Carcass quality of raw and smoked fish fillets prepared from cage raised river catfish (Hemibagrus nemurus Valenciennes, 1840) fed high protein-low energy and low protein-high energy diets

by Indra Suharman

Jurnal Teknologi

Full Paper

CARCASS QUALITY OF RAW AND SMOKED FISH FILLETS PREPARED FROM CAGE RAISED RIVER CATFISH (*Hemibagrus nemurus* Valenciennes, 1840) FED HIGH PROTEIN-LOW ENERGY AND LOW PROTEIN-HIGH ENERGY DIETS

Bustari Hasan*, Indra Suharman, Desmelati, Dian Iriani

Faculty of Fisheries and Marine Science Universitas Riau, Jl. HR. Subrantas KM 12, 5 Pekanbaru, Riau 28293, Indonesia

*Corresponding author
bustarih@yahoo.com

Article history
Received
24 October 2015
Received in revised form
6 January 2016
Accepted
16 Februari 2016

Graphical abstract

Abstract

The purpose of this study was to evaluate the effect of high protein-low energy and low protein-high energy diet on carcass quality of raw and smoked river catfish fillets. Two diets containing high protein-low energy (40 % protein, 2.75 kcal g^{-1} energy, diet A) and low protein-high energy (34 % protein, 3.00 kcal·g^{-1} energy, diet B) which produced the best growth in our previous feeding trial were fed to river catfish. The fish, 40.14 g to 42.64 g in weight were stocked in commercial fish cage at dencity of 50 fish per m^3 and fed the experimental diets for 90 d. At the end of the experiment, all fish was weighed for weight gain, 20 fish were evaluated for carcass quality and other 20 fish were filleted and hot smoked. Smoked fillets were assessed for smoking yield, proximate composition, sensory quality and overall acceptability. Edible flesh, dressing percentage and flesh water holding capacity of the fresh raw were higher for the fish fed diet A; but carcass waste was higher for the fish fed diet B. Protein composition was higher for the fish fed diet A; however, fat composition was higher for the fish fed diet B. In terms of smoking yield and overall acceptability of smoked fish, there was no difference between smoked fillets prepared from the fish fed the two diets, while appearance and texture were higher for the smoked fillets prepared from fish fed diet A; and odor as well as flavor were higher for smoked fillets prepared from fish fed diet B.

Keywords: Carcass quality, diets, river catfish (*Hemibagrus nemurus* Valenciennes, 1840), smoking yield, sensory quality

1.0 INTRODUCTION

Hot-smoked river catfish (*Hemibagrus nemurus* Valenciennes, 1840) is a tradtional fish product of considerable economic importance in Riau Province, Indonesia. The product is usually prepared from fish cought in the wild, but the catch in the wild now is decreasing due to overfishing and environmental damage, thus the latter supply of the fish will depend on aquaculture production. However, the cultured fish is usually lower in quality than that wild fish [1–3], so improvement quality of the raw is important to produce high quality of smoked fish.

The quality of farm-raised fish is affected by nutritional quality of the fish diet. Low protein and high energy in the diet cause fat deposition in the fish body, resulting in low edible flesh and high carcass waste, soft flesh, oily flavor and short storage life [4–7]. Fatty fish is difficult to fillet; and when hot-smoked, the body fat liquidify and the final product is low in yield and sensory quality [3]. River catfish requires 34 % to 40 % dietary protein and 2.70 kcal g^{-1} to 3.25 kcal g^{-1} energy for optimum growth [8, 9]; however,

the farmers feed their fish with lower dietary protein and higher energy than recommended, thus the low quality of the raw and smoked fish quality must be due to low protein and high energy level in the fish diet.

The recent study on growth performance of river catfish fed diets containing two dietary protein and two dietary energy levels at a laboratory scale revealed that the diets containing 40 % protein, 2.75 kcal g^{-1} energy and 34 % protein, 3.00 kcal g^{-1} energy resulted in the best growth [9]. However, the diets producing good quality of raw and smoked fillet have not yet been investigated. This research therefore was proposed to evaluate carcass quality of raw and smoked fish prepared from harvested cultured catfish fed diets containing 40 % protein, 2.75 kcal g^{-1} energy (high protein-low energy diet) and 34 % protein, 3.00 kcal g^{-1} energy (low protein-high energy diet) at a commercial culture scale.

