Uganda Journal of Agricultural Sciences, 2013, 14 (1): 37 - 44 ISSN 1026-0919

The effect of bleeding on the quality of farmed African catfish in Uganda

M. Masette[1], P. Olowo-Ochieng[2] and D. Bamwirire[1]

[1]Food Biosciences Research Centre (FBRC), P. O. 7852, Kampala, Uganda
[2]Makerere University, P. O. Box 7065, Kampala, Uganda

Abstract

Despite the wide use of bleeding to improve product appearance and probable shelf-life extension, it has not been practiced in Uganda. Most local fish consumers dislike African cat fish (*Clarias gariepinus*) because of its redflesh colouration in spite of the decliningper capita fish consumption. The present study tested the bleeding effect and keeping quality of catfish. Farmed catfish, 60 in number were divided into four batches, consisting of 15 fish each. Two batches, one bled and the other unbled were kept on ice while the other two batches similarly treated were held at ambient temperature (28°C). The results indicated that fish that was bled had extended shelf-life compared to fish that was not bled, regardless of the holding temperature. Bled fish kept at ambient temperature remained acceptabletaste wise for 19.5 hrs compared to 14 hrs for fish that were not bled.Under chilled conditions the shelf-life of bled fish was 29 dayscompared to 17 days for unbled. It was concluded that bleeding and chilling intervention measures extended the shelf-life of *C. gariepinus* substantially.

Key words: Aquaculture,*Clarias gariepinus*, shelf-life and market demands

Introduction

Bleedingof freshly caught fish is normally carried out by making an incision at the caudal penducle or the isthmus, nape, depending on the species. This allows bloodto flow from the fish. The removal of blood by making cuts or by evisceration has been noted as a means of accelerating death (Howgate, 2003) and retarding spoilage (Fellows, 1988) and thus maintaining the quality (Braker, 1992).A cut at the isthmus severs the ventral aorta; at the nape, it severs the dorsal aorta and the spinal cord as well, thereby immobilising the fish; and at the caudal peduncle, it excises the tail and severs the dorsal aorta.In *Salmogairdneri*, the greatest amount of bleeding occurs with the caudal peduncle cut (Trestven and Patten, 1981). The practice of bleeding essentially removes significant amounts of blood which would have provided sufficient nutrition for the invading post-mortem spoilage bacteria (Fernly, 2007). It has been observed that fish blood remains in fluid form for about 30 minutes after capture (Howgate, 2003) and therefore it can easily be removed by the jerking action of a dying fish. Besides, the iron component of haemoglobin, blood contains precursor ionic free radicals that normally catalyse lipid oxidation (Huss, 1995) and therefore its removal in significant quantities will prolong the initiation of oxidative rancidity.

Cat fish (*Clarias gariepinus*), was once the leading farmed fish in Uganda (FAO, 2000, 2003, 2008) followed by Tilapia and Mirror carp in order of commercial importance. The bleedingof fish is rarely done in Uganda, although it remains a common practice for other animals as part of the slaughtering process. Struggling fish are usually stunned by a blow to the head, by an electric shock (Trestven and Patten, 1981) or are immersed in chilled water to facilitate the killing procedure. Limited research has however, been done to show the effect of bleeding and stunning on the post-mortem quality of fish flesh, although available literature indicate advantages from such practice.

Quality is a subjective parameter which varies with the type of product and end-user perceptions, specifically, for the fisheries sector, which may be defined as the degree of excellence or spoilage under gone by fish (Afolabi, 1984; Huss, 1995). Qualityis influenced by a number of factors which include; temperature, handling practices and initial microbial load. In farmed fish,particularly catfish, other factors which can influence quality include the fish feed used, bleeding and stress. Bleeding operation soon after capture or harvest contributes substantially to consumer acceptance based on colour appearance of flesh fish (Ahimbisibwe *et al*., 2009).

