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The Effect of Increased Scale of Production on Fish Silage Quality

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ABSTRACT

Dead fish due to reversal of water mass in floating net cages cultivation, most of which cannot be sold because they are not suitable for consumption or processing into food. One effort that can be done to increase the added value of dead fish is processed into silage. Silage is a very good feed ingredient for fish and poultry because of its low metabolic basal energy. This study aims to determine the effect of increasing the scale of production on the characteristics of fish silage quality. The research method used was experimental with a complete randomized design consisting of 3 treatments namely a) scale of production of 1 kg of fish, b) scale of production of 5 kg of fish, and c) scale of production of 25 kg of fish. The three treatments were repeated 3 times. The parameters observed were protein content, fat, ash content, water content and amino acid composition of silage fluid and rendemen. Data obtained from all observation variables except amino acid compositions were analyzed by F test, if significant continued with Duncan test, each test was carried out at 95% confidence level. The results of the study obtained conclusions that the quality characteristics of fish silage made from dead fish due to reversal of water mass were not affected by the scale of the production process. The silage quality characteristics produced in this study were protein content of 16.02%, fat content of 8.98%, ash content of 2.35%, carbohydrate content of 2.45% and moisture content of 70.2%. Rendemen is 62.72%.

***Keywords*:** dead fish, production, quality characteristics, scale increase, silage, *Cyprinus carpio*

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1. INTRODUCTION

The mass mortality of fish in the Floating Net Cage (FNC) system, due to reversal of water masses, has an impact on the emergence of economic and social losses to the FCN system fish farmers community. The perceived economic loss is the potential profit lost for fish farmers, fish feed traders and fish traders. The social impacts that are taken into account economically are the loss of sources of livelihood [1].

The handling of dead fish must be carried out as soon as possible, if not then there will be more severe environmental pollution. The handling that has been done so far is that the dead fish are removed from the body of the water and then buried. In addition, some are sold if the fish still looks fresh, but the price is very low compared to if it is sold alive.

One of the efforts to handle mass dead fish due reversal of water mass is made silage. Fish silage is a product in the form of thick liquid resulting from the breakdown of complex compounds into simple compounds carried out by enzymes in a controlled environment. Based on the control process, making fish silage can be carried out chemically and biologically [2].

The resulting silage quality depends on the method and process conditions. The method of making silage can be carried out chemically and biologically. Based on previous research chemical silage making is the most frequently performed. Chemical silage production is known as acid silage because the chemical compounds used are acid compounds such as formic acid, acetic acid or propianic acid. The role of these acid compounds is to soften fish tissue and reduce acidity. As a result, proteolytic enzymes contained in the fish's body will actively work to break down proteins (complex compounds) into dipeptides and amino acid acids (simple compounds) which are soluble in water [3].

The handling of dead fish waste due to reversal of water mass into silage is an effective and economical and environmentally friendly treatment [4]. Silage contains a lot of protein and amino acids so it is very good for animal feed and mixtures in fish rations [5].

The Making of silage to handle mass dead fish must be on a high scale of production. Previous research was still carried out on a laboratory scale. Thus, research of increasing the scale of fish silage production is very important. The purpose of this study was to determine the effect of increasing the scale of production on the quality characteristics of the resulting silage of fish.

2. RESEARCH METHODS

The research method used was experimental with a complete randomized design consisting of 3 treatment levels of production scale namely a) scale of production of 1 kg of fish, b) scale of production of 5 kg of fish, and c) scale of production of 25 kg of fish. The three treatments were repeated 4 times. The parameters observed were protein content (Kjeldahl [6]), fat (Soxhlet [6], ash content [6], water content [6] and amino acid composition (HPLC) of silage fluid and rendemen. Data obtained from all observation variables except amino acid compositions will be analyzed by variance test (F test), if significant, followed by Duncan test, each test was carried out at 95% confidence level.

The experimental procedure was carried out as follows [7].

1) Carp (*Cyprinus carpio*) dead due to reversal of water mass washed with clean water and then finely chopped using a machete or chopper. Next, the chopped fish is weighed. The weight is in accordance with the level of the production scale.
2) Chopped fish was inserted into each reactor tank (plastic barrel). Then added a mixture of formic acid and propianate (1:1) as much as 3% of the total weight of the chopped fish.
3) Then each reactor was stirred 4 (four) times every day for 4 (four) days, then on days 5 to 8 are stirred once a day.
4) After that, the solids and liquid fractions are separated. The silage liquid obtained from each reactor was then analyzed for protein, fat, ash content, water content and amino acid composition.