2.0 EXPERIMENTAL

2.1 Feeding Trials

River catfish, ranging from 40.14 g to 42.64 g in size were stocked in two triplicate commercial floating cages at a density of 50 fishes per m^3 (Figure 1); and fed the diets containing high protein-low energy (40 % protein and 2.75 kcal g^{-1} energy, diet A) and low protein-high energy (34 % protein and 3.00 kcal g^{-1} energy, diet B) (Table 1) for 90 d.

Table 1 Formulation and proximate composition of the experimental diets

Composition	Diets (%)	
	A	B
Fishmeal	55	33
Soybean meal	17	30
Rice bran	26	32.5
Palm oil	0	2.5
Vitamin mix	1	1
Mineral mix	1	1
Proximate composition by analyses		
Dry matter	94.49	94.88
Protein	40.96	34.83
Fat	7.31	6.95
Ash	16.9	13.91
Fiber	6.99	8.78
FE	25.84	31.03
Estimated Digestible Energy (kcal · g^{-1})	2.78	3.04

Figure 1 Experimental fish

At the end of experiment, the fish were weighed for weight gain. Fourty fishes from each cage were randomly sampled; 20 fishes were slaughtered and calculated for carcass quality; and other 20 fishes were filleted and made for hot smoked fillets.

The fillets were smoked in a smoke kiln using stratified temperatures, 50 °C to 60 °C at initial step for drying, 80 °C to 90 °C at a further step for cooking, and 50 °C to 60 °C at final step for product finishing [3]. The smoking process was stopped after the fillets were cooked and turned golden yellow to brown in color.

2.2 Raw Carcass and Smoked Fish Fillet Quality Analysis

Carcass quality of raw was calculated for edible flesh, dressing percentage, carcass waste, water holding capacity and flesh chemical composition. Smoked fish quality was evaluated for smoking yield, chemical composition, sensory value and overall acceptability. Water holding capacity was analized by a centrfugation method [10]; and the value was expressed as the percentage of water lost after centrifugation for 5 min at 1 500 rpm (1 rpm = 1/60 Hz) (Centurion Scientific K3 Series, K241R). Edible flesh, dressing percentage, carcass waste, water holding capacity and smoking yield was calculated using the following formulas.

Weight gain = (Final weight-Initial weight)/(Initial weight) x100

Edible flesh (%) = (Flesh weight/Body weight) x 100

Dressing percentage(%) = (Body weight – head – fins – skin– viscera)/(Body weight) x 100

Carcass waste (%) = (Fish waste weight/ Body weight) x 100

Water Holding Capacity = (Flesh mince weight – Flesh mince weight after centrifuge)/(Flesh mince weight) x 100

Smoking yield = (Fillet weight after smoking/Fillet weight before smoking) x 100

Chemical composition of raw and smoked fish fillet was analyzed for moisture, protein and fat composition using AOAC method [11]. Moisture was determined after oven-drying at 105 °C until the

sample weight was constant; protein content was analyzed using Kjeldahl procedure; and crude protein was estimated as N × 6.25. Crude fat was determined after soxhlet extracted using petroleum ether.

Sensory quality was evaluated by six trained panelists comprising of teaching staffs of Fish Processing Technology Department. The sensory quality assessment was made using a 9–1 smoked fish quality score sheet recommended by Hasan and Edison [12]; score 9 was the highest and 1 was the lowest. The sensory quality attributes included appearance (smoothness, fat secretion, translucent, hue, and color intensity); odor (specific smoked catfish odor); flavor (specific smoked catfish flavor); texture (elasticity, oiliness and juiciness). Overall acceptability were evaluated by 50 untrained panelists using a nine-point hedonic scale, 9 = like extremely and 1 = dislike extremely.

2.3 Data Analysis

Triplicate data of carcass characteristics and smoked fish fillets quality prepared from fish fed two different diets were analyzed using t-test [13].

