Biogenic amines in sea products

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Abstract

Sea food products are being processed through various techniques, i.e. chilling and freezing, heating, irradiating, and curing; regard to the condition of processing, formation of biogenic amines are probable, as raw materials are usually rich in respective precursors. Fermented fish products are among the most vulnerable items to this challenge, these products due to their nutritious value are being popular in many coastal regions of the world and being used as condiment or main dish. But formation of biogenic amines may lead to food poisoning, metabolic disorders or even occurring diseases such as cancer, chronic disorders, and neoplastic cell growth. Regulatory limitations have set by standard agencies for these secondary metabolites in raw and processed seafood. The negative amine-producing starter culture could also prevent the formation of biogenic amines during storage. Therefore, the addition of an appropriate starter is advisable to produce safer products with low levels of biogenic amines

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Introduction

Biogenic amines in Fermented fish products

Basic nitrogenous compounds which produced in meat based products i.e. seafood, processed meat, dairy and fermented variaties, through decarboxylation of amino acids or amination and transamination of aldehydes or ketones in the flesh, being known as biogenic amines are (Biji *et al.*, 2016). The term "fermented fish products" is used to describe the products of freshwater and marine fin fish, shellfish, and crustaceans processed by the activity of enzymes and bacteria in the presence of salt (Boziaris, 2014). One of the most limitations regard to production and consumption of fermented fish products is biogenic amine catabolism in the raw ingredient or processed products. Formation of biogenic amines in raw ingredient dependent on the portion of dark/white muscles of fish so it is species- specific (Prester, 2011).

Dark muscles have more histidine content compare to white muscles and if being kept under elevated temperatures the process of accumulating of histamine accelerated (Rodtong *et al*., 2005; Rossano *et al*., 2006). Fish with high portion of dark muscle are prone to accumulate other biogenic amines i.e. putrescine, cadaverine and tyramine in a lower amount compare to histamine (Du *et al*., 2002).

White muscles instead porne to accumulate putrescine and cadaverine during poor handling and being exposed to high temperatures. As cephalopods i.e. cuttlefish being used as raw material, agmatine has be introduced as a quality indicator (Zhoa *et al*., 2007; Vaz-pires *et al*., 2008). Hala'sz *et al*. (1994) revealed that agmatine can has a synergistic relation with histamine. In the case of crustaceans, penaeid shrimps and lobster, putresine has determined as the best indicator (Benner *et al*., 2003; Prester *et al*., 2010); and with a similar pattern cadaverine can be measured as an effective indicator in several shrimp species (Shakila *et al*., 1995; Benner *et al*., 2003; Zhoa *et al*., 2007) and swimming crab (*Portunus trituberculatus*) (Kim *et al*., 2009).

Histamine and tyramine are not also a good indicator for bivalves edible parts, as being produced in lower levels compared to fish muscle (Prester, 2011). Determination of overall polyamines with stress on putrescine, spermidine, and cadaverine have been announced as an effective indicator for evaluating the effectiveness of the raw material (Kim *et al*., 2009; Erkan, 2005).

As polyamines have an important role in developing/controlling diseases i.e. abnormal cell proliferation, differentiation, chronic disorders, immunity problems (Ali *et al*., 2011), neoplastic cell growth (Thomas and Thomas 2003; Kee *et al*., 2004; Casero and Morton 2007), and prostate cancer (Watanabe *et al*., 2009).

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Acceptable levels of biogenic amines

As it is mentioned previously not only the presence of biogenic amines in raw and processed seafoods can be harmful for consumers, but also the amount of these compounds are used as indicators of freshness degree of fish products. Histamine as the most important biogenic amine with toxicological effect has a maximum acceptable limit announced by EU and USA (Table 1). The codex alimentarius standards declare that products shall not contain more than 10mg/100g of histamine based on average of sample unit tested in the species of clupeidae, scombridae, scomberesocidae, pomatomidae, coryphaenidae (Biji *et al*., 2016).

Table1: Regulatory limits of Histamine in seafood (Biji *et al*., 2016).

Country	Limit	Reference
EU	1. Fishery products from fish species associated with high amount of histidine n=9, c=2, m=100mg/kg, M=200mg/kg 2. Fishery products which have undergone enzyme maturation treatment in brine n=9, c=2, m=200mg/kg, M=400mg/kg	Commission regulation (EC) No 2073/2005
USFDA	50ppm(50mg/kg)	FDA 2011
Australia, Germany and New Zealand Food Standards Code (FSC)	200mg/kg	Ezzat *et al*. (2015)
South Africa and Italy	100mg/kg	Ezzat *et al*. (2015)

Nnumber of units comprising the sample, c number of sample units giving values over m or between m and M.

