

Proximate content of wild and cultured eel (*Anguilla bicolor*) in different part of body

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Abstract. Proximate content in fish varies depends on intrinsic and extrinsic factors. Intrinsic factors include species, sexual maturity, size and body parts. Extrinsic factors include habitat, season and type of food (diet). This study aimed to know the effect of fish body parts (intrinsic factor) on proximate levels in wild and cultured eel (extrinsic). The experimental design used factorial completely randomized design with two factors 2x3. The first factor is the habitat of eel (wild and cultured) and the second factor is the part of the body (head, body and tail) with five replications. The result of statistical analysis showed that there was interaction between fish habitat and body part on moisture, protein, ash and carbohydrate content ($P < 0.05$), but no interaction on fat content and energy ($P > 0.05$). The highest water content (67.02%) was found in head of wild and the lowest one (59.44%) in the tail of wild eel; The highest protein content (18.09%) was found in the body of cultured eel and the lowest one (15.72%) was in the body of wild eel; The highest ash content (3.73%) was the head of wild eel and the lowest (1.32%) was in the body of cultured eel; The highest carbohydrate (3.73%) was found in the head of cultured eel and the lowest one (0.16%) was in the body of cultured. The wild eel had higher fat content and energy than cultured one, while the fat content and energy in body and tail were higher than in head.

Keywords: *Anguilla sp*, proximate, part of body

1. Introduction

Fish is one of the nutrient-rich foods. High protein content and low fat are preferred by all levels of society. Fish protein contains the complete essential amino acids needed by the body. Fat in fish contains EPA and DHA essential fatty acids for both children and adults. Mineral content in fish is also quite complete, consuming enough fish can meet the body's need for essential minerals.

The content of nutrients or proximate in fish is very diverse. Internal influencing factors include species [1-2], size/age [3-4], sex [3], sexual maturity [5] and body parts [6]. External influencing factors include habitat [7-9], seasonal variations [10-13] and feed [14-16].

Eel is one of Indonesia's native fish that has high protein and fatty nutrients. Proximate composition of this type of fish allegedly also varied. Eel is an export commodity that is in great demand by Japan, Korean and China. The eel farming is continuously developed to meet increasing demand. In addition to cultivation eel fish are also caught in their habitat in the river. Different feeding significantly



affected the proximate composition of eel [17]. However comparison of proximate composition of wild and cultured eel has not been extensively investigated.

Eel are exported in fresh or processed form. In processed form, eel is filleted without head. The eel's head may contain nutrients that could be used as valuable products. The composition of the different parts of the eel body (head and tail) should be known to provide information and utilize eels according to their nutritional content. The purpose of this research is to know the difference of proximate content of wild and cultured eel in different body parts.

2. Materials and methods

2.1. Research materials

The materials used in this study were some fresh wild and cultured eel of consumption size or weight of about 300 grams. Samples were collected from Cilacap in the southern area of Central Java. Then they were transported to the laboratory for further analysis. Each parameter was tested three samples. The chemical materials used for proximate analysis were H₂SO₄, NaOH, HCl, KMnO₄, Boric Acid, and n-hexane (Merck, Germany)

The equipments used in this study consisted of those for sample handling of eel from the site to the laboratory (Styrofoam boxes) and those for the proximate analysis (oven, Kjeltex system, furnace, soxlet apparatus, desiccator, filter paper, reaction test tubes, spectrophotometers and GC (FOCUS Gas Chromatograph with autosampler A 2000, equipped with Polaris Q MS detector (Thermo Scientific, USA).

2.2. Sample preparation

Samples were brought from Cilacap waters to the lab in living condition. In laboratory both samples of wild and cultured eel were immediately killed and cut into 3 parts, namely the head, flesh of the body and flesh of the tail. Further samples were analyzed for proximate content (moisture, protein, lipid, carbohydrates and energy content).

2.3. Design

This study was aimed to describe the proximate content of both wild and cultured Eel in three different part of body (tail, body and head). The experimental design of this study was completely randomized design (CRD) Factorial with two factor (2x3). The first factor were type of fish comprises two levels (wild and cultured) and second factor were different part body (tail, body and head) and repeated 3 times.