3.0 RESULTS AND DISCUSSION

3.1 Weight Gain and Carcass Quality Characteristics of Raw

There was no difference in weight gain (Table 2) between fish fed diet A and B, but edible flesh, dressing percentage and flesh water holding capacity were higher for fish fed diet A than B. Carcass waste was higher for the fish fed diet B than A. Improving carcass quality of harvested fish as a result of increasing protein in fish diet has also been proved by other workers in other species [7, 14, 15, 16, 17].

Flesh composition of harvested fish differed between fish fed diet A and diet B, except for moisture. Protein composition was higher for fish fed diet A than B, however, fat composition was higher for fish fed diet B than A. Edible flesh, dressing percentage and flesh water holding capacity of harvested fishin this study showed a paralel relationship with body protein but inverse relationship with body fat. Dietary protein with sufficient energy in the diet will be metabolized completely to body protein; however an excess of energy in the diet will be converted to body fat which are devoted in skin and visceral cavity, thus reducing edible flesh and dressing percentage as well as flesh water holding capacity. Increasing protein level in the diet improves body protein and decreases body fat was also reported in many species of fish such as chinook salmon (*Oncorhynchus tshawytscha*) [18], bagrid catfish (*Pseudobagrus fulvidraco*) [16], Grass Carp (*Ctenopharyngodon idella*) [19], rainbow trout (*Salmo gairdneri*) [20, 21], channel catfish (*Ichtalurus punctatus*) [23–26] and clarias catfish (*Clarias macrocephalus* × *Clarias gariepinus*) [7].

Table 2 Carcass quality characteristics of harvested fish fed high protein-lowenergy diet (A) and low protein-high energy diet (B)

Carcass quality characteristics	Composition (%)	
	Diet A	Diet B
Weight gain	276.76[a]	272.67[a]
Edible flesh	43.45[b]	41.20[a]
Dressing percentage	53.71[b]	51.99[a]
Carcass waste	46.29[a]	48.52[b]
Water holding capacity	11.77[a]	14.73[b]
Moisture	70.08[a]	69.66[a]
Protein	17.95[b]	15.75[a]
Fat	9.57[a]	11.43[b]

Note: Data in the same rows indicated by the same latter were not significantly different (P > 0.05)

3.2 Smoking Yield and Chemical Composition of Smoked Fillets

There was no difference in yield of smoked fillets prepared from diet A and B (Table 3), indicating that the difference in body protein and fat of raw fish did not affect smoking yield. Smoking yield, the most economic inportance of smoked fish industry, is usually correlated with fat and other componen lost during smoking.

In cold smoking method, the smoking yield usually increased with increasing fat content of the raw [27]; but in hot-smoking method, smoking yield decreased with increasing fat content of the raw as some of the body fat melted during smoking [3]. Smoking yield was also affected by water holding capacity, the ability of muscle to resist water and fat of the raw fish [28–30].

Table 3 Smoking yield and chemical composition of smoked fillets prepared from fish fed diet A and B

Chemical composition (%)	Diets	
	A	B
Smoking yield	35.31[a]	36.68[a]
Moisture	11.73[a]	14.06[b]
Protein	48.07[b]	43.21[a]
Fat	18.72[a]	22.67[b]

Note: Data in the same row indicated by the same latter were not significantly different (P > 0.05)

The fact that the smoking yield did not differ between the two smoked fillets prepared from fish of different fat and protein content in the present study was probably associated with smoking method in this study, which used low temperature 50 °C to 60 °C at initial smoking step for drying the fish fillet. The gradual increase in temperature 80 °C to 90 °C) at further step to cooke the fish might be capable of

minimizing excessive loss of fat of the fatty fillets during smoking. Other reason was because moisture composition of smoked fish prepared from fish fed low dietary protein-high energy diet was still fairly higher since increasing drying temperature would defact and liquidify the body fat. Higher protein in smoked fish prepared from fish fed diet A, and higher fat in smoked fish prepared from fish fed diet B (Table 3) was proportional to protein and fat composition of the raw. The similar results were also demonstrated by hot-smoked Pangasius catfish (*Pangasius hypophthalmus*) prepared from fish of different sizes [3].

