Quality Costs in Intensive African Catfish Culture: Reduction of Off-flavors.

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Summary

A quality cost analysis was performed with the cooperation of six full-time African catfish farmers, *Clarias Gariepinus*, in the Netherlands. The results showed that it is likely that a considerable reduction in quality costs can be achieved with respect to sorting and rewatering, while a further reduction is possible if agreement on quality criteria can be reached. In a pilot-study some aspects of the process of rewatering were investigated: in a series of sensory tests the effects of temperature and duration on the removal of off-flavors were studied. In addition, the algae, probably responsible for the production of compounds which cause off-flavors, were identified and the presence of these compounds in fish was investigated.

Quality Cost Analysis

In the Netherlands African catfish (*Clarias gariepinus)* are cultured in recirculation systems. This culture is a relatively new development. Hogendoorn [1] discovered the potential possibilities of African catfish for intensive land-based culture outside the tropics. Although the first results were promising, farmers were soon confronted with falling prices. Until now, farmers have succeeded in reducing production costs by technological improvements, thus keeping the production economically feasible. In the near future it is to be expected that not only production technology but also the quality and the control of the production cycle will need continuous attention. Analysis of quality costs is considered to be an important tool in business operations: it shows whether investing in quality management can be profitable and also highlights bottlenecks in the functioning of quality systems, thus enabling managers to set priorities for improvements.

In order to gain insight into the quality costs involved in African catfish culture, six of the seven full-time farmers, responsible for about 70% of the annual production in the Netherlands were interviewed [2]. It appeared that for an average Dutch African catfish farm, with an annual production of 125 t and an annual turnover of US$ 250,000, the calculated quality costs were US$ 85,000 in 1993, nearly 34% of the turnover (table 1). The most important quality costs are given in column 2 as a percentage of turnover. The calculated standard deviation is given between brackets. In column 4 the estimated priority index is given. In columns 3 and 5 the ranking of the items before and after priority indexation is given. Rewatering, controlling and checking, end-sorting and normal mortality were the predominant sources, accounting for roughly 60% of the quality costs. From the results it can be deduced that, in the absence of well-defined quality criteria, farmers tend to apply very high quality standards, leading to extra (and unnecessary) costs. Based on these results, a number of recommendations were made:

Table 1. Most Important Quality Cost Items (ref. 2).

Quality cost item	% of turnover (SD)	Ranking	Priority index	Ranking (PI)
Prevention Costs (subtotal)	*13.14*			
101 Cleaning/disinfection	2.33 (1.26)	6	83	8
103 Interim sorting	2.87 (2.01)	5	1003	2
105 Methods to reduce pollution	1.26 (1.11)	9	4	19
107 Controlling/checking	5.47 (0.93)	2	207	5
110 Preventative maintenance	1.04 (1.35)	10	45	10
Examination Costs (subtotal)	*5.23*			
204 End sorting	4.04 (2.76)	3	1123	1
206 Process control	0.65 (0.65)	11	46	9
Internal Failure Costs (subtotal)	*15.12*			
303 Normal mortality	3.23 (4.18)	4	117	7
304 Accidental mortality	1.27 (1.11)	8	36	12
307 Unplanned emptiness	0.21 (0.70)	16	275	4
310 Rewatering	7.41 (2.51)	1	445	3
311 Drainage costs	1.99 (1.47)	7	167	6
External Failure Costs (subtotal)	*0.23*			
402 Customer Complaints	0.20 (0.32)	17	<1	25

- To avoid costs caused by the absence of well-defined quality criteria, the quality requirements of consumers (not necessarily end-consumers) should be known. It is of great importance to evaluate whether these requirements are met by the deliveries.

- Attention is needed for the definition of quality criteria with respect to size, weight and genetic homogeneity of the fish. A more uniform quality of juvenile fish in this respect will lead to a decrease in the costs related to sorting. To achieve this, it is necessary that producers make their demands clear to their suppliers.

- The results show that it is likely that a considerable reduction in quality costs can be achieved with respect to sorting and rewatering.

Rewatering

Rewatering (keeping the fish in a flow-through tank during the last stage of the production process) is necessary to eliminate off-flavors - i.e.: a muddy taste - which may appear in fish. With respect to this phenomenon the algae and actinomycetes thought to be responsible for the off-flavor of the fish were characterized. Microscopic analysis of water revealed that high numbers of blue-green algae were present. In particular the presence of *Oscillatoria limnetica* was found (figure 2). This species (up to 10^9 l^{-1}) is capable of producing 'muddy odour compounds', thought to be responsible for off-flavors in fish [3]. *Oscillatoria redekei* was found in much lower concentrations. Actinomycetes were not found. Although there is probably a number of compounds involved in the occurrence of off-flavors in fish, it is commonly accepted that geosmin (trans 1,10-dimethyl-trans-9-decalole) and methyl isoborneol (MIB, 1,2,7,7-tetramethyl-exo-bicyclo [2.2.1] heptane-2-ole) are the most important. Using gass chromatography with mass spectrometric detection (GC-MS), the presence of 'muddy odour compounds' in fish was investigated.

