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Postharvest and nutritional loss assessment of fish at different handling stage from Genale River, Southeastern Oromia

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Abstract
Post-harvest and nutritional loss assessment of fish was conducted between July 2014 and June 2015. A post-harvest loss was recorded from landing site and hotel. Nutritional loss between landing site and hotel was compared. From a total of 1581 kg of fish harvested, 1130 kg was *Bagrus*, 259 kg was *Labeobarbus* and 192 kg was Eel. From 176 kg of *Bagrus* harvested, 60 kg (34.09%) of quality deteriorated fish was discarded. Crude protein content has significantly decreased from 86.32% to 63.25% from landing site to hotel. The decrement of protein content is due to long distance transportation and high temperature have favored microbial growth which resulted in proteolysis and denaturation of protein by heat. It was concluded that the long distances during the transportation and the high ambient temperature in combination with the poor packing materials could be the main reason for losses.

Keywords: Bagrus, post-harvest loss, protein loss

1. Introduction
Fish is one of the most important food staples on the planet. Its flesh is a source of top quality protein and for many, in the less developed parts of the world, it represents a significant proportion of the animal protein in their diet. However, fish is one of the most perishable of all staple commodities, and in the tropical climates of most developing countries, it will become unfit for human consumption within about one day of capture unless it is subjected to some form of processing. Even after the fish has been processed, particularly if traditional methods have been used, the fish is still subject to many forms of loss and spoilage [1].
Because of the influence of chemical composition on keeping quality, a proximate composition like moisture, lipid, protein and ash/mineral contents of fish from the time of harvest to different transportation and storage periods decreased with increased drip loss due to quality deterioration [1].
Post-harvest losses occur at different points from capture to marketing and in some fishery the level of losses could be considerable. Food and Agricultural Organization has estimated postharvest losses in developing countries to be up to 50% of domestic fish production [2]. A substantial amount of fish can be lost after harvest in tropical countries. Due to high temperature in the tropics fish can spoil while still in the boat, at landing, during storage or processing, on the way to market and while waiting to be sold. In Africa, some estimates put post-harvest losses at 20 to 25 percent and sometimes as much as 50 percent [1]. Post-harvest losses in small-scale fisheries can be among the highest for all the commodities in the entire food production system. It is known that substantial losses of fish occur at all stages in the chain from capture to marketing of fresh and cured fish. The instigation of an elaborate and lengthy loss assessment survey will not of itself increase the income of all fishermen or improve the protein content of the diets of all! Then there will the need for information on what losses actually occur and when, in order to identify improvements needed in existing processing systems. It is known that substantial losses of fish occur at all stages in the chain from capture to marketing of fresh and cured fish. The instigation of an elaborate and lengthy loss assessment survey will not of itself increase the income of all fishermen or improve the protein content of the diets of all! Then there will the need for information on what losses actually occur and when, in order to identify improvements needed in existing processing systems. Fish losses are expressed in economic, physical and nutritional terms.

The first of these (economic losses) implies a net reduction in potential revenue from a given lot of fish; the second (physical losses) means a direct loss of nutrient material and is taken in this case to imply a loss in water free solids and the third (nutritional losses) implies a reduction in nutritional value or increase in toxicity of the product [2]. There are very few documented studies in our country. So, it is imperative to quantify the kind and level of fish post-harvest losses and to determine nutritional losses during postharvest losses of fish at different handling stage from Genale river.

2. Materials and methods

2.1 Postharvest loss assessment

The annual catch data from Genale River was recorded daily using standard format at Genale kebele. Postharvest loss assessment was recorded from hotel when the fishermen came to hotel to sell fish. The nutritional loss between landing site and hotel was compared using independent samples t-test. Chemical analysis was done for three different fish species.

2.3 Sample collection and preparation

Fish were harvested using hooks and lines baited with fish flesh and Gill nets. The most commercially important fish species like *B. docmak* and *L. intermedius* and *Mormyrus caschive* in Genale River were considered for the chemical analysis. Fish specimen was cleaned, descaled, eviscerated and filleted manually using plastic knife. Immediately after filleting, it was semidried under shade. The dried sample was ground with mortar and pestle into fine powder and stored in polythene bag for analysis. Proximate composition was analyzed using the standard procedure [3].

