

Evaluation of small barbus silage through inclusion into commercially formulated poultry feed

Alemu Lema Abelti*

Batu Fishery and Other Aquatic Life Research Center, Oromia Agricultural Research institute, Ethiopia

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*Corresponding author: Alemu Lema Abelti, Batu Fishery and Other Aquatic Life Research Center, Oromia Agricultural Research institute, Associate Researcher of Fish postharvest technology, Ethiopia, , Tel: +251913189100; E-mail: alemulema@yahoo.com

Abstract

The aim of the present study was to produce fish silage by formic acid fermentation and evaluate its use in feeding of Lohman brown. A total of twenty five 120 day old Lohman brown were used for the experiment. A 24 weeks experiment was conducted to investigate the utilization of a diet based on commercial poultry feed and silage. Five diets containing various levels of fish silage (0, 2, 4, 6 and 8%) were evaluated. The birds were weighed and allotted to five pens containing five birds each. Daily feed intake, number and weight of egg laid were daily measured. Body weight was measured monthly. The highest average feed intake was recorded in treatment four (135.89 ± 7.82) g/ poultry in which 6 % of silage was included into commercial diet. The highest body weight obtained was (1968.00 ± 119.39) during 33rd week in which 6 % of silage was included into commercial diet. The highest average weight of egg (68.59 ± 4.96) was observed in T4 (6% silage included). It was concluded that addition of 6% fish silage into commercial poultry diet increased early egg laying, feed intake, body weight gain, egg production and average weight of eggs. Laying hen fed on 6% silage gained average weight of 649 gram, average egg number (117) and egg weight (60 gram) for feeding period of 24 weeks.

Keywords: Silage; small barbus; poultry; feed intake; weight gain; egg production;

Introduction

Fish silage is a semi-liquid product resulting from the preservation of whole fish or parts by the addition of acids (inorganic or organic) or by bacterial fermentation, adding latter a carbohydrates source along with lactobacilli species to convert sugars into lactic acid [4, 13]. Acid silage was developed in 1920 by A. I. Virtanen, using hydrochloric and sulphuric acid for the conservation of forages. Experiments with fish began in Sweden in 1936, using hydrochloric, sulphuric, and formic acids and sugars [28]. The presence of mineral or organic acids or the lactic fermentation decreases the pH, which inhibits the growth of bacteria, and hence enables long-term storage of the raw material. Fish silage made with organic or mineral acids is commonly referred to as acid fish silage, while that which requires the addition of a source of carbohydrates and anaerobic storage conditions is known as fermented or biological fish silage [6]. Liquefaction is caused by enzymes present in the fish,

and is accelerated by the acid which in addition to creating the right conditions for the enzymes to work, helps to break down bone and limits the growth of spoilage bacteria [30]. When fish is ensiled with formic acid, the pH is kept under 3.5 [28]. This preserves the amino acids, but during storage autolysis takes place so that the protein is broken down to shorter peptides and free amino acids [6].

Fish silage is used in Norway in feeds for fur animals and farmed fish and recently it has become permitted for use at a 30 g/kg dry weight basis in feed mixtures for poultry and pigs. Since then, several scholars have successfully utilized acid-preserved silage obtained from different raw materials in diets for different animal species. Fish silage can substitute fish meal or soybean for quality protein at low cost. Feeding experiments which substituted fish silage with fish meal/soybean meal in diets of different animals has been conducted. Some of the animals used were White leghorn chickens [6]; broiler chickens [2, 18, 15, 9, 16]; laying hens [16]; Labeo rohita fingerlings [21]; Juvenile *Litopenaeus vannamei* [24]; Tilapia [8] laying Japanese quails [15, 31], Common Carp (*Cyprinus carpio*) fingerlings [25] and Young rats [6]. The incorporation of fermented fish silage in dietary feed formulation in poultry may be used as an effective, suitable and cheaper protein source [31]. Reported that 15% of a mixture of fish silage-sorghum (70% - 30%) might be included in the diet without adverse effect on feed intake, weight gain and feed conversion ratio of broilers [18]. Other research conducted by [17] reported that chicks (36.3 ± 0.6 g) fed with fish silage diets (by-products of farmed salmon) at levels of 5 and 10% had a significant greater weight gain and feed intake. Recently, [2] reported that fish silage could replace up to 20% of soybean meal in broiler diets without affecting growth performance and sensory quality of meat.