2.4. Variable observed

The research variable observed in this study was nutritional characteristic of eel. The analysis of nutritional characteristics carried out within wild and cultured eel were consisted of proximate analysis (moisture, protein, fat, ash, and carbohydrates).

2.5. Analysis procedures

2.5.1. Moisture content

Determination of water content was based on samples weight before and after drying [18]. An empty cup was dried in an oven for 1 hour at 105 ° C temperature, and then it was put in a desiccator for 15 minutes and afterward it was weighed. One gram sample was inserted into the cup and then it was dried in an oven at 105 ° C temperature until its weight was constant (Drying proses was approximately done for 6 hours) . Afterward, the cup was inserted into the desiccator for 30 minutes. Later, it was weighed again. The water content was determined by the formula of:

$$\text{Water Content} = \frac{\text{Final Samples Weight (B)}}{\text{Early Samples Weighr (A)}} \times 100\% \quad (1)$$

2.5.2. Protein content

Analysis of protein content was conducted according to Kjeldahl method[18]. The principles of the method are that how to do the oxidation of carbonaceous materials and the conversion of nitrogen to ammonia by sulfuric acid. Then, ammonia reacts with the excess of acid to form ammonium sulfate. Later, formed ammonium sulfate is elaborated and the solution is made to be alkaline with NaOH. Evaporated ammonia is then going to be tied with boric acid. The quantity of nitrogen contained in the solution is determined by titration using standard solution of acid.

Five grams of dried samples was placed in a 100 ml Kjeldahl flask, followed by addition of 0.25 grams of selenium and 3 ml of concentrated H_2SO_4 in it. Furthermore, the destruction was done (heating through boiling process) for 1 hour until the solution was clear. Then, 50 ml of distilled water and 20 ml of 40% NaOH were added and then they were distilled. Distillation result was escrowed in Erlenmeyer flask containing a mixture of 10 ml of 2% H_3BO_3 and 2 drips of pink Brom Cresol Green-Methyl indicator. When the distillate reached a volume of 10 ml and become bluish-green colour, distillation process was stopped. Then, the distillate was titrated using 0,1N HCl until the colour become pink. The same treatment was also done against the blank. The protein content was calculated by the formula of:

$$\text{Nitrogen Content (\%)} = \frac{(B-A) \times C \times 14,007 \times 100\%}{D} \quad (2)$$

$$\text{Protein Content (\%)} = \text{Nitrogen Content (\%)} \times FK \quad (3)$$

Where :

A = HCl volume for blank titration

B = HCl volume for samples titration (ml)

C = normality level of HCl used (N)

D = samples weight (mg)

FK = conversion factor (6.25 for fishery products)

2.5.3. Fat content

Fat content analysis was according to AOAC [18]. Two grams of eel meat (W1) were spread out over the cotton which was reposed on filter paper and then it was rolled up to be a thimble. Wrapped samples were inserted into a fat flask that had been weighed before (W2) and it was connected to Soxhlet tube. Later, fat sheath was inserted into the tube Soxhlet extractor chamber and doused with fat solvent (n-hexane).

Then, reflux process was done for 6 hours. Fat solvent in the fat flask was distilled until all it was evaporated. During distillation process, the solvent will be accommodated in an extractor chamber, and then it was discarded so it reenter into the fat flask. Afterward, fat flask was dried in an oven at temperature of 105 ° C. Subsequently, fat flask was put in a desiccator until reached constant weight (W3). The fat content was determined by the formula of:

$$\text{Fat Content (\%)} = \frac{W3 - W2}{W1} \times 100\% \quad (4)$$

Where :

W1 = Samples Weight (gram)

W2 = Fat Flask Weight without fat (gram)

W3 = Fat Flask Weight with fat (gram)