Although significant quantities of smoked catfish are exported to regional markets such as the Democratic Republic of Congo, as well as traded in the domestic markets, the products have a limited shelf-life despite the preservative effect of smoke (Masette, 1990). The inability to maximise shelf-life and maintain keeping quality of *C. gariepinus* impacts negatively on the financial benefits accruing from its production and trade. As a result, it undermines the campaign being undertaken by the Department of Fisheries Resources (DFR) to promote aquaculture enterprises in Uganda. The quality of *C. gariepinus* is further compromised by a lack of knowledge on the benefits of bleeding and chill storage in relation to Uganda National Bureau of Standards (UNBS) requirements.Prior to the formulation of standards, UNBS requires authentic data on various aspects of post-mortem changes and food safety risks including keeping quality and shelf-lifeduration hence the need for the present study. Compliance to standards enhances regional as well as international trade in farmed fish. This study seeks to; assess the effect of bleeding on the keeping quality of the *C. gariepinus* held at designated temperatures; generate data for standards formulation; provide data oniron content;and provide recommendations to improve *C. gariepinus* product quality and marketability.

Materials and methods

Clarias gariepinus (64) at an average age of 4 months and weighing 300 g was harvested using a scoop net (none stress method) were collected from Umoja fish farm, Wakiso District(0.48°N and 32.35°E) located 76km along Kampala-Hoima road in Busunju village, Kakiri sub-county, Wakiso District in Uganda. Using Braker (1992) method of bleeding a total of (32) fish was bled while32 fish were left un-bled. From the bled batch, 20 fish were kept on ice in an insulated box as recommended by FAO (1995) while the remaining 12 fishwere held at ambient temperatures (28°C). From the un-bled batch 20 were similarly kept in another ice box and the remaining 12fish were left ambient temperatures.After all preliminary treatments at the farm, all samples were transported to the Makerere Department of Zoology laboratory for analyses.

Before a panel of 12 individuals were asked to assess the quality of fish samples subjected to different treatments, they underwent training procedure was based on Watts *et al*. (1989). The sampling plan varied with holding temperatures as shown in Table 1.

From each batch A and B,one fish was sampled once every 7 days and the frequency increased to one fish every two days after the 14th day while a fish from batch C and D were sampled every 2 hours. Each fish sampled from either batch was cut into 12 steaks weighing approximately 5 g each, incised from the middle part of the fish and steamed in a closed beaker for 10 minutes before being served tothe taste panel.Using Meilgaard *et al.* (2006) hedonic scale of 1-5, each panelist was requested to score the general acceptability of the sample, 0.5 g of the remaining portion of the remaining fish sample was reduced to ashes at 500°C for 2 hours. Using the AOAC (1980) official method for the analysis of iron in fish, the ash was dissolved in aquaragia at 3: 1 ratio (Hydrochloric acid: Nitric acid) and the solution was aspirated using an atomic absorption spectrometer (AAS) to quantify the iron content.

The mean scores obtained from the taste panel were plotted against time in hours for fish held at ambient temperatures and time in days for fish held at chill temperatures. The point at which samples were rejected was deciphered from panel responses and shelf-life of different sample treatments determined from the curve intercepts along the

Table 1. Sampling plan based on holding conditions and treatment of *C. gariepinus*

Batch No.	Number of fish per batch	Holding temperature	Type of treatment	Sampling Frequency
A	20	0°C	Bled and kept iced in insulated box	1 fish during 1st week and every other day after the 14th day
B	20	0°C	Un-bled and kept iced in insulated box	
C	12	28°C	Bled and kept exposed on a table	1 fish every 2h
D	12	28°C	Un-bled and kept exposed on a table	

rejection line. A T-test was used to assess the significance differences between samples that were bled compared to samples that were not bled.

Results

The results of the study as shown in Table 2 indicate that the iron content of the samples varied with treatment and temperature as shown in Table 1. Bled fish predictably showed less iron content and the corresponding un-bled samples showed high levels of iron. However, the t-Test showed no significant difference between bled and unbledsamples ($P< 0.05$).

When a taste panel assessed the bled and un-bled fish samples that were held at ambient temperatures, the point of rejection varied with treatment. Whereas the unbled fish was rejected 14h after capture, the bled fish remained acceptable for an extra 5h (Fig. 1).

Data for samples held at chill conditions showed that un-bled were given a rejected score of 2on the 15th day and bled samples were rejected on the 29th day (Fig. 2).

