



Risk factors in street food practices in developing countries: A review

Bulyaminu Adegbemi Alimi*

Department of Bioresources Engineering, School of Engineering, College of Agriculture, Engineering and Science, University of KwaZulu-Natal,
Private Bag X01, Pietermaritzburg, Scottsville 3209, South Africa

Received 9 November 2015; received in revised form 25 February 2016; accepted 3 May 2016

Available online 9 May 2016

Abstract

Street food trading solves major social and economic problems in developing countries through the provision of ready-made meals at relatively inexpensive prices and employment for teeming rural and urban populace along its value chain. However, due to informal nature of the enterprise, the activities of the practitioners are not regulated. This gives ample room for unwholesome practices. The results are the risks such activities pose to the health and safety of practitioners along the value chain. This review paper, a summary of literature reports on risk factors in street food trade in developing countries and recommended safety intervention, is written with the hope of providing global baseline for intervention to ensure safe food practices. Adoption of safety approaches that permeates the entire chain of street food business from good agricultural practices through hazard analysis critical control points strategy to good hygiene practices by farmers, vendors and consumers would significantly reduce risks in street food consumption. Above all, active collaboration of all stakeholders toward the strengthening and proper enforcement of public health policies to ensure safe practices and engender safer and healthier society is recommended.

© 2016 Beijing Academy of Food Sciences. Production and hosting by Elsevier B.V. All rights reserved.

Keywords: Street food; Risks; Safe practices; Public health policies; Vendors and consumers

1. Introduction

Street foods are enjoying increasing patronage due to industrialization which is forcing many city dwellers to eat their major daily meals out of home [1]. Street food vending is a common feature of most cities and towns in developing countries [2]. Aside provision of ready-made instant meals at relatively inexpensive prices, teeming urban dwellers are attached to street foods because of its gustatory attributes. These attributes are linked to the culinary prowess of the vendors [3,4]. Akinyele [5] reported the significant contribution of street foods to nutrition and food security for millions of practitioners along the

chain. Draper [6] also identified them as potential vehicles for micronutrient fortification.

Street food vending activities in most developing countries are mostly outside the regulation and protection of the governments. The economic importance of the activities is not well appreciated due to the informal nature of the enterprise and lack of official data on volume of trade involved [7]. Street food vending makes up the significant proportion of informal sector of the economy of most developing countries. About 28.5% labor force in Mexico were reportedly employed in the informal sector, 30.8% of the activities in this sector were in the street food which employed over 120,000 vendors in Mexico city alone in 1998 [8]. Dawson and Canet [9] reported that street food vending in Malaysia is a multi-million US dollar trade providing direct employment for over 100,000 vendors with gross annual sales volume of about 2 billion US dollars. Hiemstra et al. [10] also mentioned the significant contribution of microbusinesses made up largely of street food sector to the economy of Vietnam.

However, the sector is fraught with unwholesome activities which have been reported to pose serious concerns over the safety of the practitioners, especially the health of the consumers [11]. These unwholesome activities traversed the whole chain of street food business from agricultural raw materials

* Corresponding author at: Department of Bioresources Engineering, School of Engineering, College of Agriculture, Engineering and Science, University of KwaZulu-Natal, Private Bag X01, Pietermaritzburg, Scottsville 3209, South Africa. Tel.: +234 7036711250/+27 738948678.

E-mail address: bun5574@yahoo.com

Peer review under responsibility of Beijing Academy of Food Sciences.



Production and hosting by Elsevier

to the final retail street foods and have been fingered in the outbreak of diseases and illnesses [12]. The prevention, maintenance and treatment of diseases from street food borne illnesses were reported to result in heavy drain on the purse of individuals and governments in the developing countries due to huge spending involved [2]. The meager resources that could have been used for infrastructural development are being channeled to treatment of preventable diseases outbreak due to the unwholesome activities mentioned above. This review aims to provide exposition on the sources of risks of significant health importance to the consumers and safety of the practitioners along the chain of street foods reported in the literature and the safety intervention proposed. This could assist to provide holistic intervention baseline to safeguard the health and safety of all along the entire chain.

2. Risk factors

Several factors which predispose street foods to public health risks were mentioned in the literature. They were described as possible areas of control to improve on the safety of street foods [7]. The risks reported in the literature were classified into three major categories, namely: environmental, chemical and microbiological [13]. However, the risk concerns mostly expressed were majorly health and spoilage/microbial related [14,15]. The risk factors, also referred to as points of hazards, permeate the whole chain of street food business and are discussed below.