Nitrosamine production

N-Nitrosamines (NAs) are potent carcinogens that can motivate tumours in different kind of animal species. Biogenic amines accumulation in fish tissue will lead to nitrosamine synthesis (carcinogenic factors) (Yurchenko and Molder, 2006). Nitrosamines are the product of the reaction between secondary amines and nitrite comes from colouring, flavouring, preservatives, and impure salt and also applied heat during the heat processing (Al Bulushi *et al*., 2009). Dimethylamine (DMA), is the most commonly encountered volatile NA in nitrite-cured fish meat (Sugimura, 2000; Al Bulushi *et al*., 2009). However, biogenic amines subjected to heat may also creat nitrosatable amines. Putrescine and cadaverine, which are mostly found in decomposed in seafoods (next section), may produce N-nitroso compounds, nitrosopyrrolidine (NPYR) and nitrosopiperidine (NPIP), respectively (Yurchenko and Molder, 2006; Al Bulushi *et al*., 2009). Furthermore, dietary tyramine is converted to a

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mutagen compound, 3-diazotyramine (3-DT) which induced carcinoma of the oral cavity in rats (Ochiai *et al*., 1984; Fujita *et al*., 1987).

Many studies revealed a significant correlation between consumption of cured fish and certain types of cancer (Tsugane, 2005; Michaud *et al*., 2009; Biji *et al*., 2016).

Biogenic amines degradation by non-lactic acid bacteria

Biogenic amines are widely present in food products, especially fermented seafoods such as fish sauce (Shalaby, 1996). Biogenic amines are physiologically degraded through oxidative deamination catalyzed by amines oxidase by the following reaction: R-CH2-NH-R' +O2 + H2O→R-HO + H2N-R' + H2O2 (Murooka *et al*., 1979). Monoamine and diamine oxidases are present and have a critical effect on the production of amines in human, plant, and animal cells. Furthermore, these enzymes have also been found in some bacterial strains (Murooka *et al*., 1979). Some bacteria, among Lactic acid bacteria species, are able to degrade biogenic amines by means of amino oxidases. This could be of interest for fish sauce production, to control biogenic amine build-up in this product (Dapkevicius *et al*., 2000).

Lee *et al*. (2016) reported that *Bacillus polymyxa* D05-1, isolated from salted fish product and possessing amine degrading activity. Total biogenic amine contents (including histamine, putrescine, cadaverine, and tyramine) in the samples were less (p<0.05) than those of the inoculated control samples during fermentation. During fermentation for four months, the amount of biogenic amine in the inoculated samples was decreased around 30.0%, respectively to control samples. Usage starter culture with amines degrading potential in salted fish products could reduce biogenic amine accumulation.

Inoculation of dry sausages by starter cultures of *Staphylococcus carnosus* and *Staphylococcus xylosus* revealed that production of biogenic amines (tyramine) reduced in inoculated samples compared to control samples (Bover-Cid, 1999). The study was carried out on the reduction of biogenic amine contents in *Myeolchi-jeot***,** a salted and fermented anchovy. *Staphylococcus xylosus* had the highest potential for degradation of histamine and tyramine compare to seven potential starter cultures tested. (Jae-Hyung and Han-Joon, 2009). *Staphylococcus carnosus FS19* and *Bacillus amyloliquefaciens* identified in fish sauce and showed amine oxidase activity, so can be used as a result can be used as a starter cultures. In general, biogenic amines concentration namely histamine, putrescine, cadaverine and tyramine increased markedly in the control as compared to the samples treated with starter cultures (Zaman *et al*., 2011). Also Xinhui *et al.* (2015) manufactured fermented sausages by starter culture composed of

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Pediococcus pentosaceus, *Lactobacillus sakei* and *Staphylococcus xylosus*. The starter culture had a great potential for histamine degradation in fermented sausages and was beneficial to food safety of fermented sausages.

These finding cleared the production of fermented foods with low predictable amounts of biogenic amines is desirable, and this should also be taken into account in the selection and implementation of starter cultures. The manufacture of fermented sauce with the inoculation of the negative amine-producer culture, could efficiently reduce the formation of biogenic amines during the ripening of fermented sauce. Furthermore, the negative amine-producing starter culture could also prevent the formation of biogenic amines during the sauce storage. Therefore, the addition of an appropriate starter is advisable to produce safer sauce with low levels of biogenic amines (Visciano *et al.*, 2012).

Conclusion

Seafood is sensitive to contamination by biogenic amines producing microorganisms at different points of the food chain. Formation of biogenic amines in raw ingredient dependent on species of fishes. Biogenic amines such as histamine, putrescine and cadaverine are considered as indicators of seafood spoilage. Determination of overall polyamines with stress on putrescine, spermidine, and cadaverine have been announced as an effective indicator for evaluating the effectiveness of the raw material for further processing. The maximum acceptable limit for histamine in seafood based on FDA regulation is 100 mg/Kg or 100 ppm. Novel techniques like using Non-Lactic acid bacteria starter culture are able to degrade biogenic amines by means of amino oxidases. This could be of interest for fish sauce production, to control biogenic amine build-up in this product.

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