Discussion

Bleeding leads to pale appearance of fillets and inevitably reduced iron content by a factor of 1 for fish held at ambient temperature and by almost 1.5 for fish kept on ice. The holding temperatures per se did not have an effect on iron content but the rinsing effect of melting ice reduced

Table 2. Variation of iron content in muscle of catfish held at different temperatures

Storage conditions	Mean concentration of iron (ppm) n= 6	
	Bled Catfish	Un-bled catfish
Ambient (28°C)	2.827 [0.121]	3.835[0.178]
Chilled (0°C)	2.475 [0.117]	3.973 [0.159]

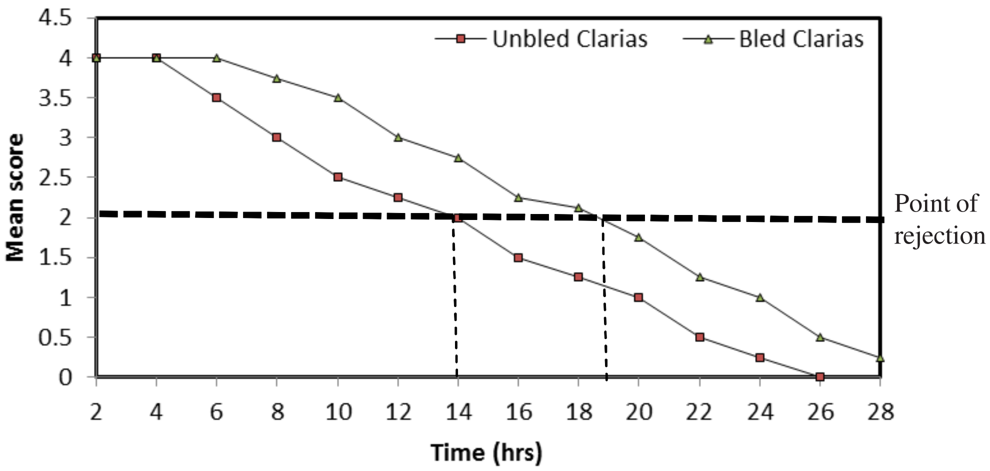

Figure 1. The variation of keeping quality of *C. gariepinus* fillets held at ambient temperatures (28°C) for 28 hours as determined by organoleptic assessment: illustration ofthe benefits of fish bleeding.

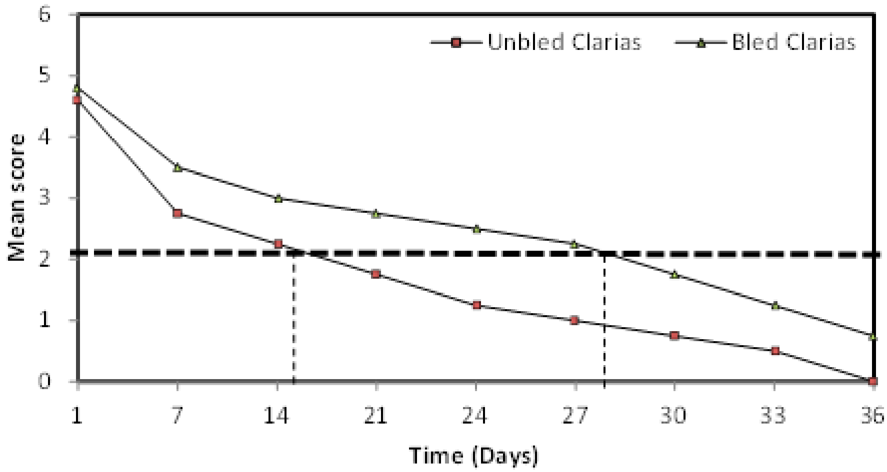

Figure 2. The variation of keeping quality of *C. gariepinus*fillets held at chilled temperatures (0°C) for 36 hours as determined by organoleptic assessment: illustration of the benefits of fish bleeding and chilling operations.

iron content by a slight margin of 0.5.The observed slight variation in iron content was not significantly different (P<0.05) which was in agreement with Martin (1996). Since iron is a precursor of oxidative rancidity (Huss, 1995) its slightly elevated content in fillets held at ambient temperatures, accelerates spoilage and thereby compromises quality and shelf-life of fillets. According to Richards and Hultin(2002) blood removal is associated with the reduction in iron content and the eventual reduced susceptibility to oxidative rancidity.