3.3 Sensory Quality and Overall Acceptability

There was no difference in overall acceptability of smoked fish (Table 4) between the two smoked fish; however, appearance and texture values were higher for smoked fillets prepared from fish fed diet A; and flavor as well as odor values were higher for the smoked fillets prepared from fish fed diet B. A better appearance and texture of smoked fillets prepared from fish fed high protein diet was probably due to the fish body protein composition and water holding capacity which were higher in fish fed high protein diet. This reason was in accordance with findings reported by Rora *et al.* [27] and Einen *et al.* [31]. Moreover, a better odor and flavor of smoked fillet may be correlated to fish body fat composition which was higher in the fish fed low protein diet. Fish body fat at a certaint amount improving odor and flavor of smoked fillet was also consistent with our previous study on sensory quality characteristics of smoked fish prepared from Pangasius catfish (*Pangasius hypophthalmus*) of different sizes [3].

Table 4 Sensory quality and overall acceptability of smoked fillets prepared from fish fed diet A and B

Sensory quality	Diets	
	A	B
Appearance	9.00[b]	7.80[a]
Texture	8.27[b]	7.67[a]
Odor	8.20[a]	9.00[b]
Flavor	8.20[a]	9.00[b]
Overall acceptability	8.61[a]	8.56[a]

Note: Data in the same row indicated by the same latter were not significantly different (P > 0.05)

4.0 CONCLUSION

There was no difference in weight gain and body moisture of the raw between fish fed the two diets, but edible flesh, dressing percentage, flesh water holding capacity and body protein were higher for the fish fed diet A, and body fat was higher for fish fed diet B. Smoking yield and overall acceptability of the smoked fish prepared from fish fed the two diets were similar, however protein composition, appearance and texture values were higher for smoked fillets prepared from fish fed diet A; while fat, moisture, odor and flavor values were higher for smoked fillets prepared from fish fed diet B. As high protein diet is expensive while weight gain, smoking yield and overall acceptability of smoked fish are not different between fish fed the two diets, diet B therefore may be recommended for better raw and smoked fillet quality.

Acknowledgement

The authors wish to express their grateful acknowledgement to Unversity of Riau for providing research grant. Appreciations are also extended to Directur of Fish Hatchery Sungai Paku for providing fasilities and materials.

References

[1] Hatae, K., K. H. Lee, T. Sutchiya, A. Shimada. 1989. Textural Properties of Cultured and Wild Fish Meat. *Bulletin Japanes Societee Science Fish*. 55: 363–368.

[2] Farmer, L. J., J. M. McConnell, D. J. Kilapatrick. 2000. Sensory Characteristics of Farmed and Wild Atlantic Salmon. *Aquaculture*. 187: 105–125.

[3] Hasan, B., Edison. 2007. Karekteristik Kimia dan Sensoris Fillet Asap yang Dibuat dari Ikan Patin (*Pangasius hypophthalmus*) dari Berbagai Ukuran [Chemical and Sensory Characteristics of Smoked Fillets Prepared from Pangasius Catfish (*Pangasius hypophthalmus*) of Different Sizes]. *Jurnal Perikanan dan Kelautan*. 2(2): 19–25. [Bahasa Indonesia].

[4] Lovell, R. T. 1976. Fish Feed and Nutrition: Energy. *Commercial Fish Farmer*. 2: 40–41.

[5] Stickney, R. R. 1977. Lipid in Catfish Nutrition. In Stickney R. K., R. T. Lovell (eds.). *Nutrition and Feeding of Channel Catfish*. Southern Cooperative Series No. 21 B.

[6] Hasan, B., I. S. Boer. 1994. Masa Simpan Ikan Baung (*Macrones*, sp) dalam Es (5 °C) [Shelf Life of Baung Catfish (*Macrones*, sp) Stored in Ice (5 °C). *Berkala Perikanan Terubuk*. 59(1): 45–50. [Bahasa Indonesia].

[7] Jantrarotai, W., Sitasit, P. Jantrarotai, T. Viputhanumas, P. Sarabua. 1998. Protein and Energy Levels for Maximum Growth, Diet Utilization, Yield of Edible Flesh and Protein Sparing of Hybrid Clarias Catfish (*Clarias macrocephalus* x *Clarias gariepinus*. *Journal of the World Aquaculture Society*. 29: 281–289.

[8] Hasan, B., C. R. Saad, A. A. Alimon, M. S. Kamarudin, Z. Hassan. 1999. The Effects of Various Dietary Energy Levels and Protein Concentrations on Growth Performance of River Catfish (*Mystus nemurus*). *Malaysian Journal of Animal Science*. 5(1 & 2): 83–92.