2.5.4. Ash content

Ash content was analyzed according to AOAC [18]. The cup was cleaned and then dried in an oven for 30 minutes at the temperature of 105 °C, following by storing in desiccators and weighing. Five grams of sample was then weighed and put in the cup. The sample was then burned in the electric stove. When there was no longer smoke come out from the stove, the sample was put into the incinerating furnace with a temperature of 600 °C. After 7 hours the cup was inserted in a desiccators and then was weighed. The ash content was determined by the formula of :

$$\text{Ash Content (\%)} = \frac{\text{Ash Weight}}{\text{Dried Samples Weight}} \times 100\% \quad (5)$$

3. Result and discussion

3.1. Moisture content

Moisture content data is presented in Table 1. Moisture content of wild and cultured eel in different parts of the body vary from 59.44% - 67.02%. Statistical data analysis shows that there was interaction between fish type and body part ($P < 0.05$) on moisture content of eel. The highest moisture content is in the head of wild eel, but it was not significantly different with the head of cultured one. The lowest moisture content was in the tail of the wild eel.

Table 1. Moisture Content (%) of Wild and Cultured Eel in Different Part of Body

	Head	Body	Tail
Wild	67.02±0.86 ^a	60.5 ±0.36 ^{cd}	59.44±0.82 ^d
Cultured	66.55±1.16 ^{ab}	63.57±0.59 ^{bc}	63.71±1.51 ^b

Values with different superscript are significantly different ($P < 0.05$)

Moisture content on the tail wild eel showed the lowest value. Other study reported that the moisture content of the tail (caudal) in the fish Hilsa (*Tanualosa ilisha*) was lowest compared to the dorsal and ventral [6], which is line with our finding.

The results of this study indicate the water content in the body and tail of cultured fish was higher than wild eel. The results of this study were similar to the results of Onyia et al [8] which showed that moisture content of cultured African catfish (*Heterobranchus bidorsalis*) was higher than wild one.

3.2. Protein content

Protein content of wild and cultured eel in different parts of the body are presented in Table 2. The results of data analysis indicate there are interaction between different types of fish and body parts.

Table 2. Protein Content (%) of Wild and Cultured Eel in Different Part of Body

	Head	Body	Tail
Wild	16.79±0.48 ^{bc}	15.72 ±0.28 ^d	15.75±0.19 ^d
Cultured	16.07±0.49 ^{cd}	18.09±0.81 ^a	17.15±1.54 ^{ab}

Values with different superscript are significantly different ($P < 0.05$)

The highest protein content was found in body of cultured eel but not significantly different with protein content in the tail. The lowest protein content was in the head of cultured eel but not significantly different with head of wild eel. In general, protein content of cultured eel were higher than natural eel. Mahboob et al [7] reported that the protein content of wild *Labeo rohita* in various sizes were higher than in the cultured one.

Protein content of cultured fish were higher than wild one which is likely caused by higher protein intake of cultured eel than wild one. High protein feed will be converted to protein in fish meat. Seo et al reported that eel that fed with the highest protein content showed the highest protein levels in flesh[17].

Protein content in wild eel fish indicate that the head has the highest protein content, while the body and tail were not significantly different. Fish such as other animals exhibit bio-accumulation of specific nutrients in various organs of the body[19]. From this study, it has been observed that wild eel protein was more concentrated in the head than any other part of the body in this study. Kefas et al reported protein levels in the head of the fish *Synodontis clarias* and *Oreochromis niloticus* that live in reservoirs were higher than in body parts[19].

3.3. Lipid content

Lipid content of eel is presented in Table 3. Lipid content of wild and cultured eels in different sections showed a high value (above 5%). Lipid content in this study ranged from 10.36% to 20.36%. Data analysis showed no interaction between fish type and fish body part, but each factor had significant effect on lipid content. lipid content in wild eel was lower than in cultured one. Among the part of body showed the lowest lipid content was in the head while the body and tail were not significantly different.

