Microbiological stability of canned tuna produced in Italy and in non-European countries

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Abstract

The results of a study on the microbiological stability of canned tuna produced by Italian companies and similar canned products manufactured in countries outside Europe are reported herein. The study involved 38 samples of canned tuna of various brands, of which 14 were produced by companies outside Europe and 24 by Italian companies. Qualitative and quantitative microbiological tests were conducted for the following parameters: bacterial colony counts at 30°C, total coliforms, total Enterobacteriaceae, sulphite-reducing anaerobes, Salmonella spp., Bacillus cereus, Escherichia coli, Staphylococcus aureus, yeasts and molds. Bacterial loads and mold contamination were respectively found in 8/14 (57%) samples from outside EU and 7/24 (29%) Italian samples. The bacterial flora was represented by Gram-positive bacteria (Staphylococcus warneri, Staphylococcus lentus, Streptococcus mitis, Enterococcus faecalis, Leuconostoc mesenteroides), Gram-negative bacteria (Sphingomonas paucimobilis, Acinetobacter iwoffii, Rhizobium radiobacter), spore-forming bacteria (Bacillus vulgaris), while the fungal species was represented by Penicillium spp., Rhizopus spp., Rhodotorula spp. and Alternaria spp. Excluding anomalies in the thermal treatment process of products and any contamination after treatment, the contaminations encountered in both cases were most likely due to insufficient production quality standards and the quality of the raw material used. These results may require a redefinition of the concept of commercial stability as hitherto stated.

Introduction

Globally, the production of canned tuna is continuously increasing and the current European market demand far exceeds the availability of raw material that the fishing areas of the European Union (EU) are able to provide, forcing fish processing companies to seek new and cheaper sources of supply, such as zero duty Africa, Caribbean and Pacific (ACP) countries. There are therefore considerably increased imports of tuna from countries such as the Ivory Coast, Mauritius and Papua New Guinea and, with regard to Italy, also from the Seychelles (+48%) (FAO, 2014), with Italian processing companies increasingly supplied by fish from non-European waters (Aniol and Rupert, 2011). According to a study by the Ministry of Agriculture, Fisheries and Food of the Spanish Government (Interatun, 2007), the EU’s decision to lower the 12% tax on the importation of fish products from some non-European countries, has significantly reduced the competitiveness of European fishing. Moreover, the checks carried out on imported products are not exhaustive and do not always meet all the parameters set by European legislation, in particular Regulations (CE) 852/2004, 854/2004, 882/2004 and 558/2010, with the consequent risk that the raw material is not of good quality and that the sterilisation processes normally used in the canning industry may be insufficient to eliminate the microbiological contamination present at the time of processing (Landry et al., 1998; Warne, 1988). The level of tuna meat contamination is influenced by the environment and the conditions and methods of fishing, time of year, handling, processing and evisceration, but particularly by the handling on board and the delayed cooling of fish during storage and transfer at markets and processing plants (Figueroa et al., 2006; Grau et al., 2003; Doyle et al., 2000). Several research studies have examined the stability of canned fish (Ali et al., 2008; Figueroa et al., 2006; Gonzales et al., 1997), but there are no specific studies on the difference in stability between the same type of canned products manufactured in different production and commercial environments. On the basis of this assumption, we performed a study on the comparison of the microbiological stability of canned tuna produced in Italy and that manufactured by outside EU processing companies. The investigation covered microbiological laboratory analytical controls, aimed at verifying the presence of bacterial and fungal contamination in a number of commercial samples of canned tuna produced partly in Italy and partly in non-European countries and purchased at food retailers during the commercial phase of the food chain.

Materials and Methods

Thirty-eight samples of canned tuna in oil from various brands available on the market in some Italian regions, were analysed in packs of 80 and 125 g, of which 14 samples were manufactured in non EU factories and marketed on EU markets, while the other 24 were manufactured in Italian factories and sold outside EU. Samples from outside Europe came from Ivory Coast, Colombia, Peru, Ecuador, Thailand, Mauritius, Indonesia and Seychelles. The 24 samples of tuna manufactured in Italy, belonging to the most popular brands, were from 5 of the most famous canning companies in the domestic market, which will be indicated by letters of the alphabet A, B, C, D and E. Samples were displayed on shop shelves for sale at room temperature, before being identified and selected according to the purpose of the investigation. Each sample was composed of at least 6 packs of canned tuna in olive oil, of which three were used for testing pre-incubation and three were incubated at 35°C for 21 days. During incubation, the samples were checked daily to identify possible impairment (loss of content, can swelling, etc.), but no samples were removed for these reasons before testing began. The samples to be analysed, both those incubated and those non-incubated, were first subjected to a thorough cleaning and cleansing of the external surface of the containers and subsequently disinfected with a 5% chlorine solution. All packaging was equipped with ring pull opening, practiced in sterile conditions under a laminar flow hood. Once collected, the samples were subjected to a series of qualitative and quantitative microbiological tests for verification of the possible presence of bacterial and fungal contamination. We proceeded to draw 10 g of content from each sample, diluted in 90 mL of saline solution and subsequently homogenised for 2 min, with the final prepara-
Table 2. Samples of canned tuna produced in Italy that proved to be non-standard on microbiological testing.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Non-standard data pre-incubation</th>
<th>Non-standard data post-incubation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>TPC 2,727 CFU/g; presence of Sphingomonas paucimobilis</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>TPC 291 CFU/g; presence of Streptococcus mitis/oralis and Acinetobacter iwoffii</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>TPC 109,091 CFU/g</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>TPC 1,236,364 CFU/g</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>TPC 1,209,091 CFU/g</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>TPC 3,801 CFU/g; presence of Staphylococcus lentus and Leuconostoc mesenteroides spp. cremoris</td>
</tr>
</tbody>
</table>

