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Consumers' attitudes and willingness to pay for *Anisakis*-free fish in Spain

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ABSTRACT

The presence of parasitic nematodes of the genus *Anisakis* and/or their proteins in seafood poses a risk to human health through a fish-borne zoonosis, namely anisakiasis, that can cause gastrointestinal disease and allergy. The presence of *Anisakis* may also dissuade consumers from purchasing fishery products, resulting in economic losses to the fishing industry. This is the first time a survey-based contingent valuation study has been performed to investigate consumers' willingness to pay for *Anisakis*-free fish, and to analyse consumers' responses to the presence of *Anisakis* in fishery products. In a survey conducted in Spain, the majority of consumers (77%) were willing to pay extra for an *Anisakis*-free product, indicating a willingness to pay 10% above the usual fish price at market (6.60€/kg compared with 6€/kg). Past reluctance to purchase or consume fish due to the presence of *Anisakis* was reported by > 25% of consumers, with hake being the most frequently rejected species. Nearly two thirds of consumers would cease consuming or purchasing fish due to the presence of *Anisakis*. Consumers' willingness to pay was found to be significantly related to gender, stated past and future avoidance of fish consumption or purchase due to the presence of *Anisakis*, stated past avoidance of cod, hake and mackerel, stated consumption of sardines, and to their perception of the degree of risk of future development of anisakiasis and/or allergy to *Anisakis*. The study revealed two main types of reaction to the presence of *Anisakis* in fish: the avoidance of eating parasitized fish, and a willingness to pay above market price to avoid adverse effects on health and food quality. Overall, the results suggest that the presence of *Anisakis* in fish is an important health and aesthetic issue for consumers, and this is relevant for the fishing and food industries as well as for food safety authorities. Improvements in parasite inspections and development of technologies to prevent *Anisakis* infection in fishery products would likely both improve the economic sustainability of the industry and benefit public health.

1. Introduction

Fish-borne zoonotic parasites are of high public health and socio-economic concern (Chai et al., 2005; Dorny et al., 2009; EFSA-BIOHAZ, 2010). Aquatic helminths (e.g. cestodes, trematodes and nematodes) are the etiological agents of a number of fish-borne zoonoses (e.g. diphyllobothriasis, trematodiasis, anisakiasis) (Chai et al., 2005). In particular, anisakiasis is a zoonosis caused by gastrointestinal (rarely ectopic) parasitism by marine parasites of the genus *Anisakis* (Nematoda: Anisakidae) that typically use cetaceans as final or definitive hosts, small crustaceans as intermediate hosts and fish and cephalopods as intermediate or transport hosts within their life cycle (EFSA-BIOHAZ, 2010; Gregori et al., 2015; Klimpel et al., 2004; Mattiucci and D'Amelio, 2014). They can cause human anisakiasis which may be associated with allergic symptoms following the consumption of raw or lightly cooked fishery products containing live *Anisakis*. Allergy to *Anisakis* can also occur in sensitized individuals, resulting from consumption of fishery products contaminated with *Anisakis* allergens (Audicana and Kennedy, 2008; Carballeda-Sangiao et al., 2016; EFSA-BIOHAZ, 2010; Mattiucci and D'Amelio, 2014).

Approximately 20,000 anisakiasis cases were reported worldwide prior to 2010, of which over 90% were from Japan, where it is

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estimated that around 2000 cases are diagnosed annually (EFSA-BIOHAZ, 2010). Recently, the annual number of anisakiasis cases in Spain was estimated to be around 8000 cases (Bao et al., 2017). There has been a global increase in the number of epidemiological studies describing *Anisakis* infection levels in different commercial fish species (Bao et al., 2013, 2015; Cipriani et al., 2015, 2016; Gómez-Mateos et al., 2016; Levsen and Karl, 2014; Madrid et al., 2016), as well as the number of studies reporting new human anisakiasis cases (Amir et al., 2016; Carrascosa et al., 2015; Del Rey Moreno et al., 2013; Mattiucci et al., 2013; Mladineo et al., 2016; Muwanwella et al., 2016; Shih-Wei et al., 2015; Shimamura et al., 2016; Sohn et al., 2015).

Presence of anisakids may reduce the marketability and commercial value of fishery products due to food safety and quality implications, reducing consumer confidence and thus provoking economic losses to the fishing industry (Abollo et al., 2001; D'amico et al., 2014; Llarena-Reino et al., 2015; Mattiucci and D'Amelio, 2014; McClelland, 2002). For example, in 1987, fish sales dropped 80% and many fishery employees lost their jobs in Germany after a television broadcast which showed anisakids (*Anisakis* sp.) crawling out of fish fillets, leading to a loss of consumer trust (Karl, 2008). It has been estimated that economic losses due to anisakids in fish flesh among fish processors have reached several millions of dollars (Bonnell (1994) cited in Llarena-Reino et al., 2015). In addition, inspection procedures to control and remove visible nematodes also introduce additional costs to the commercial processing (Abollo et al., 2001; Hemmingsen et al., 1993; Llarena-Reino et al., 2015; McClelland, 2002). The detection and removal of *Pseudoterranova decipiens* (Nematoda: Anisakidae) from the flesh of demersal fish (especially Atlantic cod (*Gadus morhua*)) has been estimated to cost Atlantic coast Canadian fish processors a total of $26.6–$50 million per year, due to downgrading and discarding of products (McClelland (2002) and references therein). Social concerns caused by the negative perception of these parasites by consumers have also arisen in a number of Southern European countries (e.g. Italy and Spain) in the last 20 years (D'amico et al., 2014; Llarena-Reino et al., 2015 and references therein). In Spain, fishery operators reported concern about the possible rejection of fishery products caused by anisakids and other fish parasites and their negative effects on consumer confidence and business profits (Llarena-Reino et al., 2015).