[9] Hasan, B., I. Suharman, Desmelati, D. Iriani. 2013. *Peningkatan Karakteristik Mutu Daging Baung* (Mystus nemurus) *Hasil Budidaya untuk Pengolahan Fillet dan Ikan Asap Melalui Formulasi Protein dan Energi dalam Diet* [An Improvement of Carcass Quality Characteristic of Farmed Baung Catfish (*Mystus nemurus*) for Smoked Catfish Processing through Dietary Protein and Energy Formulation]. Lembaga Penelitian Universitas Riau Pekanbaru. [Bahasa Indonesia].

[10] Eide, O., T. Borresen, T. Strom. 1982. Mince Fish Production From Capelin (*Mallotus villosus*). A New Method for Gutting, Skinning and Removal of Fat from Small Fatty Fish Species. *Journal of Food Science*. 47: 347–349.

[11] AOAC (Association of Official Analytical Chemists). 1990. *Official Methods of Analysis of the Association of Official Analytical Chemists*. K. Helrich (ed.). 15th ed. Arlington: Association Analytical Chemists.
[12] Hasan, B., Edison. 1996. *Mutu dan Penerimaan Konsumen terhadap Ikan Asap Jambal Siam Hasil Budidaya (Pangasius sutchi)* [Quality and Consumer Acceptance of Farm Raised Pangasius Catfish (*Pangasius sutchi)*]. Lembaga Penelitian Universitas Riau Pekanbaru. [Bahasa Indonesia].
[13] SPSS. 2000. SPSS for Windows, Release 10. SPSS Inc, Chicago, IL.
[14] Cowey, C. B. 1993. Some Effects of Nutrition on Flesh Quality of Cultured Fish. In Kaushik S. J., P. Luquet (eds.). *Fish Nutrition in Practice*. Les Colloques. No.61. INRA Edns. Paris. 227–236.
[15] Shyong, W. J., C. H. Huang, H. C. Chen. 1998. Effects of Dietary Protein Concentration on Growth and Muscle Composition of Juvenile *Zacco barbata*. *Aquaculture* 167: 35–42.
[16] Yang, S. D., C. H. Liou, F. G. Liu. 2002. Effects of Dietary Protein Llevel on Growth Performance, Carcass Composition and Ammonia Excretion in Juvenile Silver Perch (*Bidyanus bidyanus). Aquaculture*. 213: 363–372.
[17] Wang, J., Y. Jiang, X. Li, T. Han, Y. Yang, S. Hu, M. Yang. 2016. Dietary Protein Rrequirement of Juvenile Red Spotted Grouper (*Epinephelus akaara*). *Aquaculture*. 450: 289–294.
[18] Silver. G. R., D. A. Higgs, B. A. Dosanjh, B. A. McKeown, G. Deacon, D. French. 1993. Effect of Dietary Protein to Lipid Ratio on Growth and Chemical Composition of Chinook Salmon (*Oncorhynchus tshawytscha*) in Sea Water. In Kaushik, S. J., P. Luquet, (eds.). *Fish Nutrition in Practice*. Les Colloques. No.61. INRA Edns. Paris. 459–468.
[19] Kima. L. O., S. M. Lee. 2005. Effects of the Dietary Protein and Lipid Levels on Growth and Body Composition of Bagrid Catfish (*Pseudobagrus fulvidraco*). *Aquaculture*. 243: 323–329.
[20] Jin. Y., L. Tian, S. Xie, D. Guo, H. Yang, G. Liang, Y. Liu. 2015. Interactions Between Dietary Protein Levels, Growth Performance, Feed Utilization, Gene Expression and Metabolic Products in Juvenile Grass Carp (*Ctenopharyngodon idella*). *Aquaculture*. 437: 75–83
[21] Reinitz, G., F. Hizel.1980. Formulation of Practical Diets for Rainbow Trout Based on Desired Performance and Body Composition. *Aquaculture*. 19: 243–252.
[22] Refstie, T., E. Austreng. 1981. Carbohydrate in Rainbow Trout Diets: III. Growth and Chemical Composition of Fish From Different Families Fed Four Levels of Carbohydrate in the Diets. *Aquaculture*. 25: 35–49.
[23] Lovell, R. T., E. Prather, J. Tres-dick, L. Chorn. 1974. Effects of Addition of Fish Meal to All-Plant Feeds on the Dietery Needs of Channel Catfish. Processing Farm-Raised Catfish. *Proceeding 28th Annual Southeastern Assosiation of Game and Fish Commission*. 222–227.
[24] Page, J. W., J. W. Andrews. 1973. Interaction of Dietary Levels of Protein and Energy on Channel Catfish. *Journal of Nutrition*. 103: 1339–1346.
[25] Garling, D. L. Jr., R. P. Wilson. 1976. Optimum Dietary Protein to Energy Ratio for Channel Catfish Fingerlings. *Journal of Nutrition*. 106: 1369–1375.
[26] Mangalik, A. 1986. *Dietary Energy Requirements of Channel catfish*. Ph.D. Dissertation. Auburn University, Auburn, AL.
[27] Rora, A. M. B., A. Kvale, T. Morkore, K. A. Rorvik, S. H. Stein, M. S. Thomassen. 1998. Process Yield, Color and Sensory Quality of Smoked Atlantic Salmon (*Salmo salar*) in Relation to Raw Material Characteristics. *Food Research International*. 31: 601–609.
[28] Rora, A. M. B., O. Einen. 2003. Effect of Freezing on Quality of Cold-Smoked Salmon Based on The Measurements of Physicochemical Characteristics. *Journal of Food Science*. 68(6): 2123–2128.
[29] Regost, C., J. P. Jacobsen, A. M. B. Rora. 2004. Flesh Quality of Raw and Smoked Fillets of Atlantic Salmon as Influenced by Dietary Oil Sources and Frozen Storage. *Food Research International*. 37: 259—271.
[30] Lakshmanan, R., J. A. Parkinson, J. R. Piggott. 2005. High Pressure Processing and Water-Holding Capacity of Fresh and Cold-Smoked Salmon (*Salmo salar*). *LWT* 40: 544–551.
[31] Einen, O., T. Morkore, A. M. B. Rora, M. S. Thomassen. 1999. Feed Ratio Prior to Slaughter – APotential Tool for Managing Product Quality of Atlantic Salmon (*Salmo salar*). *Aquaculture*. 178: 149–169.