2.1. Agricultural practices

Growing world population is putting tremendous pressure on food production. The attendant effect is the increasing need to maximize available resources for improved farm yield to feed the growing population. Farmers use inorganic agrochemicals and organic manure to improve the yield of farm produce, prevent competition with weeds and maintain the quality by preventing infestation by insects and spoilage by microorganisms on the field and during storage. The use of these chemicals is well regulated in developed countries through the enactment and enforcement of acts and laws which control and limit their usage for agricultural practices. These laws are to prevent the residual effect of these chemicals on consumers [16]. However, opposite is the case in developing countries where farmers use excessive chemicals to achieve bumper yields. Farmers in developing countries often patronize easily synthesized, cheap and patent expired chemicals [17]. Residues from excessive chemical applications to boost farming operations have been reported in high concentrations in soils, livestock and aquatic animals [17,18]. Significant relationship has been established between residual chemical accumulation in the soil and uptake by crops during growth [19]. These chemicals are stored in the edible parts of crops, livestock and aquatic animals [17,20]. Scientific research has proven that the presence of the residual agro-chemicals in foods is detrimental to human health. The accumulation of foreign chemicals such as lead (Pb), arsenic (As), cadmium (Cd), copper (Cu) and mercury (Hg) in human system has been linked

to immune-suppression, hypersensitivity to chemical agents, breast cancer, reduced sperm count and infertility [21,22].

2.2. Sources and quality of raw foods and ingredients

Quest for profit maximization by the vendors or the need to make street foods affordable for the consumers make some vendors patronize cheap and unsafe ingredients that may be detrimental to the health of the consumers. Results of survey conducted by Omemu and Aderoju [23] showed that vendors of street foods in Nigeria considered the volume (94%) and the price (93%) than the freshness and cleanliness when buying raw foods to be cooked or vended. In the study conducted in India, Choudhury et al. [3] observed that procurement habits of food items by street vendors differ according to the size of the establishments and was significantly ($p < 0.05$) influenced by the type of vendors, ownership and average monthly income. The study reported that all the mobile vendors and owners of small restaurant procure unlabeled and unpacked food grains and semi-processed ingredients from grocery shops. While majority (87%) of owners of small restaurants procure labeled and packed condiments, dry fruits and spices from grocery, most (44%) of the mobile food vendors purchase condiments and spices, nuts and dry fruits from traditional weekly or daily markets with 37% of them prepared, dried and powdered their own ingredients at home. Close to 56% of mobile vendors used unlabeled and unpacked condiments and spices. Studies have shown that home-made cereal flour and condiments used in street foods preparations are contaminated with *Bacillus cereus* [14,24,25] which was reported to be responsible for outbreak of food borne illness [26]. Umoh and Odoba [14] reported that highest frequency of *B. cereus* observed for 'kunu', a fermented cereal product in West Africa was due to local spices and raw materials used as condiments in their survey of microbial quality of street foods sold in the street of Zaria, Nigeria.

Some street food vendors use leftover perishable raw materials for next day preparation without storage facility. Not a single small restaurant owners interviewed by Choudhury et al. [3] had refrigeration facility, whereas 20%, 93%, 97% and 30% of them stored left-over green vegetables, raw food materials, canned/bottled foods, and milk and milk products, respectively for more than 24 h.

Poisoned fish from chemically treated ponds [27], meat and milk from sick and old animals, use of substandard slaughter facility [28], and vegetables and crops with heavy chemical residues are often use for food preparation in some developing countries. These practices were encouraged by weak regulatory and inspection facilities in these countries [28]. Distance from slaughter facility, exorbitant user fees and inadequate security at the slaughter house which led to theft of meat were the major reasons given by the suppliers of meat for street food preparation in Ga District, Ghana for not using slaughter facility provided by the government [29].

Inadequate cooking of ingredients with heavy microbial loads could result in the survival of pathogens of significant health importance to the consumers [30]. In the four months survey of the microbiological loads of street vended fruit salads and

gravies in Johannesburg, South Africa, Kubheka et al. [31] reported high aerobic plate counts (APC) and spore counts in gravies despite the fact that they were generally cooked before consumption. However, the APC and spore counts were significantly lower than those from salad samples which are usually consumed uncooked. *Clostridium perfringens* was isolated in 3% of the salad samples. The report implicated tomatoes and onions, major ingredients for salads and gravies, as the major sources of contamination because they are grown close to the grounds and are expected to contain large numbers of vegetative bacteria and spores. Bryan et al. [32] reported high load of APC in street vended beans and chick peas in Dominican Republic and Pakistan. Mensah et al. [30] also reported high load of *Shigella sonnei* and pathogenic *Escherichia coli* in samples of salads, soups and sauces, and macaroni served with stew sold in the streets of Accra, Ghana. Aside tomato, which was the major ingredients in the stew for macaroni, water sources for watering of vegetables during growth and wetting to preserve the freshness before sales, and animal wastes, such as chicken droppings, used as manure were also considered to be responsible for the high fecal microbial load. Black et al. [33] also reported that 1.8% of soup and stew samples from the streets of Peru were contaminated with fecal bacteria.