3. RESULTS AND DISCUSSION

3. 1. Rendemen of silage liquid

Rendemen of fish silage is the percentage of silage liquid obtained on the raw materials of fish used. Silage liquid is the desired product in the process of making silage, while the waste is pulp. This pulp consists of scales, bones and fish skin. High rendemen of fish silage indicate that the process of making silasas runs optimally. Raw material for silage of dead goldfish due to water mass reversal in this study, simulated with goldfish which were turned off 12 hours before being processed into silage. The rendemen of silage obtained in this research from various levels of production scale is shown in Table 1.

Table 1. The rendemen of fish silage liquid made from dead fish due to reversal water mass

Treatment of production scale	Rendemen (%)
Production scale of 1 kg	63.38
Production scale of 5 kg	62.80
Production scale of 25 kg	61.98

Based on Table 1, the greater the scale of production, the lower the yield value. The results of the variance analysis (Appendix 1) show that the scale of production does not affect the yield of silage produced. This means that the silage yield produced from the scale of production of 25 kg is statistically the same as the silage yield produced from a production scale of 1 kg.

The composition of raw materials plays an important role in the rendemen of fish silage. Thick fleshed fish and spines and bones less, will have a higher rendemen than thin fleshed fish and many spines and bones. The rendemen of trash fish silage has a yield of 65.40% [8]. This rendemen value is higher than the yield produced from this study (mean = 62.72%). The high value of trash fish rendemen compared to the rendemen of carp because trash fish do not have as many scales as carp. In addition, trash fish offal is less than carp.

3. 2. Moisture content of silage liquid

The moisture content of a product is the amount of water that can be evaporated to the extent that the water contained in the product cannot be evaporated again through a drying process at a temperature of 110 ºC. Water contained in a product can be physically and chemically bound. Water that can be evaporated through the drying process is physically bound water. The results of the analysis of the silage water content of fish from various levels of production scale are presented in Table 2.

Table 2. Water content of fish silage liquid made from dead fish due to reversal water mass

Treatment of production scale	Water content (%)
Production scale of 1 kg	70.24
Production scale of 5 kg	70.14
Production scale of 25 kg	70.23

The level water content of fish silage from raw materials of dead carp due to reversal of mass of water in various levels of production scale is in the range of 70.24 - 70.14%. This range of the level water content based on statistical analysis shows no significant difference, because the results of the variance analysis showed that the increase in production scale did not affect the silage water content produced (Appendix 2). Thus the production of fish silage made from dead fish due to mass reversal can be mass produced and the resulting silage has a water content that is no different from small-scale production.

Silage water content depends on the raw material and process technology used. The fish silage obtained from this study was 70.2% on average. This value of the water content is smaller than the value of silage water content of fish market waste which is 75, 40 % as reported by Palkar et al [5] who uses chemical techniques.

3. 3. Ash content of silage liquid

The ash content of a product including fish silage liquid is the amount of mineral content contained in the product. The level of silage liquid ash is very important to know because it is related to the use of liquid silage as a feed ingredient for both fish and livestock. Mineral is a micro nutrient that is needed by fish and livestock in managing the process of growth and survival. The results of the analysis of the ash content of fish silage from dead fish due to reversal of water mass from various levels of production scale are shown in Table 3.

Based on statistical analysis shows that the silage liquid ash content is not influenced by the level of production scale. The results of this statistical test can be used as a basis for producing fish silage on a mass scale without worrying about the decrease or increase in ash levels compared to small scale (Appendix 3). The level of silage liquid ash content from of dead fish due to reversal of this water mass was 2.35% on average (Table 3). When compared with silage liquid ash content made from fish market waste (4.93%) [5], the ash content of silage liquid from this study was smaller. According to Ramasubbu Rayan et al., [9] the quality of

silage fluids including ash content is highly dependent on raw materials and process technology that used. Widjastuti et al., [10] also state the same thing that silage quality is influenced by raw materials and process technology. Based on these information, it is more convincing that the scale of production in making silage is not a factor that influences the quality of silage produced.