Carcass quality of raw and smoked fish fillets prepared from cage raised river catfish (Hemibagrus nemurus Valenciennes, 1840) fed high protein-low energy and low protein-high energy diets

ORIGINALITY REPORT

19%	10%	16%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	"Fishery Products", Wiley, 2009 Publication	1%
2	Submitted to Universitas Jember Student Paper	1%
3	Submitted to University Der Es Salaam Student Paper	1%
4	K. Mishra. "Interacting effects of dietary lipid level and temperature on growth, body composition and fatty acid profile of rohu, Labeo rohita (Hamilton)", Aquaculture Nutrition, 12/2004 Publication	1%
5	Gustavo Meyer, Débora Machado Fracalossi. "Protein requirement of jundia fingerlings, Rhamdia quelen, at two dietary energy concentrations", Aquaculture, 2004 Publication	1%

6	vtechworks.lib.vt.edu Internet Source	1 %
7	A.M.B. Rora. "Effects of Freezing on Quality of Cold-smoked Salmon Based on the Measurements of Physiochemical Characteristics", Journal of Food Science, 8/2003 Publication	1 %
8	ppid.unri.ac.id Internet Source	1 %
9	Oyedapo Fagbenro, Kim Jauncey. "Chemical and nutritional quality of fermented fish silage containing potato extracts, formalin or ginger extracts", Food Chemistry, 1994 Publication	1 %
10	repository.kmou.ac.kr Internet Source	1 %
11	Submitted to Mahidol University Student Paper	1 %
12	Mohammad Anwar. "Effect of Dietary Lipid Levels on Growth, Feed Conversion, and Muscle Composition of the Walking Catfish, Clarias batrachus", Journal of Applied Aquaculture, 10/27/1995 Publication	1 %