2.4 Moisture content

The moisture content was determined using oven drying method. For the purpose 5 g of dried powdered fish fillet was in the oven and determined as follows:

$$Moisture\ content = \frac{Wt\ of\ powdered\ fillet - weight\ of\ dried\ powdered\ fillet}{Weight\ of\ wet\ fillet} \times 100$$

2.5 Determination of crude protein

Crude Protein was determined by AOAC procedure. 0.5 g of dried powdered was weighed into Kjeldahl flask and digested by heating at 370 ^{0}C for four hours in the presence of 6 mL sulfuric acid (H_2SO_4), 3.5 mL Hydrogen peroxide (H_2O_2) and 3 g of catalyst copper sulfate ($CuSO_4$) and potassium sulfate (K_2SO_4). After digestion was completed, formed clear solution was cooled for 30 minutes and neutralized by addition of 25 mL of NaOH (40%) and diluted using 25 mL distilled water. Then 25 mL of distilled water, 25 mL of boric acid and 3 drops of methyl blue was added into receiving flask of 250 mL capacity connected to the distiller by tube. The distillation process was terminated when the volume of receiving flask reached between 200 to 250 mL. Eventually, the nitrogen content was estimated by titration of the borate anion with 0.1 N HCl using the following formula.

$$\%\ N = N\ HCl \times \frac{(Vol\ of\ HCl\ consumed\ by\ sample - Vol\ of\ HCl\ consumed\ by\ blank)L}{Weight\ of\ sample} X\ 14\ \frac{g}{mole} X\ 100$$

Note: all reagents were added to blank except the sample.

2.6 Determination of crude fat

Crude fat was determined by semi-continuous solvent extraction methods (Soxhlet method). Accordingly, 2 g of fine powder fillet was placed in porous cellulose extraction thimble and covered with fat free cotton. The thimble was placed in extraction chamber which is suspended above a flask containing 50 mL diethyl ether. The flask was heated at 55 ^{0}C and the solvent evaporates and moves up into the condenser where it converted into a liquid that trickles into the extraction containing the sample. At the end of extraction process, which typically lasts for 3 hours, the flask containing the solvent and lipid was removed, the solvent evaporated at 70 ^{0}C and the weight of lipid remaining was quantified gravimetrically.

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

2.7 Determination of total ash

Total ash content was determined using dry ashing method. For the purpose, 2 g of powdered fish fillet was weighed into ashing crucibles, placed on a hot plate under a fume hood and the temperature was slowly increased and awaited until smoking ceases and the samples become thoroughly charred. The crucible was placed inside muffle furnace set at 550 ^{o}C for 4 hours and removed from the muffle furnace and then placed in desiccators for 1 hour to cool. The amount of ash in the sample was measured from difference in weights and expressed as

$$Ash\ content = \frac{Mass\ of\ crucibles\ with\ ash - Mass\ of\ empty\ crucibles}{Mass\ of\ sample} X\ 100$$

2.8 Calculation of gross energy

Gross energy value (Kcal/ 100g) was calculated according to Atwater's conversion factors by overall addition of the protein content multiplied by four and total fat content by nine.

2.9 Method of data analysis

All data of proximate composition (moisture, protein, fat and ash) in g/100g dry matter (DM). Mean of three fish species was compared using one analysis of variance (ANOVA) of Statistical Package for Social Sciences (SPSS). All data was presented as Mean ± standard deviation. Differences were considered statistically significant at $p < 0.05$. Data was subjected to Dunkan Multiple Range Test (DMLT) where differences detected.

3. Results and discussion

Fish butcher sale gutted *B. docmak* (Fig 1.) during fasting season. Fishing is seasonal and the supply of fish is largely available during drier period from December to May, however, occasional fishers catch fish during the wet season [4].

Fig 1: Gutted *Bagrus docmak* ready for sale

3.1 Fish quality and economic loss

From a total 1581 kg of different fish harvested from Genale river through wadara districts (Genale kebele), 1130 kg was *B. docmak*, 259 kg was *L. intermedius* and 192 kg was Eel (*A. bengalensis labiata*) (Fig 2.). Fish production was intense during dry season when the river volume decrease. The production was highest in February (565 Kg) followed by March (534 Kg) and became decreased in April (134 Kg) due to the onset of fall rainy season. A surveillance made at a hotel located at Negelle Borana, out of 176 kg of Bagrus fish harvested from Genale river through Somalia region, 60 kg (34.09%) of quality deteriorated fish was discarded by fish trader. In terms of financial loss, it amounts to 2700.00 ETB (two thousand and seven hundreds birr). For all species, there are no physical losses.