Table 3. Ash content of fish silage liquid ash made from dead fish due to reversal water mass

Treatment of production scale	Ash content (%)
Production scale of 1 kg	2.41
Production scale of 5 kg	2.34
Production scale of 25 kg	2.31

3. 4. Fat content of silage liquid

Fish silage liquid can be used as a source of raw material in making fish pellets. One of the nutrients that must be present in fish pellets is fat. This fat compound is used as a constituent of organelles in the body of the fish. Besides that it is also used as an energy reserve. The existence of a very important fat compound in the source of this pellet raw material was considered necessary to was analyzed the fat content in fish silage liquid obtained from this study. The proximate test results of fat content in fish silage liquids from this study was show in Table 4.

Table 4. Fat content of fish silage liquid made from dead fish due to reversal of water mass.

Treatment of production scale	Fat content (%)
Production scale of 1 kg	9.07
Production scale of 5 kg	8.95
Production scale of 25 kg	8.93

Based on Table 4, the fat content of fish silage from the treatment results from various levels of production scale ranged from 9.07% to 8.93%. Fish silage liquid which has the highest fat content is obtained from the production scale of 1 kg. The larger the scale of production, the smaller the fat content in the silasenya fluid. However, based on the results of statistical analysis the fat content in silage liquid is not influenced by the scale of production (Appendix 4).

The fat content average of silage liquid from raw materials of dead fish due to the reversal of this water mass obtained from various levels of production scale is 8.98%. The value of this fat content is higher than the fat content of fish silage from the raw material of nile tilapia which

is 3.26% [11] and fish offal which is 8.6% [12]. The high fat content of the fish silage liquid is because the raw material used is carp that including fat fish.

High fat content in fish silage fluids can have an impact on the short shelf life of the silage fluid. Fat compounds are easily oxidized by oxygen to rancid-smelling compounds. This rancid odor is an unpleasant odor and can reduce the acceptability of fish's silage liquid by livestock or fish.

3. 5. Carbohydrate content of silage fluid

Compounds belonging to the group of carbohydrates found in fish tissues are glycogen and some intermediate compounds in the krebb cycle process. The carbohydrate compounds contained in fish tissues are relatively small compared to protein compounds. Therefore, the content of carbohydrate compounds in fish silage fluids is also relatively small when compared with their protein levels. The results of carbohydrate level calculation of fish silage fluids made from goldfish that die from water mass reversals are presented in Table 5.

Table 5. Carbohydrate content of fish silage liquid made from dead fish due to reversal of water mass.

Treatment of production scale	Carbohydrate content (%)
Production scale of 1 kg	2.15
Production scale of 5 kg	2.56
Production scale of 25 kg	2.65

The results of statistical tests show that the carbohydrate content of fish silage as found in Table 5 is not affected by the level of scale of production (Appendix 5). That is, although the number of carbohydrate levels is different, statistically not significantly different. The average carbohydrate content of carp silage liquid is around 2.45%. This value is greater than the carbohydrate content of the liquid silage nila tilapia (1,0%) [11], and when compared with silage liquid made from tuna waste (head and bone which still contains tetelan meat) is also still greater. The liquid silage level of carbohydrate tuna waste is 1.01% [10].

The relatively low carbohydrate content value of fish silage liquid as one of the feed ingredients is not an important problem. This is because the use of silage liquid in the feed constituent is intended not as a source of carbohyrate but as a source of protein.

3. 6. Protein content of silage fluid

Proximate test results of proteins on fish silage fluids made from dead fish due to water mass reversals are presented in Table 6. After statistical testing, the value of liquid silage protein levels from various levels of production showed no real effect (Appendix 6). This means that the protein content of fish silage fluid is not affected by the level of production scale. The conclusions of this statistic are in line with those informed by Vidotti et al., [13] that the silage making process does not depend on the scale of production.

Table 6. Protein content of fish silage liquid made from dead fish due to reversal of water mass.