Sensory evaluation

An experiment was carried out in which the rewatering phase was examined. It was expected that the time needed to eliminate off-flavors is influenced by feed, water temperature and the flow rate of the water in the system. Of these, the effect of the feed was not investigated. Under practical conditions, rewatering takes place for 2 days at 25 °C. Sometimes the temperature is elevated to 30 °C. In the experiment, rewatering time (0, 12, 24, 36 and 48 hours), temperature (20 - 30 °C) and flow rate (5.7 - 11.4 $ml.kg^{-1}.min^{-1}$) were varied. Fish were collected and blended fish samples were prepared according to Johnsen and Kelly [4]. The samples were cooked for 12 minutes in nylon bags and organoleptically evaluated by a panel, consisting of 29 volunteers. The samples were rated on a scale of 0 (no off-flavor) to 10 (strong muddy taste). The results of the sensory evaluation were highly significant ($p<0.01$) for the samples collected at 0,12 and 24 hours, as shown in figure 2. The samples collected at 36 and 48 hours were also evaluated in triangle tests. No influence of flow rates on the elimination of off-flavors could be proven. The triangle tests showed no significant changes in the taste of the fish after a rewatering period of 1.5 day. The ratings shown in figure 2 suggest that even after one day no significant changes in the taste of the fish occur. Therefore it is likely that the rewatering period can be reduced, while the temperature can be kept at 25 °C, leading to a considerable decrease in production costs.

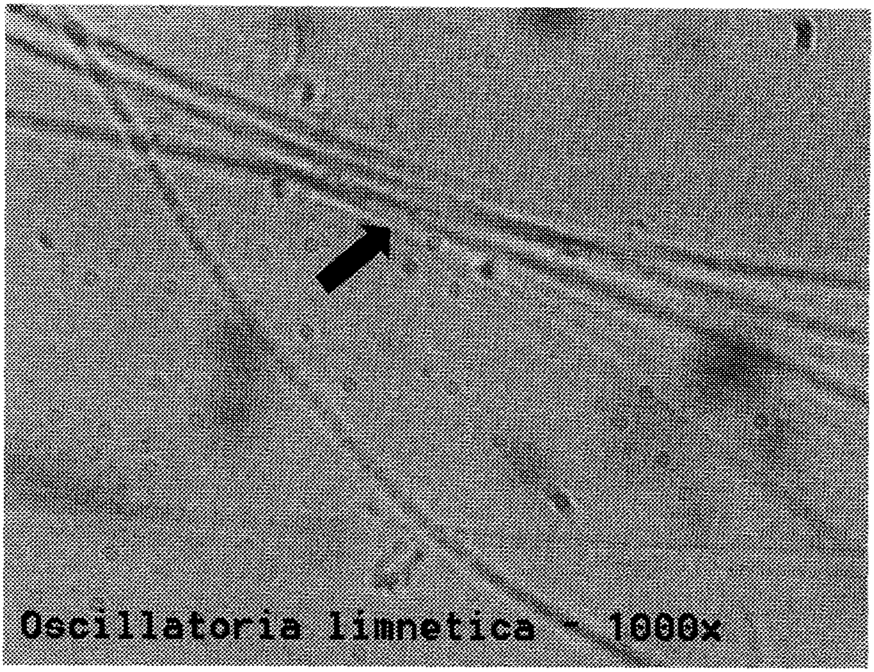

Figure 1. Blue-green algae (*Oscillatoria limnetica*), present in a water sample, collected at an African catfish farm in the Netherlands. Arrow indicates algae.

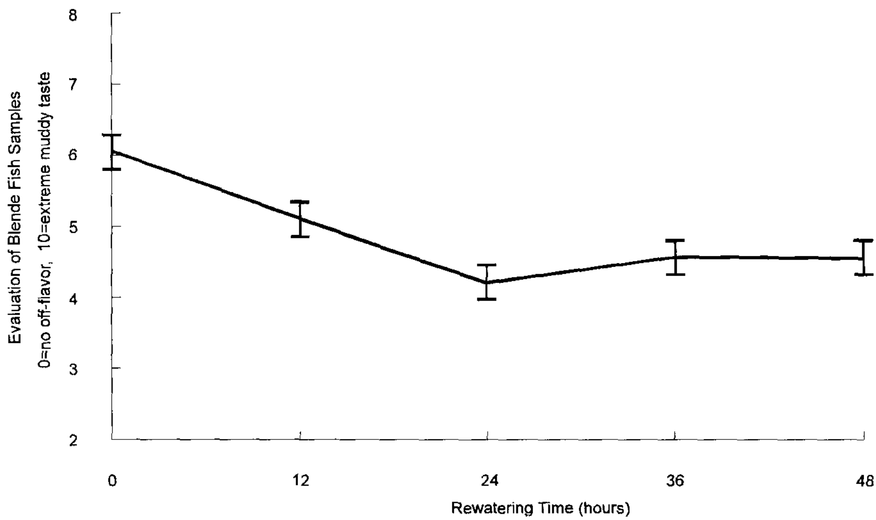

Figure 2. The presence of 'muddy' taste in Blended Fish Samples (BFS) in relation to rewatering time (N=29). Error bars indicate Standard Error of the Mean.

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