

Fish processing in Uganda: waste minimisation

C. McDonald, M.E. Ince, M.D. Smith, and M. Dillon, WEDC

THIS STUDY FOCUSES on Gomba Fishing Industries (Gomba), a fish processing factory in Uganda, on the shore of Lake Victoria at Jinja. Here they process up to 45 tonnes per day of Nile Perch, mainly into fresh chilled fillets for export to Europe.

Problem definition

Present waste production is mostly two streams wastewater:

- human sewage, which is sewered and then goes to an off-site treatment plant; and
- fishery waste water which enters the sewer after preliminary treatment.

The factory is keen to reduce its waste production and inherent cost as such wastewater disposal is expensive and likely to rise as the National Environment Management Authority is exploring effluent discharge maximum permissible limits.

Objective

The objective of this paper is to explore methods of waste minimisation for Gomba, in terms of waste reduction, waste reuse and recycling and determine discrete possible actions which will reduce either the volume of waste, its strength or both. This requires an understanding of where and how wastes are formed and what presently happens to them.

Production process: inputs and outputs

Process

Figure 1 illustrates each unit operation or process involved in the production of fresh chilled fillets from reception through to despatch. Gomba fishing industries produces both fresh chilled and frozen fillets with a total maximum throughput of 45 tonnes fish processed per day.

Inputs

The main inputs are whole fresh fish, water, ice, calcium hypochlorite, packaging materials and electricity plus liquid soap used during cleaning.

Outputs

- The most profitable output is the fresh chilled fillet exported mostly to the European Union and earning valuable foreign exchange (US\$).
- Swim bladders, removed from fish carcasses to be sold in Hong Kong, have a value per kilogram similar to fillets but their weight per fish is very much less.

- Nile Perch skins are processed into leather at an on-site tannery (pilot scale). It is hoped this leather may be sold into the international fashion world in the future.
- The remaining fats, red meat carcasses (with swim bladders removed) and fillets rejected on quality grounds can either be sold into the local market for human consumption or made into fish meal. The factory process for fish meal production is on-site but as yet demand is low.
- Wastewater of varying strengths, especially from the filleting and trimming processes, contains fat, oil and grease (FOG) with blood, small pieces of fish and protein; [NB: Small fish pieces readily dissolve in wastewater making treatment more difficult.]
- Human sewage is produced from cistern flush toilets;
- Yard run-off can contain a small amount of fish material but also leaked diesel and oil from transport trucks; and
- Waste heat from ice manufacture, chilling, and the cold room (to atmosphere).

Minimisation options: reduce; reuse; recycle

Reduction of waste can be achieved by:

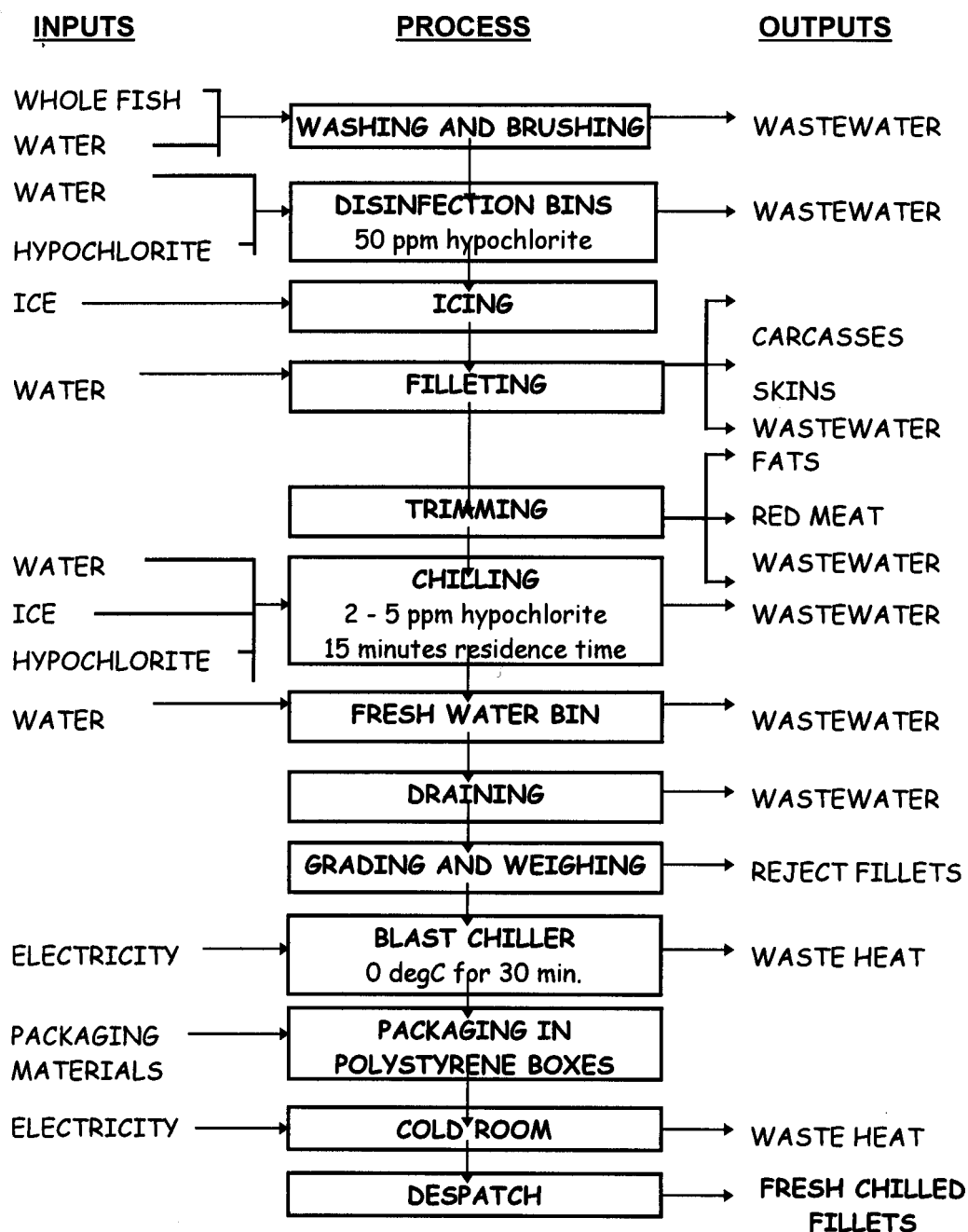
Water consumption

Conserving water use, although an integral part of waste management, can be hard in industries, is hard in an industry where hygiene must be the overriding priority. A 1998 ban on Gomba fresh chilled fillet was only lifted after factories demonstrated improved hygiene conditions. Water use should, therefore, be as low as is feasible while still maintaining hygienic conditions.

Howard (1997) defined three categories of water use per tonne of fillets produced: good (less than 6 m³); average (between 6 and 15 m³) and poor (greater than 15 m³). On this scale, Gomba's water consumption of ~10 m³ per tonne fish processed or 30 m³ per tonne of fillets produced would be considered poor, providing a real opportunity for reduced waste production.

Housekeeping

Housekeeping covers prevention of accidental spillages (chemicals, fuel, fish materials) and good management of raw materials and products to avoid contamination and rejection from the main fillet product stream. Raw material control is also key in reducing waste production and profit



One final output, which is easily forgotten, is the waste heat coming from ice

Figure 1. Process flowsheet for Gomba Fishing Industries

maximisation. Actual fillet production per weight of fish for Gomba is 37 - 38, which is less than the theoretical 42% (FAO). This is mainly attributed to post harvesting fishery losses, such as fish deterioration due to time held in the nets; boat and landing hygiene; inadequate icing; lack of potable water or ice at landing sites and transportation of fish for long distances at greater than -4°C (Dillon, 1993).

Similar problems of fish deterioration exist with the product fillets.

Process modification

One significant process modification to reduce waste production and wastewater strength is to avoid pieces of fish from filleting and trimming reaching the floor: the recovered fish may be sold as a by-product. Installing trays along the edges of filleting and trimming benches will catch the fish pieces as they accumulate (Howard, 1997). In addition to catching trays, wastewater can be screened to remove fish solids and make the wastewater more easily treatable.