13	Nutrition & Food Science, Volume 45, Issue 5 (2015) Publication	1 %
14	www.chiriottieditori.it Internet Source	1 %
15	S. P Rose, I Kyriazakis. "Diet Selection of Pigs and Poultry", Proceedings of the Nutrition Society, 2007 Publication	<1 %
16	vuir.vu.edu.au Internet Source	<1 %
17	I. Bartov. " Differential effect of age on metabolisable energy content of high protein - low energy and low protein - high energy diets in young broiler chicks ", British Poultry Science, 1995 Publication	<1 %
18	riunet.upv.es Internet Source	<1 %
19	www.coursehero.com Internet Source	<1 %
20	www.frontiersin.org Internet Source	<1 %
21	Nahar Sabikun, Allah Bakhsh, M. Shafiur Rahman, Young-Hwa Hwang, Seon-Tea Joo. "Evaluation of chicken nugget properties	<1 %

using spent hen meat added with milk fat and potato mash at different levels", Journal of Food Science and Technology, 2020
Publication

22	Shang, Xiaolan, Anjun Liu, Jie Zheng, Ping Wang, and Shi Yin. "High Pressure Processing and Water Holding Capacity of Sea Bass Skeletal Muscle", Journal of Aquatic Food Product Technology, 2015. Publication	<1 %
23	sinta.ristekdikti.go.id Internet Source	<1 %
24	www.scribd.com Internet Source	<1 %
25	Dias, J.. "Regulation of hepatic lipogenesis by dietary protein/energy in juvenile European seabass (Dicentrarchus labrax)", Aquaculture, 19980201 Publication	<1 %
26	Mohammad H. Ahmad. "Response of African Catfish, *Clarias gariepinus*, to Different Dietary Protein and Lipid Levels in Practical Diets", Journal of the World Aquaculture Society, 08/2008 Publication	<1 %
27	Wimol Jantrarotai. "Protein and Energy Levels for Maximum Growth, Diet Utilization, Yield of	<1 %

	Edible Flesh and Protein Sparing of Hybrid Clarias Catfish (Clarias macrocephalus ♦ Clarias gariepinus)", Journal of the World Aquaculture Society, 9/1998 Publication	
28	www.diva-portal.org Internet Source	<1 %
29	Eglal Ali Omar. "Studies on feeding of mirror carp (Cyprinus carpio L.) in intensive culture", Journal of Animal Physiology and Animal Nutrition, 01/08/1987 Publication	<1 %
30	M. Tabatabae, A.R. Shahverdi, M. Oliazadeht, M. Sanati. "Desulfurization of Tabas coal by thiobacillus ferrooxidans", Minerals Engineering, 1996 Publication	<1 %
31	Wei Liu, Ming Jiang, Jin-Ping Wu, Fan Wu, Juan Tian, Chang-Geng Yang, Hua Wen. " Dietary Protein Level Affects the Growth Performance of Large Male Genetically Improved Farmed Tilapia, , Reared in Fertilized Freshwater Cages ", Journal of the World Aquaculture Society, 2017 Publication	<1 %
32	media.neliti.com Internet Source	<1 %

33	sherekashmir.informaticspublishing.com Internet Source	<1%
34	vital.seals.ac.za:8080 Internet Source	<1%
35	Cardinal, M.. "Relation of smoking parameters to the yield, colour and sensory quality of smoked Atlantic salmon (Salmo salar)", Food Research International, 2001 Publication	<1%
36	Marco Foddai, Chris G. Carter, Pollyanna E. Hilder, Harley Gurr, Nicole Ruff. " Combined effects of elevated rearing temperature and dietary energy level on heart morphology and growth performance of Tasmanian Atlantic salmon (L.) ", Journal of Fish Diseases, 2021 Publication	<1%
37	Niagara ., Muhammad Agus Supra, Mia Setiawati, Hafrijal Syandri. "Influence of Different Protein Levels and Protein to Energy Ratios on Growth, Feed Efficiency and Survival of Bonylip Barb (Osteochilus vittatus Cyprinidae) Fingerlings", Pakistan Journal of Nutrition, 2018 Publication	<1%
38	Salhi, M.. "Growth, feed utilization and body composition of black catfish, Rhamdia quelen,	<1%

fry fed diets containing different protein and energy levels", Aquaculture, 20040305

Publication

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		