Recently, experts from FAO/WHO (Food and Agriculture Organization of United Nations and World Health Organization) ranked anisakids 4th out of 24 food-borne zoonotic parasites in terms of relevance to international trade (FAO/WHO, 2014). In the European Union, the Rapid Alert System for Food and Feed (RASFF) reported, between 2010 and November 2016, a total of 289 RASFF notifications of parasitic infestation in fish and fishery products, of which 234 (81%) were suspected to be *Anisakis*; 50 (21%) of them were notified by Spain and 46 (20%) were notified by other countries due to *Anisakis* infestation in fishery products from Spain (RASFF, n.d.).

Contingent valuation (CV) is a survey-based methodology for placing monetary values on non-market resources (Carson, 2000). This approach is rooted in random utility theory (Hanemann, 1989; McFadden, 1973) and it is argued that individuals are accustomed to making such choices since this is the way they make decisions. CV has been widely used for over 4 decades and numerous studies have been carried out in over 130 countries looking at cultural, environmental, health and other issues (Carson, 2000, 2012). It measures the willingness to pay (WTP) as reflected in the stated preferences of survey respondents regarding the use of or the benefit from a product, service or public good not transacted in the markets (Carson, 2000, 2012). Several CV studies have been performed worldwide to estimate WTP for a reduction in the likelihood and severity of fatal and chronic diseases (Basu, 2013; Brandt et al., 2012; Hadisoemarto and Castro, 2013; Milligan et al., 2010; Udezi et al., 2010; Yasunaga et al., 2006) as well as to guarantee food safety (Sundström and Andersson, 2009; Wang et al., 2009; Wang and Huo, 2016). For instance, Basu (2013) has used CV to estimate the WTP of U.S. adults aged 50 or above for a prescription drug to prevent Alzheimer's disease, and Sundström and Andersson (2009) have used CV to estimate Swedish consumers' WTP for reducing the risk of infection by *Salmonella* bacteria in chicken fillets. To the best of our knowledge, no CV study has been performed to estimate the WTP of consumers for preventing the presence of anisakid nematodes (or any other fish parasite) in fishery products.

The goal of this CV study is to provide an understanding of how fish consumers may value the eradication of *Anisakis* in fishery products and to determine if WTP varies in predictable ways with individuals' perceptions of risks, fish consumption habits and other socio-demographic characteristics. Consumers' attitudes regarding the presence of *Anisakis* in fishery products as well as their knowledge about anisakiasis and prevention methods will also be investigated.

2. Materials and methods

2.1. Survey and sample selection

A questionnaire survey was developed to enable determination of WTP for *Anisakis*-free fish by CV. A pilot version of the questionnaire was conducted with 18 staff and students from the University of Aberdeen. Subsequently, an online version of the questionnaire was produced and distributed among the partners of the EU project PARASITE, who are experts on *Anisakis* and associated human diseases, for discussion and revision.

The online questionnaire (see supplementary material) was tested by project partners, then finalised and disseminated via the Internet to the general Spanish population. It was publicised on the website of the EU project PARASITE, on social media, press and radio, by e-mails sent to professional and personal contacts and by "word of mouth".

2.2. Questionnaire design

The questionnaire comprised a total of 44 questions (i.e. mainly closed questions and few open-ended questions). In a covering letter the respondents were informed that: 1) the questionnaire was part of the EU project PARASITE; 2) their responses would be treated as confidential and anonymous; and 3) only people aged 18 or over should answer the questionnaire. The questionnaire was organised in sections to gather information about: 1) socio-demographic information about the respondent (sex, age, nationality, education, job status, occupation, income, etc.); 2) allergy and health status; 3) fish consumption behaviour (frequency of consumption of fish, fish species consumed, preparation of fishery products eaten (e.g. fresh, raw), etc.); 4) knowledge about *Anisakis* (awareness of *Anisakis* and how to avoid *Anisakis* infection); 5) attitudes to the presence of *Anisakis* in fish (e.g. past avoidance of purchase or consumption of fish); 6) WTP for *Anisakis*-free fish; 7) attitudes to hypothetical future scenarios regarding the presence of *Anisakis* in fish (i.e. future avoidance of purchasing or consuming parasitized fish) and 8) perception of risk (perceived likelihood of suffering anisakiasis or related allergy in the future).

Immediately before the WTP question (question 23), respondents were informed about: 1) the occurrence of *Anisakis* in many fish species; 2) how they may accidentally infect humans; 3) the probability and severity of *Anisakis* related diseases and 4) how *Anisakis* infection can be prevented. This information sheet ended with a compulsory question (question 22). Respondents had to confirm or deny that they had read the information provided before they completed the questionnaire. The aim was to provide enough information to respondents, to allow them to make an informed decision of their WTP for *Anisakis*-free fish (Carson, 2000).

2.3. Willingness to pay for Anisakis-free fish

The following hypothetical scenario was used to determine the WTP for *Anisakis*-free fish (question 23):