Restricting the use of detergents and soaps would make separation and recovery of fats from the wastewater stream easier. However, any reduction can only be achieved while still ensuring surfaces are clean and therefore food safety maintained.

Yard run-off presently mixes with wastewater prior to the simple existing treatment process, increasing the volume to be treated especially during heavy rainfall. This could be reduced by segregating yard run-off and, following settling out of debris, allowing the resulting wastewater to soak away.

Product modification

It is hard to see how the product could be modified to reduce waste in this case.

Raw or Process material substitution

With the Nile Perch fillet occupying the coveted position that it does in the European market it is hard to see a replacement.

Other process materials, i.e. soaps, detergents and hypochlorite, are all necessary to ensure food hygiene. Hypochlorite use is minimised by pre-treating potable water by filtration and UV treatment.

Reuse

Very little is wasted in Ugandan fisheries, however, possible reuse options include:

Fats, Oil and Grease (FOG)

If wastewater is to be treated aerobically the excessive amounts of FOG should be removed. As the majority of fats are already removed from carcasses for local sale and additional material would have a local sale value. Simple fat traps could be used, with the FOG retained by baffles and being removed by manual skimming (Dalzell, 1994).

Scales

Scales were the biggest waste material at Ugandan fish processing factories. One site had dug a pit just to dispose of scales which were hampering wastewater pumping. At Gomba scales were not separated from the wastewater and therefore tended to settle to the bottom of the first treatment pond necessitating frequent digging out.

One possible use for fish scales is as an organic wastewater coagulant (Gonzalez, 1996), which could be used to greatly improve the sedimentation or flotation of small particles.

Viscera

The viscera (internal organs) are not presently a product in their own right. Those not removed from the fish are sold locally as part of the carcass. Any removed or damaged during filleting or trimming, however, enter the wastewater. Once there, they behave like fat solids, floating on the surface and could thus be removed by fat traps (see paragraph FOG) and sold (if there was demand).

Modified By-products

'Modified By-products' are defined as those which involve substantial physical or chemical alteration, e.g. minced fish; fish meal; and fish protein concentrate. Of these the only one having any demand in Uganda is fish meal, produced from the viscera, and any unwanted fish. However, the current cost of production means that people prefer to use fats and carcasses, even though fish meal remains safe for human consumption for much longer than ordinary fish.

Perhaps, in the light of the current economic climate and local demand for non-modified by-products, these are the ones to concentrate on in the short term. If the local wealth increases or export markets are opened up, these more expensive, more technically demanding products may well become important.

Recycle

The food industry presents few opportunities for recycling due to the stringent cleanliness required (Wheatley, 1990). It is conceivable that wastewater could be cleaned up sufficiently to be used for a non food contact use, such as cooling water. (NB: Existing chilling machinery at Gomba, uses air and fans rather than water to remove waste heat.)

Conclusions

In this case study has investigated raw materials, processes and outputs for Gomba Fishing Industries in Uganda. Waste streams have been defined and suggestions made for their minimisation along the lines of 'reduce', 'reuse' and 'recycle'. The main points highlighted are the need to:

- reduce Post Harvesting fishery losses - by maintaining optimum fish capture, landing, transportation and storage conditions to reduce spoilage;

- avoid fish pieces reaching the floor - by using trays to catch small pieces of fish resulting from filleting and trimming;
- segregate yard run-off - to reduce wastewater dilution and therefore volume;
- screen wastewater - to further remove small fish pieces and other debris;
- remove Fats, Oil and Grease - these can hinder downstream wastewater processing and the recovered material may be sold locally;
- restrict use of detergents and soaps - as these promote emulsions of fats, oil and grease (FOG) making FOG harder to remove; and
- investigate use of scales as a coagulant - dried, and ground up into a powder scales can be used to aid suspended solids removal from organic wastewater.

In conclusion, there is much that can be done to both minimise the waste produced from Gomba Fishing Industries and generate further profit. It is not suggested that all these measures be attempted at the same time, rather that the more simple and cheaper ones be attempted first. If improvements are seen, this will provide the incentive to make further changes.

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C. McDONALD

M.E. INCE

M.D. SMITH

M. DILLON