Table 3. Lipid Content (%) of Wild and Cultured Eel in Different Part of Body

	Head	Body	Tail
Wild	12.22±0.66 ^{Ab}	20.36 ±1.75 ^{Aa}	19.29±0.45 ^{Aa}
Cultured	10.36±1.66 ^{Bb}	16.84±1.66 ^{Ba}	17.15±0.77 ^{Ba}

Superscript with different capital letter show significantly different between wild and cultured (P<0.05); superscript with small letter show significantly different among part of body (P<0.05)

Lipid content of wild and cultured eels were significantly different due to the scarcity of food in nature which results in reduced fish growth due to limited food supply to natural fish[7]. Onyia et al reported that lipid content of wild catfish was higher than cultured one[8], that similar with our finding.

The lipid content of the heads was lower than that in the body and tail. Kefas et al reported similar results that the lipid content in the head of *Synodontis clarias* and *Oreochromis niloticus* was lower than that of the body[19]. Lipid content content of wild and cultured eel in all parts of bady showed a high value (> 10%) indicating that this fish is an excellent source of fish oil. Fish fats, especially the content of unsaturated fatty acids are needed by humans[20].

The ash content of eel is presented in Table 4. Statistical analysis shows there were an interaction between fish type and fish part (P <0.05). The highest ash content was found in the head of the wild eel, while the lowest one was in the body of cultured eel but was not significantly different with the tail of the cultivated fish and the body part of wild one (P> 0.05).

Table 4. Ash Content (%) of Wild and Cultured Eel in Different Part of Body

	Head	Body	Tail
Wild	3.73±0.28 ^a	1.44 ±0.30 ^d	2.38±0.17 ^c
Cultured	3.29±0.11 ^b	1.32±0.09 ^d	1.59±0.21 ^d

Values with different superscript are significantly different (P<0.05)

The ash content in the head of wild eel showed the highest content, it is likely that the head contains many minerals in the form of calcium. The results of research by Kefas et al show the same trend that the ash content of fish head of *Synodontis clarias* and *Oreochromis niloticus* was higher than in body or flesh[19].

3.4. Carbohydrate content

Carbohydrate content of both wild and cultured are eel relatively small (0.23% -3.73%). Carbohydrate levels vary greatly (Table 5). The highest carbohydrate is achieved by cultured eel fish on the head, while the lowest one in the body of cultured eel.

Table 5. Carbohydrate Content (%) of Wild and Cultured Eel in Different Part of Body

	Head	Body	Tail
Wild	0.23±0.29 ^c	1.89 ±0.26 ^c	3.09±0.17 ^{ab}
Cultured	3.73±0.83 ^a	0.16±0.23 ^c	0.88±0.14 ^{bc}

Values with different superscript are significantly different (P<0.05)

3.5. Energy content

Energy content of wild and cultured eel in different parts of the body varies between 176.7 -258.98 Kcal/100g (Table 6). Data analysis showed no interaction between fish type and fish body part, but each factor had significant effect on the amount of energy. Energy in wild eel was higher than in cultured eel.

Table 6. Energy Content (Kcal/100g) of Wild and Cultured Eel in Different Part of Body

	Head	Body	Tail
Wild	183.3±4.8 ^{Ab}	258.98 ±10.59 ^{Aa}	253.84±2.02 ^{Aa}
Cultured	176.73±6.29 ^{Bb}	230.39±11.56 ^{Ba}	226.15±8.97 ^{Ba}

Superscript with different capital letter show significantly different between wild and cultured (P<0.05); superscript with small letter show significantly different among part of body (P<0.05)

The energy contained in wild eel fish was higher than cultured one. It is closely related to water content in wild eel fish which was lower than cultured fish. In the eel's body also showed higher energy than the head. It is also closely related to moisture content of the body which were lower than in the head. Ball et al suggests that increased energy density in fish may be due to reduced water supply [21].

4. Conclusion

There was interaction between type of fish and body part on moisture, protein, ash and carbohydrate content (P <0,05), but no interaction on fat content and energy (P> 0,05). The body of cultured eel had higher protein than wild one. The wild eel had higher fat content and energy than cultured one, while the fat content and energy in body and tail were higher than in head. Our research found that different body part of wild and cultured eel had different proximate content.

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6. References

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