Fish silage offers an opportunity to make use of by-catch, viscera and by-products from the fishing vessels and fish processing sites. By-catch is often thrown overboard because of its low price. Preserving and storing as silage is a convenient way of utilizing such resources. In Lake Ziway, unexploited strait fin barb, *Barbus paludinosus* was identified and its MSY (Maximum

Sustainable Yield) is estimated between 0.60 - 0.83 tons per km². Considering the total area of the lake (434 km²) it is estimated that an annual production of 260.4 to 360.2 with mean of 312 tons per annum of *B. paludinosus* can be harvested from Lake Ziway. With the observed substantial biomass, high productivity, high growth rate and short generation of *B. paludinosus* fishery can be started at pelagic habitats [12]. It is based on this recommendation that, the by-catch, unexploited strait fin barb (*Barbus paludinosus*) was selected as a raw material for silage preparation. The objective of this study was to determine the chemical composition (Moisture content, crude protein, Fat and Ash content) of fish silage and evaluate small barbus silage through inclusion into commercially formulated poultry diet.

Materials and methods

Experimental site

This trial was conducted at Batu fishery and Other Aquatic life researcher center. Five houses having an area of 4m² were constructed from mud brick; roof was covered with twisted bamboo, the polyurethane finally thatched by typha. The front side of the houses was built by 90 cm x 100 cm mesh wire to let the light enter (Figure 1).

Preparation of silage

A total of 50 kg specimen of Small barbus (*Barbus paludinosus*) was harvested from Lake Zeway using a monofilament. The total length of the specimen ranged from 7.4 to 12.5 cm with mean

length of 8.89 cm, and the weight ranged from 3.9 to 15.1 g with a mean weight 7.68g. The fish was minced using electric meat mincer (220 kg/hr) then mixed with 3% by weight solution of 98% formic acid in the ratio of 30L for 1 tone [30] to lower the pH up to 3.5, then continuously stirred twice a day for ten days. Initially, the mixture was in semi-solid form but it started to liquefy on the fourth day. Eventually the silage was placed in acid-resistant container plastic bucket and sealed until fermentation was completed. The mixture was stored at room temperature for a period of 120 days (Figure 2).



Figure 1: Poultry house



Figure 2: Small barbus harvested using monofilament

Determination of chemical composition of fish silage and prepared feed

Proximate composition and anti-nutritional factors of prepared fish acid silage was determined by standard methods of Association of Official Analytical Chemists (2005) for moisture, protein, fat and ash contents.

Moisture determination

Wet silage sample was weighed, placed in crucible and then dried in oven at 105°C for overnight. Crucible was taken out the next day and weighed again. The loss in weight represented the moisture contents and was determined. The percentage is determined by the following formula:

$$\text{Moisture} = ((W1 - W2) / W1) \times 100$$

Where W1 = initial weight of the sample W2 = final weight of the sample

Protein determination

Five grams of dried fish silage sample was taken in a flask and mixed with mixture of (Potassium Sulphate + Copper Sulphate) and transferred to a flask containing 200 mL of concentrated H₂SO₄. This flask was placed on a heating block, the heaters were turned on and the flask was kept there until white fumes stopped appearing and the solution became clear, indicating completion of the digestion process. The solution was removed away from the heater and then cooled. The solution was diluted with the

addition of 60 mL of distilled water and its pH was raised to 6.5–7 by adding 45% NaOH solution. Then five to six drops of indicator solution was added and the flask was connected with a condenser with the tip immersed in standard acid and heated until NH₃ was evaporated. The final solution mixture was then titrated using 0.2N HCl against NaOH. Protein contents were then determined applying the following mathematical formula:

$$\text{Protein} = \frac{(A - B) \times N \times 14 \times 6.25}{W}$$

A = volume of 0.2 N HCl used for sample titration

B = volume of 0.2 N HCl used in blank titration

N = normality of HCl

W = weight of sample

14 = atomic weight of nitrogen

6.25 = constant for nitrogen calculation

Ash determination

Ten grams of sample was taken in a crucible and weighed. Crucible with sample was placed in muffle furnace at a temperature of 550°C for 5 hours. When the sample turned white, it was taken out and weighed again. White-colored contents remaining at the bottom of the crucible represented ash, which was carefully weighed and its percentage present in the feed was calculated by the following formula.

$$\text{Ash content} = \frac{W_2 - W_1}{W_3} \times 100$$

Where: W₁ = Mass of empty porcelain dish

W₂ = Mass of dish with ash

W₃ = Mass of original product sample

Lipid determination

The soxhelt apparatus was set and 5 g of sample was placed in the extraction thimble and transferred to the condenser. Petroleum ether was filled in a flask and the apparatus was switched on. This process was continued for 16 hours. Then turned the heaters were switched off, and the flask was removed and gently dried on the same heater. When the contents of the flask smelled oily, they were removed and weighed and the fat content in the test sample was calculated using the following formula.

$$\text{Fat content} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

Feed preparation

Feed was prepared by adding fish silage into commercially formulated poultry feed purchased from Alama koudijs plc.

T1= 0% fish silage + 100% commercially formulated poultry feed

T2= 2% fish silage + 98 % commercially formulated poultry feed

T3= 4% fish silage + 96 % commercially formulated poultry feed

T4= 6 % fish silage + 94 % commercially formulated poultry feed and

T5= 8% fish silage + 92 % commercially formulated poultry feed

Poultry management

A total of twenty five 120 day old Lohman brown were used for the experiment. Twenty five poultry was assigned to five different silage inclusion rates. Each of five poultry house was equipped with round feeder and waterier. The birds were weighed and allotted to five pens containing five birds each. The birds were maintained under the standard management practices with ad libitum feeding and clean drinking water throughout the period of the experiment (24 weeks). The eggs were weighed daily using an electronic balance to an accuracy of 0.1 g. Every month, the weight of poultry was recorded using sensitive balance.

Data collected

Body weight, feed intake, Egg production, chemical composition (Moisture content, crude protein, ash and fat content) of commercial poultry feed and prepared feed was measured. Initial body weight and final body weight of each treatment was compared using ANOVA. Feed offered and refused was recorded daily to determinate the feed intake. Feed intake was monitored by feeding weighed quantities of feed daily and subtracting the left over from the quantity fed the previous day. The birds were weighed monthly and body weight between two consecutive weighing was recorded.

Results

Chemical composition of silage and prepared feed

The total chemical composition of silage, commercial feed and the different formulated feed was reported in Table 1. Silage which was hygienically prepared from small barbs' had contain 79.8 ± 0.63 % moisture content, 16 ± 0.47 % crude protein, 0.5 ± 0.02 % crude fat and 3.5 ± 0.32 % ash. After the chemical composition of silage was determined, it was added to commercial poultry feed purchased from Alema Koudijs plc.

Feed intake

Feed intake of egg laying hen was variable, resulting in the lowest value at first 4 weeks in treatment three (62.80 ± 1.72) grams per bird in which 4 % of silage was included. The highest average feed intake was recorded between 25 and 28 weeks in treatment four (135.89 ± 7.82) gram per bird in which 6 % of silage was included into commercial diet (Table 2).

Body weight

Supplementation of fish silage in the diet had no significant (P > 0.05) effect on body weight. However, chickens showed great feed intake, which was implicated in a rapid increase in weight from the beginning of the experiment (Table 3). Body weight of chickens monthly did not show significant difference between

treatments ($P > 0.05$), although the chicks in treatment with 6 % fish silage included exhibited a slightly higher body weight (1968.00 ± 119.39 gram) than other treatments.

