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Quantitative risk assessment for formalin treatment in fish preservation: food safety concern in local market of Bangladesh

Md. Sazedul Hoque^{a,*}, Liesbeth Jacxsens^b,
Bruno De Meulenaer^b and AKM Nowsad Alam^c

^aDepartment of Fisheries Technology, Faculty of Fisheries,

Patuakhali Science and Technology University, Dumki, Patuakhali-8602, Bangladesh

^bDepartment of Food Safety and Food Quality, Faculty of Bioscience Engineering, Ghent University, Ghent, Belgium

^cDepartment of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract

In Bangladesh, fishes are adulterated by hazardous chemicals at different steps from farm to consumers. Formalin (FA) is reported to be frequently added as preservative either by dipping or spraying to the fresh fishes by the fish traders while transporting to domestic marketing chain to prevent spoilage and extend shelf life. Thus, the objective of the present study was to conduct quantitative risk assessment (QRA) for formalin treated fish in Bangladesh. The probabilistic QRA of formalin treated fish was performed based on available secondary data. Available data on concentration of formalin in fish, daily fish consumption by the consumer and their body weight were used to estimate the risk of residual formalin to the consumers. Based on the data, three different scenarios (average consumption, two and four times of average consumption considered as scenarios 1, 2 and 3, respectively) were used for exposure analysis using @Risk program version 6.0. FA concentration in consumed fresh and cooked (boiling) fish was 5.34×10^{-02} and 2.340×10^{-02} (mg/kg bw/day), respectively and national average fish consumption was 200 g/day. QRA reveals that FA intake under scenario 1 and 2 was lower than acceptable daily intake (ADI 0.2 mg/kg bw/day set by the United States Environmental Protection Agency) thus lower risk observed for both fresh and cooked fish. However, scenario 3 revealed that 0.01 % population was at risk (FA intake 0.21 mg/kg bw/day higher than ADI) upon the fresh fish consumption, where cooked fish (FA 9.38×10^{-02} mg/kg bw/day) consumer remains safe at the same scenario. The result confirmed that cooking has significant effect to reduction of formalin. Therefore, probabilistic quantitative risk assessment of formalin treated fish could provide important risk information to the risk manager (government), whether the population is at risk or not? The result could be applied to establish effective risk management strategy in Bangladesh.

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* Corresponding author.

E-mail address: sazedul_haque@yahoo.com

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1. Introduction

Fisheries is an important sector of Bangladesh in terms of creating job opportunities (16.5 million), gross domestic growth (4.39%), nutrient supply and earning of foreign exchange (470 million US dollar in 2011-2012)¹ which is contributing to the food security of the country either directly or indirectly. Fish and other seafood are the vital contributors to meet the nutritional requirement in the daily diet. About 60% of the total animal protein intake are coming from fish.

In Bangladesh, different food items are reported to be adulterated by unsafe chemicals at different marketing steps from farms to consumers. The fresh fish are sprayed with or dipped into formalin by the fish traders while transporting through domestic market chain². Formalin is carcinogenic, allergenic and induce genotoxicity. Formalin recently classified by the International Agency for Research on Cancer (IARC) in the Group 1 “as carcinogenic to humans”³. Chemical reaction of added formalin with fish composition could produce toxic product (adduct) and have residual harmful effects to the consumer. However, as consumers behavior in Bangladesh are habituated to eat well cooked fish and fishery products which could reduce the FA content up to a level. Several study reported that different household handling steps (freezing, thawing, washing, and cooking) could help to deduct the added FA from fish⁴.

Recent trends in global food production, processing, distribution and storage are creating an increasing demand for food safety research in order to ensure a safer global food supply. Methods of risk analysis, potential risks of susceptible populations and combined low-level exposure to several chemicals are taking into account. However, there is limited information was observed on quantitative risk assessment of formalin contamination in fish of Bangladesh. Therefore, objective of the present study was to quantitative risk assessment of formalin treatment in fish chain of Bangladesh and established effective risk management strategy to obtain the status of safe fish in Bangladesh.

2. Risk assessment methodology

2.1. Exposure assessment

For concentration data, available secondary data containing minimum of 10 samples were considered per fish categories (fresh fish and cooked fish) for formaldehyde content⁴. On the other hand, consumption data were obtained from the report of National Fish Week Compendium (In Bengali) published by Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh.

Formalin dietary exposure in two different categories of fish (fresh fish and cooked fish) included the formaldehyde concentrations and three different scenarios of consumptions (average consumption, 2 and 4 times of average consumption) data were analyzed. Risk assessment was done based on the available secondary data, where the current study would establish a complete modeling for the risk assessment. Available data of formaldehyde concentration in fish (*mg/kg*) and average fish consumption (*g/day/person*) was used for exposure analysis. Fish consumption (*g/day/person*) was further converted to *g/kg body weight/day* (Annex 1). In case of body weight, based on assumption three age group subpopulation namely child, adult and older was referred as minimum, most likely and maximum body weight for the distribution. Exposure was calculated as per following equation:

$$\text{Exposure} = \frac{\text{Concentration of contaminant (mg/kg)} \times \text{Consumption(kg/day)}}{\text{Body weight (kg)}}$$

Where, distribution of concentration and consumption used; Exposure expressed as *mg/kg body weight/day*

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