feathers for Ruminant Feed*. Balai Peternakan; 2004.
4. Savitha G, Joshi MM, Tejashwini N, Revati R, Sridevi S, Roma D. Isolation, Identification and Characterization of a Feather Degrading Bacterium. *Int J Poult Sci*. 2007;6(9):689-693.
5. Sari EP, Putri IST, Putri RA, Imanda S, Elfidasari D, Puspitasari RLP. Utilization of chicken feather waste as ruminant feed. 2015;1(1):136-138. doi:10.13057/psnmbi/m010123
6. Zerdani I, Faid M, Malki A. Feather wastes digestion by new isolated strains *Bacillus* sp. in Morocco. *African J Biotechnol*. 2004;3(1):67-70. doi:10.5897/ajb2004.000-2012
7. Puastuti W. Processing Technology of Chicken Feather and its Utilization as a Protein Source for Ruminant Feeds. *Wartazoa*. 2007;17(2):53-60.
8. Said MI. *By Product Ternak : Teknologi Dan Aplikasinya*.; 2014.
9. Bungsu A. Isolation and Identification of Keratinolytic Bacteria from Several. Keratin Sources and Characterization of Their Enzymes. Published online 2018. <https://repositori.usu.ac.id/handle/123456789/6163>
10. National Research Council. *Nutrient Requirements of Poultry*.; 1994. <http://www.nap.edu/catalog/2114.html>
11. Adiati U, Puastuti W, Mathius I. Opportunities for Utilizing Chicken Feather Flour as a Ruminant Feed Ingredient. *WARTAZOA*. 2004;14(1):39-44.
12. Saravanan K, Dhurai B. Exploration on amino acid content and morphological structure in chicken feather fiber. *J Text Apparel, Technol Manag*. 2012;7(3):1-6.
13. Kamarudin NB, Sharma S, Gupta A, Kee CG, Chik SMSBT, Gupta R. Statistical investigation of extraction parameters of keratin from chicken feather using Design-Expert. *3 Biotech*. 2017;7(2):1-9. doi:10.1007/s13205-017-0767-9
14. Kim WK, Patterson PH. Nutritional value of enzyme-or sodium hydroxide-treated feathers from dead hens. *Poult Sci*. 2000;79(4):528-534. doi:10.1093/ps/79.4.528
15. Said MI, Yuliati FN, Sukma M. The Effects of Acidic and Alkaline Hydrolysis Process on some Physical and Chemical Properties of Broiler Chicken Feathers. *Iran J Appl Anim Sci*. 2019;9(3):529-540. [www.ijas.ir](http://www.ijas.ir)
16. Prado JP de S, Cavalheiro JMO, Silva JA da, Cavalheiro TB, Silva FVG da. Amino acid profile and percent composition of meals and feeds used in shrimp farming. *Gaia Sci*. 2016;10(4):347-360. doi:10.21707/gaia.v10.n04a28
17. Muhtarudin, Husni A. Effect of Chicken Feather Hydrolysate Supplementation and Organic Minerals on Digestibility of Dietary Substances, Body Weight Gain, and

- Ration Efficiency of Male Peranakan Etawah Goats. Published online 2017.
18. Puastuti W, Yulistiani D, Mathius I-W. Biological value (in vitro and in sacco) of chemically treated chicken feathers as a rumen by-pass protein source. *Jitv*. 2004;9(2):73-81.
  19. Said MI, Abustam E, Pakiding W, Mide MZ, Umar A. Characteristics of broiler feather protein concentrate prepared under different production processes. *Int J Poult Sci*. 2018;17(10):507-514. doi:10.3923/ijps.2018.507.514
  20. Al-Souti A, Gallardo W, Claereboudt M, Mahgoub O. Effects of autoclaving, addition of sodium hydroxide and their combination on protein content and in vitro digestibility of chicken feathers. *Int J Poult Sci*. 2018;17(8):356-361. doi:10.3923/ijps.2018.356.361
  21. Oluba OM, Akpor OB, Alabi OO, Shoyombo AJ, Adeyonu AG, Adebisi FD. In vitro antioxidant properties and digestibility of chicken feather protein hydrolysates. *Food Res*. 2020;4(4):1053-1059. doi:10.26656/fr.2017.4(4).402
  22. Sukendro BP, Indrawati T, Rahmat D. Process Optimization of Protein Hydrolysis from Chicken Feather Waste. *Farmasains J Ilm Ilmu Kefarmasian*. 2021;8(1):7-14. doi:10.22236/farmasains.v8i1.5171
  23. Puspitasari RL, Pambudi A, Wahyuni RS, Haq A. Processing Chicken Feather Waste as Animal Feed in Jampang Bogor. *Keberlanjutan Program Pemberdaya Masyarakat Era Revolusi Ind 40*. Published online 2019:369-374.
  24. Rahayu S, Bata M. Quality of Chicken Feather Processed in Different Conditions. *Anim Prod*. 2014;16(3):170-175. <https://media.neliti.com/media/publications/68039-EN-quality-of-chicken-feather-processed-in.pdf>
  25. Rachmawati D, Samidjan I, Harwanto D, Pranggono H. Substitution of Fish Meal with Chicken Feather Silage Meal on Feed Can Improve Growth Performance of Striped Catfish (*Pangasius hypophthalmus*). *Omni-Akuatika*. 2018;14(3):60-65. doi:10.20884/1.oa.2018.14.3.455
  26. Mustapha A-RK, Adeniyi WO. Replacement of Fish Meal with Feather Meal in the Diet of *Clarias gariepinus*. *Pan African J Life Sci*. 2022;6(3):524-530. doi:10.36108/pajols/2202/60.0320
  27. Suryaningrum LH. Utilization of Chicken Feather as an Alternative Raw Material for Fish Feed. In: *Prosiding Forum Inovasi Teknologi Akuakultur*. ; 2011:1031-1036.
  28. Nurhayati W, Rachmawati D, Samidjan I. Effect of Chicken Feather Flour Silage Substitution in Artificial Feed on Growth and Feed Utilization of Gift Tilapia Fish. *J Aquac Manag Technol*. 2017;6(4):248-254.