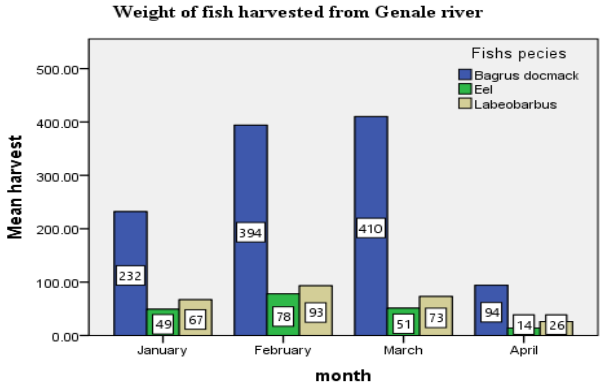

Fig 2: Weight of fish harvested from Genale River

The type of losses experienced by fishermen was fish quality loss. The major contributor of economic loss in fresh fish loss is quality loss. Given the high volume of globally traded fresh fish produce, quality loss is a major contributor to total economic loss in the fresh fish and sea food industry [5]. The prevailing of quality loss percentage (34.09) is in the range for global level of fish losses as estimated to be 20%-40% [5]. Quality loss is the difference between the potential value of fish or fish product if no deterioration had taken places and the actual value of fish after it had undergone change due to spoilage and was sold for a low price [6]. The perseverance of quality loss is owning to spoilage due to fish was gutted at 10:00 hour local time and presented the next day for butcher at 8:00 hour local time the from Somalia region. Gutted fish is transported by human being for long distance then by motorcycle. The long distances involved in the transportation of fresh fish e.g. Somalia region to Negelle, over 24 hours on foot and the high ambient temperature, in combination with the poor quality packing materials would be the main reason for losses occurring. However, there are a number of general factors (variables) that can increase the likelihood of post-harvest losses occurring and the level at which they occur. These include; inadequate preservation techniques, adverse weather conditions, diligence and skills of worker, species of fish, type of fish processing [6].

3.2 Proximate composition

The proximate composition of three different fish species was compared using one-way ANOVA. The result indicated there is statistically significant difference ($p< 0.05$) between three fish species in regard to crude protein, fat, and ash (Table 1). The crude protein content of *Bagrus docmak* (86.32 ±.67882 g/100g) is higher than that of *Labeobarbus intermedius* and *Mormyrus caschive*. The crude fat content of *Mormyrus (*8 g/100g*)* is higher than *Labeobarbus* and Bagrus. The ash content of *Labeobarbus* (6 g/100g) is higher than *Bagrus* and *Mormyrus*. The present finding supplement the study conducted on *Scomberoides* fish indicating significant difference in proximate composition between three different species [7].

Table 1: Proximate composition of some fish species in dry basis (g/100g)- Mean ± standard deviation

Fish species	Moisture content	Protein	Fat	Ash	Gross energy value (Kcal/g)
Labeobarbus intermedius	10.50 ±.141[a]	72.45 ±.247[c]	1.00 ±.000	6.40 ± .000[a]	298.80
Bagrus docmak	8.40 ± .000[c]	86.32 ±.678[a]	1.00 ±.000	3.80±.200[b]	354.28
Mormyrus caschive	9.30 ±.141[b]	83.83 ±.494[b]	8.00 ± .000	2.40 ± .000[c]	407.32
p-value	0.001 (Sig.)	0.000 (Sig.)	-	0.000 (Sig.)	

The composition of a particular species often appears to vary from one fishing ground to another, and from season to season, but the basic causes of change in composition are usually variation in the amount and quality of food that the fish eats and the amount of movement it makes [8].

3.3 Protein loss

The amount of protein lost in (%) is presented in Table 2 and pattern of protein changes is illustrated. Nutritional analysis indicated that the protein content of fresh *B. docmak* at landing site was 86.32 g/ 100 g whereas the protein content has significantly decreased ($p<0.05$) to 63.25 g/ 100 g at the retailing shop. The amount of protein varied significantly ($p<0.05$) at two different distribution chains. In this study on an average basis, 23.07% protein loss was observed during the time period from landing site to the hotel (fish retailing shop).

Table 2: Protein loss of *B. docmak* (g/100g) expressed as mean ± standard deviation

Handling stage	Moisture content	Protein	Fat	Ash
Fresh fish from landing site	8.40 ± .000	86.32 ±.678	1.00 ±.000	3.80 ±.200
Fish from retailing shop immediately after delivered by fishermen	9.27 ±.125	63.25 ± .280	4.75 ± .353	5.60 ±.000
	NS	Sig.	NS	NS

Fresh fish is extremely perishable and is subject to bacterial spoilage. As the fish spoils, the bacteria causing the spoilage degrade the protein which is intended for human consumption [1]. The lower protein content of *B. docmak* at the hotel (retailing shop) is may be due to long distance transportation and high temperature have favored microbial growth which resulted in proteolysis induced by enzymatic activities of microorganism and denaturation of protein by heat. The nutritional loss is specific biochemical changes within fish flesh, as a result of spoilage or processing [6].

The other possible reason for protein loss could be due to a gradual degradation of the initial crude protein to more volatile products such as total volatile bases, hydrogen sulphide and ammonia [5]. Reduction of crude protein is, therefore, a great nutritional concern [9].

4. Conclusions and recommendation

A Post-harvest and nutritional losses of fish from Genale River was observed. The root cause for the post-harvest quality loss was spoilage due to the long distances involved in the transportation of fresh fish, high ambient temperature in combination with the poor quality packing materials would be the main reason for losses. Post-harvest and nutritional loss can be controlled by improving the fishing activity, packaging, transportation method, storage conditions, proper organization of the marketing and distribution channels to avoid unnecessary delays. Postharvest fish losses would be highly reduced if freshly harvested fish are sold readily within 1 to 2 hours after harvest for immediate transportation to hotels and restaurants in urban areas. Unsold fresh fish should be processed to dry fish. Reducing spoilage requires improved fish handling on board, processing, preservation, and transportation, all of which are particularly deficient in small-scale fisheries.

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