Bleeding also extended shelf-life of *C. gariepinus* fillets appreciably depending on storage temperatures. This achievement of shelf-life extension would support improved marketing opportunities for fish farmers in remote parts of Uganda where ice may not be easily available or too costly. High quality bled catfish, albeit held at ambient temperatures,would have an extended shelf life and would give famers a longer time to sell their fish.Combining chilling with bleeding was found to extend shelf-life by 24 and 34-fold in unbled and bled respectively. Ice is known to delay and slow down post-mortem changes caused by autolytic enzymes and mesophillic spoilage bacteria (Huss, 1995; Clucas and Ward, 1996; Karungi *et al*., 2004). As such, their propensity to degrade the protein component of the fish muscle is greatly reduced by chilling to a level that renders them harmless. Consequently, the rate of spoilage is slowed down appreciably; hence the fish remains acceptable to consumers for a longer time than uniced fish. The difference between the rejection of bled and unbledsamples was approximately 12 days which means that there is an extended shelf life for chilled and bled fish which would improve accessibility to international as well as domestic markets (Masette, 2005).The extension of shelf-life and keeping quality as a consequenceof bleeding and chilling has also been noted by other studies (Braker, 1992; Ahimbisibwe*et al*., 2009). There were several reasons which can be advanced to explain the effect of bleeding on the keeping quality of catfish kept at different temperatures. Outdoor (2007) asserts that bled fish produces a white, acceptable fillet which is attributed to the reduced quantities of heamoglobin and hence reduced susceptibility to oxidative rancidity (Martin, 1996). In some marine fish species, bleeding is a recommended procedure for colour enhancement and shelf-life extension (Braker, 1992; Ahimbisibwe *et al.*, 2009).According to Martin (1996), removal of blood delays collagen fibril degradation and muscle softening of pelagic fish (Ando *et al.*, 1999). Several authors mention a link between extended shelf-life and a reductionin the nutrients available to spoilage bacteria (Venugopal, 1990; Fernly, 2007), while Huss (1995) highlights the reduction of the iron ionic component in the blood haemoglobin. In iced fish samples, shelf-life may also be extended by the wash-down effect of ice (Chen and Chai, 1982), whereby themelt waterwashes off spoilage bacteria from the surface of the fish.

In this study, a taste panel represented the consumer and the differences between individuals in the taste panel because of pre-training sessions which minimises subjectivity variations inherent in sensory methods (Watts *et al.*, 1989). The training that it was possible for the panel to reach a consensus on the point of sample rejection based on level of product acceptance. In addition to sensory evaluation, the level of product acceptance or keeping quality is often assessed using chemical and microbiological methods (Huss, 1995) which offer objective assessment values. However, since the consumer is the ultimate decider on whether the fish is acceptable for consumption or not, Connell and Shewan (1980) advocates for the use of subjective sensory assessment as a more realistic understanding of fish quality.

Conclusion

Essentially, immediate bleeding of farmed catfish after capture extended its shelf-life; however, the extent of variation is dependent on the storage temperature of fish. The storage of bled and unbled fish at ambient temperature of 28°C resulted in a much shortened shelf-life compared to samples held at 0°C. The combined effect of bleeding and chilling greatly extended the shelf-life of samples. This combined effect can be used as a tool to enhance the regional and international trade in farmed catfish. Although, holding temperatures did not have significant effect on the iron content of *C. gariepinus*, it is likely thatit played a significant role in the reduction of itsshelf-life; since iron is a precursor of oxidative rancidity.

Recommendations

Further studies that capture chemical as well as microbiological methods for quality assessment should be undertake to complement sensory evaluation scores. Fish quality also varies with different feed regimes so further studies should also be conducted to factor-in the effect of feed on quality of farmed fish products.

The achievements of bleeding should be used as a promotional strategy for fish farming in Uganda and farmed fish should be bled to enhance its local marketability

The Fish Quality Assurance rules of 2008 should be revised to incorporate bleeding procedure in the 1970 Fish Act as a mandatory practice for farmed catfish.

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