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Benefits and Risks of Aquaculture Foods in Primary Health Care: A Mini-Review

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HIGHLIGHTS

- Benefits and risks of aquaculture are reviewed, highlighting necessity of attention to Primary Health Care principles.
- Proper production, transportation, and storage of aquaculture products should be applied.
- Ecological and environmental factors must also be considered to improve aquaculture safety.

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Acronyms and abbreviations
PHC=Primary Health Care

ABSTRACT

Primary Health Care (PHC) is expected to serve as a basis for the country's health sector, of which it is the primary responsibility and priority, as well as the community's overall collective and economic prosperity. Promotion of food supply and proper nutrition are among eight elements of PHC. Protein deficiency is one of the most important health concerns in some parts of the world. A huge numbers of malnourished or hungry people have been reported particularly in the less developed countries. Advantages of aquaculture in nutrition are varied. However, there are some zoonotic microbial illnesses occurred due to consumption of infected seafood. Some of these challenges will be corrected by good aquaculture practices. With the right reforms in the aquaculture industry, progress can be made toward solving some of the challenges facing PHC delivery. In this mini-review, the benefits and risks of aquaculture foods in PHC are briefly discussed.

Introduction

Primary Health Care (PHC) is described as "important health care centered on hands-on, scientifically, comprehensive and publicly acceptable approaches and expertise, made universally available to people in the community through their full involvement and at a price that the communal can afford to sustain at every phase of development in the spirit of independence and self-determination" (WHO, 1978).

It should be noted that PHC is expected to serve as a basis for the country's health sector (Taylor et al., 2020). Since then, PHC ideology has been closely advocated in human development, such as collective fairness, justice, human civil rights, right to services, and emphasizing the value of the most vulnerable members of society. It was documented at the Alma Ata conference that advancing and safeguarding public health is critical to sustained economic and communal improvement and contributes to better quality of life and global peace (Agarwal et al., 2017; Muldoon et al., 2006; Taylor et al., 2020; WHO, 1978).

Promotion of food resource and also appropriate nutrition is among eight elements that form the fundamental principles of PHC. PHC is established on the

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perception upon which the health is considered as a vital human right as well as a global common objective. To obtain the gallant idea of PHC, food is an important factor. Food Security Information Network (FSIN, 2019) reported that persistent starvation and undernourishment may result in both infectious and non-infectious diseases. The occurrence of chronic malnutrition seems to have risen from 20.8 to 22.7% from 2015 to 2016 (FAO, 2017). Regarding the fact that PHC includes preventive, promotional, curative, and rehabilitative care, global food security is critical to PHC policies and strategies. The implementation of PHC policies must not only control of diseases but also involves any segment of economy in public health chain. In this paper, the benefits and risks of aquaculture foods in PHC are briefly discussed.

Aquaculture and food security

A huge numbers of malnourished or hungry people have been reported particularly in the less developed countries. Thirty-five g of animal protein should be consumed by each adult person in a day; however, this value in some Africa countries such as Nigeria has been reported as less than 7 g. Many people in Sub-Saharan Africa, estimated to be about 215 million people, are suffered from malnutrition. Protein shortage can be decreased by increasing aquaculture production. Aquaculture products are less expensive than protein sourced from cattle and poultry. The need for protein supply has increased the economical value of aquaculture trade. According to FAO (2018), fish comprises about 17% of animal protein intake in the world. In addition, fish is also an important source of lipids and micronutrients. FAO (2016) reported that more than 2 billion people are undernourished owing to a shortage of essential vitamins and minerals and this situation has resulted to health crises in many people and this has been the case in many developing countries. Deficiencies of these vital vitamins and minerals are critical at key stages of human life (pregnancy, breastfeeding, childhood). Eating fish on a regular basis may reduce the risk of cardiovascular diseases.

Microbial hazards associated with aquaculture

Some important zoonotic diseases may be caused by consumption of contaminated fish and seafood. Eating raw or semi-cooked fish in the main reason for human illnesses caused by pathogenic bacteria, parasites, or viruses (Acar and Moulin, 2006; Adedeji et al., 2011; Bondad-Reantaso et al., 2005; Tiamiyu, 2016; Tiamiyu and Soladoye, 2015). Antibiotics and other chemotherapeutics are needed to treat bacteria and parasite infections in the aquaculture industries. The excessive use of antimicrobial agents for the prevention and controlling of fish diseases may result in antimicrobial resistance as another health problem (Adedeji et al., 2011; Nya and Austin, 2011), initiating problem for animal health, environment as well as human beings (Ringø et al., 2010). Unnecessary application of antimicrobial drugs in aquaculture had led to the public health hazards which comprise expansion and spread of antimicrobial-resistant bacterial strains and the incidence of antimicrobial remains in foodstuffs derivative of aquaculture (Aly and Albutti, 2014).