Egg production

The age at first egg ranged between 149 days to 157 days (Table 4). Age at first egg was lowest (149 days) in hens feeding on 6% fish silage and highest (157 days) in hens fed no fish silage included diets.

Egg weight

Egg weights recorded at different weeks of age starting from 21 weeks of age are presented in table 5, including the first egg weight. Significant ($P < .05$) difference between egg weights at different weeks of age was observed and is in agreement with the reports of [19, 20].

Table 1: Chemical composition of fish silage, commercial control feed and formulated diets (%)

Variables	Fish silage (%)	T1 (Mean \pm Std. error)	T2 (Mean \pm Std. error)	T3 (Mean \pm Std. error)	T4 (Mean \pm Std. error)	T5 (Mean \pm Std. error)
Moisture content	79.8 \pm 0.63	6.72 \pm 0.46	6.9 \pm 0.52	7.44 \pm 0.59	7.51 \pm 0.64	8.33 \pm 0.72
Crude protein	15.9 \pm 0.47	16.0 \pm 0.2	15.98 \pm 0.2	15.89 \pm 0.1	15.85 \pm 0.3	15.80 \pm 0.4
Ether extract	0.5 \pm 0.02	5.14 \pm 0.09	4.23 \pm 0.08	6.18 \pm 0.07	5.65 \pm 0.08	5.25 \pm 0.06
Total ash	3.5 \pm 0.32	6.62 \pm 0.7	7.41 \pm 0.5	5.1 \pm 0.6	6.26 \pm 0.7	8.99 \pm 1.2
Carbohydrate	-	65.52 \pm 3.2	65.48 \pm 2.9	65.39 \pm 2.3	64.73 \pm 1.9	61.63 \pm 0.9
Phytate mg/100 g	-	151.82 \pm 5.6	145.68 \pm 4.5	143.46 \pm 4.3	95.99 \pm 3.8	56.6 \pm 2.9
Tannin mg/100g	-	53.13 \pm 2.3	51.92 \pm 2.4	46.78 \pm 2.1	44.72 \pm 1.9	43.88 \pm 1.8

Table 2: Feed intake (g/hen) of laying hens fed on diets containing different levels of fish silage

Age of poultry in weeks	T1 (Mean \pm Std. error)	T2 (Mean \pm Std. error)	T3 (Mean \pm Std. error)	T4 (Mean \pm Std. error)	T5 (Mean \pm Std. error)	p-value
17-20	67.57 \pm 2.72 ^a	68.91 \pm 1.72 ^a	62.80 \pm 1.72 ^a	70.82 \pm 3.69 ^a	68.32 \pm 2.39 ^a	0.251
21-24	103.79 \pm 4.10 ^{ab}	103.62 \pm 5.91 ^{ab}	93.16 \pm 6.29 ^b	119.41 \pm 6.31 ^a	110.06 \pm 5.61 ^{ab}	0.031
25-28	120.53 \pm 5.11 ^a	115.44 \pm 5.83 ^a	116.70 \pm 7.26 ^a	135.89 \pm 7.82 ^a	118.60 \pm 6.39 ^a	0.264
29-32	106.36 \pm 1.77 ^{ab}	105.60 \pm 1.96 ^{ab}	98.89 \pm 4.46 ^b	110.36 \pm 5.71 ^a	113.86 \pm 1.99 ^a	0.019
33-36	107.41 \pm 1.29 ^c	113.86 \pm 1.33 ^a	112.95 \pm 1.61 ^{ab}	109.21 \pm 1.18 ^{bc}	111.52 \pm 1.10 ^{ab}	0.003
37-40	104.49 \pm 1.37 ^a	106.62 \pm 1.19 ^a	104.60 \pm 5.13 ^a	102.05 \pm 4.86 ^a	105.96 \pm 1.28 ^a	0.853