Treatment of production scale	Protein content (%)
Production scale of 1 kg	16.14
Production scale of 5 kg	16.03
Production scale of 25 kg	15.88

Based on Table 6, the protein content average of liquid silage from this study was 16.02%. This value of silage protein content is relatively low compared to protein content of tilapia fish silage (17.07%) [11] and relatively high compared to silage liquid from fish market wastes (13.11%) [5]. The high protein content of fish silage liquid from this study is the main consideration in its use as a source of raw material for making fish or fish pellets. The use of dead fish due to reversing the mass of water into silage for feed / pellet materials is intended to reduce the impact of losses suffered by fish farmers in the reservoir, including in the Cirata reservoir - West Java. The use of fish silage as feed raw material is better compared to fish meal because fish silage has a higher breeding power and more complete availability of amino acids than fish meal [10]. According to Ramasubburayan et al [9], the use of captured waste silage for carp feed fingerling size provides a specific growth rate (SGR = specific growth rate) of 1.49% while the control feed is only 1.06%.

3. 7. The content and composition of the amino acid liquid silage

Table 7. Amino acid content in the liquid silage of fish produced on different production scales

Amino acid type	Production scale		
	1 kg Production	5 kg Production	25 kg Production
Aspartic acid (%, w/w)	1.38	1.42	1.52
Glutamic acid (%, w/w)	**2.45**	**2.34**	**2.41**
Serine (%, w/w)	0.65	0.49	0.53
Histidine (%, b/b)	**0.44**	**0.33**	**0.37**
Glysine (%, b/b)	1.06	1.09	0.94
Threonine (%, b/b)	0.74	1.35	0.89

Arginine (%, b/b)	0.98	0.72	0.88
Alanine (%, b/b)	1.05	0.98	1.13
Tyrosine (%, b/b)	0.48	0.39	0.41
Methionine (%, b/b)	0.46	0.35	0.41
Valin (%, b/b)	0.96	0.87	0.77
Phenylalanine (%, b/b)	0.52	0.37	0.50
I-Leusin (%, b/b)	0.92	0.85	0.71
Leusin (%, b/b)	1.36	1.42	1.10
Lysine (%, b/b)	1.45	1.34	1.53
Total amino acid	14.90	14.31	14.10

Based on HPLC analysis, the amino acid content of the three types examined from each silage liquid obtained from various levels of production scale is as shown in Table 7. The total amino acid content in the fish silage liquid is almost the same ie in the range of 14.10% to 14.90%. The highest total amino acid content is obtained from the scale of production of 1 kg while the lowest is obtained from the production scale of 25 kg. Based on Table 7, the amino acid content of histidine is the lowest in fish silage liquid produced both in scale production of 1 kg, 5 kg and 25 kg. Conversely, the amino acid content of glutamic acid is the highest both in the fish silage liquid produced from scale production of 1 kg, 5 kg and 25 kg.

Based on the protein and amino acid content as mentioned above, fish silage liquid made from dead fish due to reversing the mass of water is feasible to make a source of fish feed ingredients. In fact, the protein and acid content of the amine is higher than the fish silage liquid from the previous research results.

4. CONCLUSIONS AND RECOMMENDATIONS

4. 1. Conclusion

Based on the results of the study it can be concluded that the characteristics of the quality of fish silage made from dead fish due to the reversal of the mass of water produced are not influenced by the scale of the production. The silage quality characteristics produced in the study were 16.02% protein content, 8.98% fat content, 2.35% ash content, 2.45% carbohydrate content and 70.2% moisture content. The silage liquid rendemen is 62.72%.

4 .2. Suggestion

The scale of silage production of fish from dead fish due to the reversal of this mass of water can be increased to a scale that is as much as possible. In addition, it is necessary to make a feasibility study of its business.

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Appendix 1. Statistical analysis of data on the rendemen of liquid silage

Repeat	Treatment			Total
	1 kg scale production rendemen (%)	5 kg scale production rendemen (%)	25 kg scale production rendemen (%)	
1	62.3	60.7	61,5	184.5
2	65.9	63.9	60,5	190.3
3	60.5	64.1	63,4	188.0
4	64.8	62.5	62,5	189.8
Total	253.5	251.2	247.9	752.6
Average ± sd	63.38 ± 2.44	62.8 ± 1.57	61.98 ± 1.25	

Analysis of Varians (ANOVA)