Some of the food safety problems are caused by biological and chemical contaminations that can arise during cropping and handling. Pathmalal (2018) has pointed out that the excessive use of antimicrobials in aquaculture is connected with dangers linked with the treatment of human infections. WHO (2014) reported that only a few bacterial strains of cultivated fish have the capacity to infect human in temperate climates. However, in warmer climates, the risk of pathogenic bacteria is increased. *Pseudomonas* sp., *Edwardsiella* sp., and *Aeromonas hydrophila* are established to be important fish pathogens in the warmer countries however in a recent study carried out by Tiamiyu et al. (2011), some strains of bacteria such as *Bacillus, Escherichia, Klebsiella, Micrococcus, Proteus, Pseudomonas, Streptococcus, Salmonella, Staphylococcus,* and *Serratia* were isolated from fish cultured in some aquatic environments of Ibadan, Southwest, Nigeria.

Aquaculture products are promoted to solve the basic problem of PHC in food supply and proper nutrition. However, it is also noteworthy to note that they have been identified as a vehicle of food-borne bacterial and parasitic infections (Håstein et al., 2006; Novotny et al., 2004). Abraham (2011) reported that globally increasing of infectious diseases is probably related with spread of antimicrobial resistance. Disease causing bacterial strains through fish and fish foodstuffs are summarized in Tables 1 and 2.

Chemical hazards associated with aquaculture

The fish manufacturing processes may pose some chemical hazards due to the constant use of chemicals like lime, disinfectants, pesticides, inorganic fertilizers, etc. (Karagas et al., 2012; Okocha et al., 2018). Clausen et al. (2020) reported that some laboratory chemicals when inhaled could lead to development of respiratory problems such as bronchitis, rhinitis, and asthma. It has been observed that laboratory workers that have prolonged exposure to organic solvents such as chlorinated hydrocarbons, alcohols, ester, ketone, etc. are at risk of brain and nervous system damage. These chemicals are

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Table 1: Disease causing bacterial strains through fish

Bacterial pathogen	Diseases
Erysipelothrix rhusiopathiae	Endocarditis, fish handler's disease, fish rose
Leptospira interrogans	Leptospirosis
Mycobacterium marinum and *M. fortuitum*	Mycobacteriosis, fish tank granuloma
Photobacterium damselae *	*Photobacterium damselae* sepsis
Pseudomonas aeruginosa # and *P. fluorescens* #	Wound infections
Streptococcus iniae	Bacteremia, cellulitis, endocarditis, meningitis, septic arthritis, mad fish disease
Vibrio alginolyticus *#	Otitis media
Vibrio vulnificus *#	Septicemia

*: Aboriginal bacterial strains
#: Allegedly present in cultivated fishes of West Bengal
Source: Abraham (2011)

Table 2: Disease causing bacterial strains through fish foodstuffs

Bacterial pathogen	Diseases
*Aeromonas hydrophila**#	Enteritis and septicemia
Bacillus cereus	Gastroenteritis
Clostridium botulinum Type E*	Botulism
Clostridium perfringens	*C. perfringens* food poisoning
Delftia acidovorans (Pseudomonas acidovorans)	Endocarditis, bacteremia
Edwardsiella tarda#	Gastroenteritis, septicemia, meningitis, cholecystitis, cellulitis
Escherichia coli#	Gastroenteritis
Hafnia alvei	Septicemia, gastroenteritis, meningitis, pneumonia, wound infections
Legionella pneumophila	Legionnaire's disease
*Listeria monocytogenes**	Listeriosis
*Plesiomonas shigelloides**#	Water-borne diseases, diarrhea
Salmonella spp.#	Salmonellosis
Shigella spp.#	Shigellosis
Staphylococcus aureus#	Gastroenteritis
*Vibrio cholerae**#	Cholera
*Vibrio parahaemolyticus**#	Acute gastroenteritis
Yersinia enterocolitica	Yersiniosis