Mycotoxins in the raw foods have been reported to survive food preparation stage [34]. Kpodo et al. [35] reported aflatoxin levels between 0.7 and 313 $\mu\text{g}/\text{kg}$ aflatoxin in fermented maize dough from two 'kenkey' production sites in Accra, Ghana during 18 months sampling period.

2.3. Food preparation, handling and vending

The temperatures employed in the cooking and frying operations during street food preparations are high enough to kill the vegetative cells, but the resistant spores of micro-organisms may survive [32]. However, the ways and manners street foods are being prepared, handled and vended predispose them to recontamination, cross contamination and transmission of pathogens and food borne illnesses. Most of the foods for street vending are usually prepared in bulk at different times ahead of retailing [14]. The long holding period of more than 6 h, sometimes at ambient temperature [11], were reported to be a common factor contributing to food borne illness through multiplication of microorganisms favored by holding temperature in the range of 5 and 60 °C (described as danger zone). Mosupye and von Holy [36] suggested that holding conditions which favored the survival and germination of *Bacillus* spores may be responsible for the high load of *Bacillus* spp. isolated in ready to eat street foods.

Method of transportation plays a significant role in the contamination of street foods. It has been reported that transportation and display of meats play significant role in the acceleration of their spoilage and transmission of zoonotic diseases [28]. The manner of moving slaughtered animal carcasses from slaughter points to retailing points in crude structures such as wooden push carts, open plastic or aluminum trays on heads or "off-road" vehicles increased the chances of cross contamination. Okoli et al. [28] reported that it is a common site in Nigeria

to see vehicles not design for meat transportation such as taxis and buses without cooling facilities and even motorcycles carrying meat products from slaughter points to the retailing points. Okoli et al. [28] continued that it is not uncommon to see butchers and retailers turning carcasses meat for human consumption into sitting or resting platforms in the vehicles during the cause of transportation.

Meats are retailed in the markets and streets of Africa in open wooden trays that are usually difficult to wash thoroughly thereby harboring niches for microorganisms' contamination of meats and deposition of airborne pollutants. Mosupye and von Holy [36] reported high aerobic plate and spore counts of 7.6 and 2.2 log cfu/g, respectively, in raw beef/chicken for retails in the streets of Johannesburg, South Africa. Some studies reported high loads of microorganisms in excess of recommended tolerable levels from some processed meats for street vending despite high temperature of processing. Bryan et al. [37] and Ekanem [2] reported high coliforms levels greater than 10^5 cfu/g in processed beef and chicken sold in the streets of Zambia and Nigeria, respectively. Lues et al. [15] attributed the high levels of microorganisms isolated from the processed meats to recontamination by the hands of the vendors, utensils and vending environment.

Non-regulation of time and holding temperature had been recognized as major risk factors in street foods that contribute to diseases outbreak [11]. Majority of the vendors in Abeokuta, Nigeria (90%) and Ozamiz city, Philippines (55%), prepared their products on the morning of sale [23,38], while most of the vendors in Kampala, Uganda cooked foods on the premises (75%) and well in advance of consumption (77%) [11]. Other risk factors identified in the preparation and handling of street foods include: the common use of stove charcoal for keeping and warming of food over a long period of time which may not provide adequate temperature enough to prevent proliferation of pathogenic microorganisms [15,37]; as reheating of food at temperature below 40 °C could increase salmonella contamination [39], overheating at higher temperature could lead to loss of essential nutrients and flavors in the food; holding of foods at ground level and incessant uncovering of foods for dispensing exposed street foods to dust contamination and flies which has been linked to food borne diseases such as cholera and diarrheal [40]. Mosupye and von Holy [36] observed that ready to eat foods could be left uncovered for up to 10 min at a time when vendors were serving customers. Umoh and Odoaba [14] reported that more than 13% of street foods surveyed in Zaria, Nigeria were contaminated with *S. aureus* of which 43.8% were haemolytic strains and 18% enterotoxigenic. The report identified post processing handling as the major cause of the contamination because the high temperature of processing and low water activity of most foods surveyed were enough to prevent proliferation of microorganisms and formation of toxins which are hazardous to human health.