Means followed by the same letter with in the column are not statistically significant

Table 3: Body weight (g) of poultry during experimental period

Age of poultry in week	T1 (Mean \pm Std. error)	T2 (Mean \pm Std. error)	T3 (Mean \pm Std. error)	T4 (Mean \pm Std. error)	T5 (Mean \pm Std. error)
17th week body weight	1191.9 \pm 34.26 ^a	1190.8 \pm 19.39 ^a	1285.2 \pm 65.10 ^a	1337.6 \pm 53.11 ^a	1158.6 \pm 59.03 ^a
21st week body weight	1619.51 \pm 48.90 ^a	1482.12 \pm 51.54 ^a	1443.98 \pm 44.88 ^a	1627.14 \pm 67.70 ^a	1472.38 \pm 74.18 ^a
25th week body weight	1728.36 \pm 16.06 ^a	1633.20 \pm 42.61 ^a	1631.40 \pm 18.89 ^a	1725.80 \pm 58.95 ^a	1615.20 \pm 55.5 ^a
29th week body weight	1838.60 \pm 40.30 ^a	1818.80 \pm 72.90 ^a	1802.00 \pm 66.66 ^a	1883.80 \pm 87.80 ^a	1719.20 \pm 77.10 ^a
33rd week body weight	1863.80 \pm 35.92 ^a	1933.20 \pm 68.11 ^a	1923.80 \pm 86.62 ^a	1968.00 \pm 119.39 ^a	1794.40 \pm 57.94 ^a
37th week body weight	1862.80 \pm 36.52 ^a	1906.60 \pm 98.71 ^a	1896.26 \pm 87.80 ^a	1950.40 \pm 113.76 ^a	1746.40 \pm 64.42 ^a

Means followed by the same letters are not statistically significant

Table 4: Egg number per bird (No.) and Hen-day egg production (%) at 4 weeks interval starting from 21 weeks of age

Age of poultry in weeks	T1 (Mean ± Std. error)	T2(Mean ± Std.error)	T3(Mean ± Std. error)	T4(Mean ± Std. error)	T5(Mean ± Std. error)
21-24	11 (36.7)	8.4(28)	3.6(12)	12.2(40.7)	9.6(32)
25-28	24.6 (82)	16.6(55.3)	16.8(56)	25.4(84.7)	22.6(75.3)
29-32	24.4(81.7)	20.2(67.3)	21.8(72.7)	26.6(88.7)	25.4(84.7)
33-36	25.6(85.3)	22(73.3)	22(73.7)	26.2(87.3)	24.4(81.3)
37-40	26.8(89.3)	23.2(77.9)	22.8(76)	26.4(88)	25(83.3)
Total number of egg per bird	112.4	89.6	87	116.8	107
Over all hen day egg production (%)	74.9	59.7	58	77.8	71.3
Age at start of laying egg (day)	157	154	152	149	152

Table 5: Egg weight (g) and egg number per treatment at 4 weeks interval starting from 21 weeks of age

Age of poultry in weeks	T1 (Mean ± Std.error)	T2(Mean ± Std. error)	T3(Mean ± Std. error)	T4(Mean ± Std. error)	T5(Mean ± Std.error)
21-24	48.81 ± 0.51 ^a (55)	49.06 ± 0.94 ^a (42)	52.58 ± 0.87 ^a (18)	49.85 ± 0.97 ^a (61)	50.78 ± 0.80 ^a (48)
25-28	53.76 ± 0.44 ^c (123)	53.45 ± 0.38 ^c (83)	56.73 ± 0.47 ^{ab} (84)	56.96 ± 0.62 ^a (127)	55.42 ± 0.34 ^b (113)
29-32	57.69 ± 0.41 ^c (122)	56.77 ± 0.40 ^{bc} (101)	58.79 ± 0.35 ^{ab} (109)	59.72 ± 0.59 ^a (133)	59.75 ± 0.44 ^a (127)
33-36	59.32 ± 0.31 ^c (128)	58.31 ± 0.34 ^c (110)	61.82 ± 0.37 ^b (110)	64.79 ± 0.46 ^a (131)	61.32 ± 0.44 ^b (122)
37-40	60.70 ± 0.21 ^d (134)	62.20 ± 0.39 ^c (116)	63.93 ± 0.45 ^b (114)	68.59 ± 0.43 ^a (132)	64.59 ± 0.58 ^b (125)
Total number of eggs	562	448	435	584	535