*: Aboriginal bacterial pathogen
#: Allegedly present in cultured fishes of West Bengal
Source: Abraham (2011)

sometimes released into the aquaculture environments. The symptoms noticeable in affected people include premature ageing, memory impairment, mild depression, and anxiety. Erondu and Anyanwu (2005) have also attributed the following symptoms to formaldehyde poisoning: allergic dermatitis, asthma, and rhinitis. Pesticides, oil spills, and other xenobiotics can pollute ponds and water sources, which can also pose risks for workers. Some chemicals are used as flocculants in the ponds to precipitate suspended clay particles. Disinfectants (e.g. formalin hypochlorite) are also used to disinfect equipments and holding units. Other sources of chemical hazards may be originated from water pumping machines, feed mills, smokes, which are considered serious health risks. In pond aquaculture, a variety of chemicals and other compounds are used as additives to improve soil and water quality, as well as to monitor ecological issues including phytoplankton blooms, aquatic plant infestations, disease vectors, and the abundance of wild fish (Granada et al., 2016). Table 3 highlights some of the substances used in aquaculture ponds that may leak toxic chemicals into the environment.

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Table 3: Some of the substances used in aquaculture ponds that may leak toxic chemicals into the environment

Groups	Chemical compounds	Types of hazards		
		Human	Environment	Food
Fertilizer	Urea (H_2NCONH_2)	explosive, irritant, possible mutagen	eutrophication, ammonia toxicity, spillage from storage, nitrification with acidic reaction	none
	Ammonium sulfate ((NH_4)2SO_4)	explosive, irritant	eutrophication, ammonia toxicity, spillage from storage, nitrification with acidic reaction	none
	Potassium nitrate (KNO_3)	explosive, irritant, anemia	eutrophication, ammonia toxicity	none
	Phosphoric acid (H3PO_4)	irritant,	spillage from storage, eutrophication	none
	Potassium chloride or muriate of potash (KCl)	irritant	spillage from storage, eutrophication	none
	Triple superphosphate (Ca(H $_2$PO4)$_2$)	irritant	spillage from storage, eutrophication	none
Liming materials	Agricultural limestone (pulverized $CaCO_3$ or $CaCO_3 \cdot MgC$)	none	None	none
	Burnt lime (CaO or CaO·MgO)	Strong, caustic, Irritant	spillage from storage, high pH	none
	Hydrated lime ($Ca(OH)_2$ or $Ca(OH)_2 \cdot Mg(OH)_2$	Caustic, irritant	spillage from storage, high pH	none
Oxidants	Potassium permanganate ($KMnO_4$)	Explosive if in contact with organic substances, irritant	Spillage from storage, toxicity	none
	Hydrogen peroxide (H_2O_2) or calcium peroxide (CaO_2)	Irritant if highly concentrated	spillage from storage	none
	Calcium hypochlorite ($Ca(OCl)_2$	Irritant, poisonous	formation of trihalomethanes and Chlorinated hydrocarbons that are suspected carcinogens, toxic	none
Coagulants	Ferric chloride ($FeCl_3$)	irritant	if spilled, acidity and toxicity	none
	Aluminum sulfate or alum ($Al_2(SO4)_3 \cdot 14H_2O$)	acidic	if spilled, acidity and aluminium toxicity	none
	Calcium sulfate or gypsum ($CaSO_4 \cdot 2H_2O$)	none	none	none
Osmoregulators	Salt (NaCl)	irritant	increase in salinity	not generally considered poisonous
	Calcium sulfate or gypsum ($CaSO_4 \cdot 2H_2O$)	none	none	none
Algicides and Herbicides	Copper sulfate ($CuSO_4 \cdot 2H_2O$)	strong irritant	toxic to aquatic life in high concentrations	not bioaccumulative
	Chelated copper compounds	none	copper can be toxic to aquatic life if high doses utilized	none
	Dyes (food coloring compounds)	none	none	none
Piscicides	Rotenone ($C_{23}H_{22}O_6$)	avoid inhalation-irritant,	low residual time, toxicity	none
	Potassium permanganate ($KMnO_4$)	Explosive if in contact with organic substances, irritant	Spillage from storage, toxicity	none
	Formalin-formaldehyde solution	avoid inhalation, irritant	toxicity	none

Source: Boyd and Massaut (1999)

Conclusion

In this paper, benefits of aquaculture and also some important microbial and chemical hazards associated with aquaculture are reviewed, highlighting necessity of attention to PHC principles. It is recommended that food safety should be given proper attention in terms of proper production, transportation, storage of the aquaculture products in order to maintain the nutritional value. The ecological and environmental factors must also be considered to improve aquaculture safety.

Author contributions

A.M.T. wrote the manuscript; I.A.A. edited the manuscript. Authors read and approved the revised manuscript.

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Conflicts of interest

All the authors declared that there is no conflict of interest in the study.

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