TPC, total plate count; CFU, colony forming units.
B, 13 different samples were tested, of which 5, from a different batch and production date, were contaminated with values post-incubation between 10^3 and 10^6 CFU/g and a fungal load of 100 CFU/g.

Among the bacterial species present, *Staphyloccocus lentus* and *Leuconostoc mesenteroides* were observed, while among the fungi there were *Penicillium* spp. and *Alternaria* spp. As with the non-EU products, tests were performed on all Italian production samples for the detection of salmonellosis, *Bacillus cereus*, *E. coli* and *Staphyloccocus aureus*, as well as the determination of total coliforms, sulphite-reducing anaerobes and enumeration of *Enterobacteriaceae*, all of which gave consistently negative results. Lastly, a measurement of pH values was performed on all Italian and non-EU samples, which gave values consistently between 5.8 and 6.5.

**Discussion**

The first important fact to consider is that more than 1/3 (39.4%) of the samples of canned tuna examined were contaminated with bacteria and fungi in the microbiological tests performed after an incubation period of 15 days at 30°C, thus not being compatible with the specific criteria laid down by Regulation (CE) 882/2004 (European Commission, 2004c) and Directive 97/78/CE (European Commission, 1997). In fact, pre-incubation tests revealed bacterial and fungal contamination in only one sample (280 CFU/g), while in the other samples contaminated in the subsequent post-incubation tests, contamination was likely present in such low concentrations to be undetectable with the microbiological methods used. Another important aspect is the absence of the main pathogenic bacteria responsible for food-borne outbreaks, since contaminations were supported in some cases by bacterial and fungal species with non-pathogenic effects in humans or animals (*Bacillus subtilis*, *Rhizobium radiobacter*) (Logan and De Vos, 2009; Hood et al., 1986), or in some circumstances, responsible for various human diseases such as urinary tract infections, bacteremia, endocarditis, and meningitis (*Enterococcus faecalis*), or infections in patients with an impaired immune system (*Staphyloccocus warneri*), (Kamath et al., 1992), nosocomial infections (*Sphingomonas paucimobilis*, *Streptococcus mitis/oralis*, *Leuconostoc mesenteroides*) (Shelburne et al., 2014; Ryan and Adley 2010; Bou et al., 2008), and acute gastroenteritis (*Acinetobacter iwoffii*) (Nora and Greg, 2009). Among the species identified and in addition to human infections, only *Staphyloccocus lentus* was also associated with subclinical mastitis in sheep (Schwendener and Perreten, 2012). By then comparing the test results obtained from samples of canned tuna manufactured outside Europe and in Italy, the assessments must necessarily take into account that the same type of product has been used, although it is manufactured and sold in different social, productive and commercial contexts. If we exclude abnormalities in the thermal treatment process of products and possible contamination after treatment for both production contexts, the results may indicate problems of contamination along the production line or in the use of raw materials with such a high level of contamination to be completely inactivated by the thermal treatment of 116°Cx30 min, as normally used in the production of canned tuna. In both cases, these conditions inevitably affect the stability of the final product. The quality of the raw material might also explain the varied results found in different production batches manufactured by the same company. The contamination of 7/24 Italian samples (29%) and 8/14 non-EU samples (57%) represent negative datas and probably lead us to reconsider the concept of commercial stability of canned products as enunciated so far, especially in reference to the non-EU sample that was found already contaminant before the pre-incubation tests and also according to similar results previously obtained by other authors (Ali et al., 2008).

**Conclusions**

This research has revealed the existence of a bacterial and fungal contamination in canned tuna in olive oil commonly found in the market, both of Italian and non-EU origin. If the risk could be hypothesised for the non-EU canned products, because of the rules, of the productive standards and of the less strict food security criteria in the countries from which these samples come from; this risk does not exist for Italian canned products thanks to the very good productive level and the established tradition of the Italian canning industry, as well as the strict and effective national and EU regulation in force concerning food safety, such as Regulations (EC) of the so called *Hygiene Package* and subsequent amendments. If we exclude abnormalities of the production process, the risk of contamination of canned products may derive from the quality of health conditions of the raw materials used. The quality levels of raw materials for fish processing industries do not always correspond sufficiently to the advantageous cost proposed by the international market for the supply thereof. This may also explain the irregularities found in the official checks on contamination prevention and food safety, resulting in the activation of the national alert system and in some cases even on a European level. Hence, the need for a more incisive monitoring of the import of fresh or frozen tuna intended for processing by the canning industry. Lastly, the authors repeat the need to reconsider the concept of commercial stability applied to canned products.

**References**