Discussion

Various factors may modulate feed intake in birds such as environmental temperature, energetic content of the diet, texture and palatability of the feed [1, 26]. Feed intake may be increased due to increased frequency of feeding, feeding at cooler times of the day and use of longer periods of light (NRC, 1994). Different scholars supplemented this finding that the inclusion of fish silage in the diet showed no effect on weight gain in broilers [1, 6, 11, 18]. However, [17] found better weight gain in broilers by including 5% fish silage and 0.8 % fish oil in the diet. Reported that fish silage is a source of highly available amino acids [27]. The results of this study suggested that layers fed containing 6% biological silage had an acceptable production and egg quality performance. The age at first egg is lower than the Gramapriya and Vanaraja as reported by [10] and higher than that reported in a two-way cross variety by [23]. There exists difference for the egg production between different four weeks intervals. Egg production at different weeks of age (Table 4) indicates that the birds are laying good number of eggs at different weeks of age and the egg production was better than the report of [23] in various two way crosses except in Gramapriya, which was produced 237.35 eggs up to 72 weeks of age. Egg production at 4 weeks of interval starting from 21 to 40 weeks of age indicated that the peak production was observed between 37 and 40 weeks of age (Table 4). There were differences between treatments in egg production; which was highest for the 6 % silage treatment (116.8 eggs/hen/ five months), followed by 0% silage (112.4 eggs/hen/ five months), 8 % silage (117 eggs/hen/ five months), 2 % silage (89.6 eggs/hen/ five months) and 4% silage (87 eggs/hen/ five months), which corresponded to % hen-day egg

production rates for the four groups of 77.8 %, 74.9 %, 71.3%, 59.7 % and 58 % for the 6%, 0%, 8%, 2% and 4% treatments, respectively. The effect of treatment on mean egg weight for the whole period was significant ($P < 0.05$). Egg weight increased with an increase in the age of birds and between 37-41 weeks age, mean egg weight was 60.70 ± 0.21, 62.20 ± 0.39, 63.93 ± 0.45, 68.59 ± 0.43 and 64.59 ± 0.58 for treatments 0%, 2%, 4%, 6% and 8%, respectively. This finding is in agreement with the reports of [19, 20]. The egg weight at 40 weeks of age (68.59 ± 0.43 g) was better than Vanaraja and Gramapriya as reported by [10]. Egg weight is correlated with body weight of laying hens. The relative egg weight during a laying cycle parallels the relative body weight. Within a flock, heavier birds lay heavier eggs (NRC, 1994). Fish silage is a versatile animal feed and if correctly made can be safely stored, even for a year. Inclusion of fish silage into commercial poultry diet has enormous advantage. It was observed that, age at first egg laying was 149 days in hens fed on 6% fish silage while it was 157 days in hens fed on diet which does not contain fish silage. The average hen day egg production was best for the 6 % silage diet included (116.8 eggs/hen/ five months) as compared to diet containing no silage (112.4 eggs/hen/ five months). A Laying hen fed on 6% silage laid 68.59 gram average weight as compared to 60.7 gram average weight during feeding period of five months. Addition of 6% fish silage into commercial poultry diet increased early egg laying, feed intake, weight gain, egg production and average weight of eggs. Generally, including 6% fish silage into commercial poultry diet has increased 2.9 % hen day's egg production, decreased 8% age at first egg laying days and increased 7.89 % in egg weight. Further research needs to be done on growth performance and meat quality of broilers

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