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Minimizing and adding value to seafood processing wastes

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ABSTRACT

This study investigated waste minimization and recycling opportunities in a seafood processing industry. An environmental performance evaluation was done to benchmark performance of the company with published data including Best Available Techniques (BATs) determined by The European IPPC Bureau (EIPPCB). Four broad objectives were set improving the resource efficiency and adding value to solid wastes/by-products. 18 different techniques/measures for reducing waste and adding value to the by-product were identified. Three of the techniques/measures were selected and implemented within the company. Specific water consumption decreased 65% and 77% in anchovy thawing and gutting processes, respectively. Because anchovy is the major product of the company, total water saving was 45.0%. Annual total water saving was estimated to be 29,002 m³. The water recycling system introduced in the gutting process enabled the production of valuable fish oil/grease by-product. Payback period for the implementations was estimated to be 1.6 years. This study demonstrated that environmental and economic benefits can be obtained in the Turkish seafood industry.

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1. Introduction

By 2050 it is expected that the global population will exceed 9 billion and the demand for food products will increase dramatically 59–98% (Valin et al., 2014). Dalin and Rodríguez-Iturbe (2016) state that food production negatively impacts the environment through the use of natural (water, soil, land) and synthetic (fertilizer, pesticides, herbicides, etc.) resources. In addition to the change in intensification of resource consumption, a shift in demand for the type of food products is observed. Freibauer et al. (2011) claim that the increase in household income in emerging economies is shifting diets towards more protein-rich foods (e.g. meat, seafoods) which stimulates increased production of livestock.

The consequences of the trends are clearly reflected in seafood and fish production over the last 30 years. The

annual 8% increase in global production of seafood since 1980, is higher than any other major animal food production (Campbell and Pauly, 2013). According to The Food and Agriculture Organization of the United Nations – FAO (2015), the global seafood production reached the record levels in 2014, exceeding 164.3 million tonne. It is projected that seafood production will increase to 186 million tonne at the end of 2023 (Spanos and Hreinsson, 2015). During the same period, seafood production in emerging economies is expected to increase at an even higher level from 125 million (81.5% of total world production) to 152 million tonnes (83.7% of total world production) (OECD, 2013).

As an emerging economy, Turkey has been facing a rapid development of its seafood industry. Izmir Development Agency's – IDA (2013) records indicated that seafood production almost doubled from 364.661 tonnes/year (1991) to 703,545

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tonnes/year (2011). Moreover seafood production increased for the last 9 years from about 96 million \$ (2002) to 395 million \$ (2011) (Hekimoğlu and Altundeğer, 2012). Turkey currently ranks 7th in total seafood production in Europe. Anchovy, as 32.5% of total seafood capture/production has by far the largest share in seafood industry in Turkey (IDA, 2013).

Due to recent increase in aquacultural and industrial activities (e.g. fish processing) within the seafood sector, natural resources are under increasing pressure of overconsumption and pollution. The significant environmental issues associated with seafood processing include: (i) consumption of large volumes of water (Bello Bugallo et al., 2013; Muthukumaran and Baskaran, 2013; Barros et al., 2009), (ii) intensive energy use, which contributes to air pollution and climate change (Anh et al., 2011; Cappell et al., 2007; European Commission, 2006), (iii) generation of wastewater with high organic load (Uttamangkabovorn et al., 2005; Hall, 2010; Muthukumaran and Baskaran, 2013), (iv) by-product and solid waste production (Knuckey et al., 2004; Bello Bugallo et al., 2012; Lopes et al., 2015; Lovea et al., 2015) and (v) odour/aesthetic problems (Anh et al., 2011; Cappell et al., 2007; European Commission, 2006).

Although various studies from around the world indicate the waste minimization and recycling can be adapted in seafood processing plants, no full-scale demonstration projects have been yet realized in the Turkish seafood processing industry. To fill this gap, this study aims to investigate waste minimization and recycling opportunities including Best Available Techniques (BATs) determined by The European IPPC Bureau (EIPPCB) in a Turkish seafood manufacturing company and presenting the tangible achievements through successful full-scale implementations.

The study was done within the framework of the “National Eco-efficiency Programme” coordinated by the United Nations Industrial Development Organization (UNIDO) and implemented by Technology Development Foundation of Turkey (TTGV). The technical consultancy was provided by the Middle East Technical University. The programme was implemented as a sub-programme of the United Nations Joint Programme “MDG-F 1680: Enhancing the Capacity of Turkey to Adapt to Climate Change”. Further information about the “National Eco-efficiency Programme” can be retrieved from its web page (<http://www.ecoefficiency-tr.org/>). Two studies within the scope of the programme have been published for metal processing (Alkaya and Demirer, 2013a) and woven fabric manufacturing (Alkaya and Demirer, 2013b) industries.

2. Methodology

The methodology followed is based on successful applications previously carried out as part of “National Eco-efficiency Programme” (Alkaya and Demirer, 2013a, 2013b). Although some of the techniques developed in our previous studies were cited in this study, BATs from other sources were also considered (European Commission, 2006, 2009).

A waste minimization audit in the company included the following three:

- Planning and organization
- Pre-assessment
- Detailed assessments and analyses

Commitment and involvement of top management was obtained during “planning and organization” step. A project

team was then established by involving the environmental manager, the utilities manager and the production associate of the company. Pre-assessment was started with an initial walk-through audit, carried out with company officials, before gathering detailed process-based data on water consumption and associated energy use.

Resource (e.g. water, energy) intensive and polluting processes were focused on. For this purpose process-based data were gathered on water and energy consumption as well as solid waste production in the major processes. Information sources such as water and energy bills as well as process-based record sheets were analyzed. As part of the “detailed assessments and analyses” steps monthly water and energy consumption data were averaged for 2009, to ensure a dependable baseline before water/energy saving applications. The average monthly water/energy consumption in 2009 was regarded as the baseline situation throughout the study for comparison purposes. After setting a baseline situation, an “Environmental Performance Evaluation” was done to identify processes/practices where improvements may lead to significant achievements in environmental performance and cost savings in the company. To allow environmental benchmarking between similar production facilities reported in the literatures specific water/energy consumption (e.g. m³/tonne raw material, kWh/tonne raw material) and solid waste generation (e.g. tonne/tonne raw material) were calculated. Then, the resource intensive and polluting processes/practices could be evaluated with environmentally-friendly alternatives in the literature including BATs (European Commission, 2006).

3. Results and discussion

3.1. The case study

The company was established in 1960 as an agricultural products processing and exporting company in Adana, Turkey. The seafood processing department started operating in 1975. Since then, seafood processing (NACE Code: C.10.2.0 – Processing and preserving of fish, crustaceans and molluscs) has become the major activity of the company. The company’s main products are marinated products (e.g. anchovy, shrimp) and frozen products (e.g. escargot, squid). The processing facility is based on a covered area of 15,000 m² and employs 120 workers. Anchovy production increased and it has become major product of the company comprising 60% of total production in 2010. Total production decreased between 2008 and 2010 (Table 1).

Production procedures/practices depend on the type of seafood being processed and the products manufactured. A general process flow scheme was developed for anchovy, the major product of company (Fig. 1).

Information from the environmental performance evaluation and benchmarking was used to determine processes/practices needed to be improved in terms of water/energy consumption and solid waste generation

Table 1 – Annual amount of manufactured products.

Products	2008 (tonne/year)	2009 (tonne/year)	2010 (tonne/year)
Anchovy	169	378	607
Others	1193	792	400
Total	1362	1170	1007

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