Variety resources	db	JK	KT	F. accout	F. table
Treatmen	2	3.961667	1.980833	0.59554*	4.26
Galat (error)	9	29.935	3.326111		
Total	11	33.89667			

*) = non significan

Appendix 2. Statistical analysis of data on the water content of liquid silage

Repeat	Treatment			Total
	1 kg scale production water content (%)	5 kg scale production water content (%)	25 kg scale production water content (%)	
1	70.73	69.53	70.07	210.33
2	69.45	71.09	70.85	211.39
3	70.55	70.08	69.95	210.58
4	70.23	69.85	70.05	210.13
Total	280.96	280.55	280.92	842.43
Average ± sd	70.24 ± 0.57	70.14 ± 0,67	70.23 ± 0,42	

Analysis of Varians (ANOVA)

Variety resources	db	JK	KT	F. accout	F. table
Treatmen	2	0.02555	0.012775	0.04043*	4.26
Galat (error)	9	2.843475	0.315942		
Total	11	2.869025			

*) = non significan

Appendix 3. Statistical analysis of data on the ash content of liquid silage

Repeat	Treatment			Total
	1 kg scale production ash content (%)	5 kg scale production ash content (%)	25 kg scale production ash content (%)	
1	2.41	2.48	2.01	6.90
2	2.45	2.43	2.35	7.23
3	2.26	2.05	2.48	6.79
4	2.51	2.38	2.40	7.29
Total	9.63	9.34	9.24	28.21
Average ± sd	2.41±0.11	2.34 ± 0.19	2.31 ± 0.22	

Analysis of Varians (ANOVA)

Variety resources	db	JK	KT	F. accout	F. table
Treatmen	2	0.020517	0.010258	0.334541*	4.26
Galat (error)	9	0.275975	0.030664		
Total	11	0.296492			

*) = non significan

Appendix 4. Statistical analysis of data on the fat content of liquid silage

Repeat	Treatment			Total
	1 kg scale production fat content (%)	5 kg scale production fat content (%)	25 kg scale production fat content (%)	
1	9.21	8.95	9.05	27.21
2	9.00	8.98	8.90	26.88
3	9.05	8.90	8.85	26.80
4	9.00	8.95	8.90	26.85
Total	36.26	35.78	35.70	107.74
Average ± sd	9.07 ± 0.10	8.95 ± 0.03	8.93 ± 0.09	

Analysis of Varians (ANOVA)

Variety resources	db	JK	KT	F. hit	F. table
Treatmen	2	0.045867	0.022933	3.7189*	4.26
Galat (error)	9	0.055500	0.006167		
Total	11	0.101367			

*) = non significan

Appendix 5. Statistical analysis of data on the carbohydrate content of liquid silage

Repeat	Treatment			Total
	1 kg scale production carbohydrate content (%)	5 kg scale production carbohydrate content (%)	25 kg scale production carbohydrate content (%)	
1	1.65	3.14	3.07	27.21
2	3.05	1.45	1.90	26.88
3	1.79	2.77	2.64	26.80
4	2.11	2.87	3.00	26.85
Total	8.60	10.23	10.61	107.74
Average ± sd	2.15 ± 0.63	2.56 ± 0.75	2.65 ± 0.54	

Analysis of Varians (ANOVA)

Variety resources	db	JK	KT	F. hit	F. table
Treatmen	2	0.570117	0.285058	0.6820*	4.26
Galat (error)	9	3.76135	0.417928		
Total	11	4.331467			

*) = non significan

Appendix 6. Statistical analysis of data on the protein content of liquid

Repeat	Treatment			Total
	1 kg scale production protein content (%)	5 kg scale production protein content (%)	25 kg scale production protein content (%)	
1	16.00	15.90	15.80	47.7
2	16.05	16.05	16.00	48.1
3	16.35	16.20	16.08	48.63
4	16.15	15.95	15.65	47.75
Total	64.55	64.10	63.53	192.18
Average ± sd	16.14 ± 0.15	16.03 ± 0.13	15.88 ± 0.19	

Analysis of Varians (ANOVA)

Variety resources	db	JK	KT	F. hit	F. table
Treatmen	2	0.13065	0.065325	2.4697*	4.26
Galat (error)	9	0.23805	0.026450		
Total	11	0.36870			

*) = non significan