The vending practices and facilities use for dispensing street foods were recognized in the literature as major contributors to the cross contamination of street foods. Bryan et al. [32] reported that major contamination of street foods occurred at vending sites as a result of cross contamination during cutting



Fig. 1. Street food consumption at a market place.

and chopping. Mosupye and von Holy [36] observed that raw meat and poultry as well as gravy and salad being sold by a vendor in Johannesburg, South Africa were cut and chopped with the same knife on the same surface without cleaning in-between. The study added that the same vendor chopped salad raw materials for food preparation with bare hands and even exchange knives with fellow vendors without in-between cleaning thereby increasing the chances of cross contamination.

Majority of street vendors, as reported in different studies, used non-disposable plates, cups and cutleries for serving foods [11,23,38]. These utensils were usually washed with soap solution and rinsed in cold water, while in some other instances washed with cold water and scouring towels. While some vendors changed the washing and rinsing liquids twice in a day, others used the same liquids unchanged for the whole day. These practices, observed by the authors, create favorable environment for recontamination of street vended foods. The use of same set of cutleries (not properly cleaned after each use by different consumers) led to cross contamination and transmission of infectious diseases among unsuspecting consumers [36]. Example of this practice is shown in Fig. 1.

A comparative study on the risks involved in the use of hands and cutleries to serve street foods in Ghana by Mensah et al. [30] showed that the use of bare hands to serve increased the level of contamination. The study recognized serving stage as a critical point in the street food industry. Enteropathogens, such as *Salmonella typhi* that can survive on human hands for more than three hours have been isolated in vendors' hands in Ghana [41]. Enterogenic *E. coli* of the type isolated in diarrhea cases were isolated in some women's hands in Thailand [42]. Serving of some street foods with bare hands is a common practice in most developing countries (Fig. 2).

Fermentation is an age-long food preservation technology the world over. Traditional fermentation technology is still being used in developing countries, especially Africa where refrigeration is not a readily available option. Despite the preservation advantage offer by the low pH of between 3.5 and 5.0 as a result of lactic acid bacteria (LAB) activities, the safety of street vended traditional fermented food products in Africa is still of serious concerns in view of the reported isolation of microor-

ganisms of public health importance from some fermented food products. Alimi et al. [4] reported isolation of pathogenic organisms from 'nunu' (fermented milk product) samples, while Olasupo et al. [43] isolated *S. aureus* and *Klebsiella* spp. from 'wara' (West African soft cheese), *E. coli*, *Salmonella* sp. and *Klebsiella* sp. from 'nunu', and *Bacillus subtilis*, *E. coli*, *S. aureus* and *Enterococcus faecalis* from 'ogi' and 'kunu' (cereal based fermented foods). The fact that traditional fermentation technology is still at rudimentary stage which does not give room to the control of the process coupled with the ways and manners the products are being vended in the streets further predisposed their consumers to serious health risks [44]. While some processors use residuals from previous batch as starters for the next batch of products which was recognized by Edelsten [45] to be partly responsible for the spread of pathogenic microorganisms in some traditionally fermented products, others leave the fermentation process to proceed spontaneously by the dictate of the environment [46]. Since the process is not controlled, Umoh and Odoaba [14] believed that the type and number of different strains, environmental conditions and pH would dictate whether fermenting or pathogenic microbes would prevail.

2.4. Vending environments

Studies have raised serious concerns on the dangerous abuse street foods are exposed to in the vending environments. Street food vendors usually target high human traffic areas for the display of their products to enhance sales. Street food vending is a common site in such areas as major street corners, industrial/construction sites, bus/train terminals, public places and school compounds [12]. The vending units are either mobile or stationary using open or protected crude structures such as push carts, display wooden tables, aluminum trays or bowls or chop bars [38]. Retailing of a street food along a major street in a developing country is shown in Fig. 2.



Fig. 2. Street food retailing on major street.

The environments under which street foods are being prepared, vended and consumed predisposed them to recontamination and cross contamination from environmental pollutants such as airborne chemicals in dusts, exhaust discharges from moving vehicles and industrial engines, burning fumes and offensive smell from accumulated waste and effluent from industrial discharge, insects and rodents [27,30]. Airborne diseases and microbes which may be pathogenic if allowed to settle on the prepared food surfaces abound in dust [11]. Bryan et al. [37] observed accumulation of large heaps of garbage around street food vending sites in Zambia which harbored insects and animal pests (known vectors of diseases). Littering was also reported to be a common practice at the vending sites in Uganda [11].

Since nearness to customers is the primary target of street food vendors, vending sites usually lack basic facilities such as toilets, hand washing facilities, potable water, good drainage and waste disposal system [47]. Where some of these facilities are provided, large concentration of vendors in human congested areas usually placed serious strain on them resulting in interference with city plans and adverse effects on daily life [11]. All these conditions enhance the incidence of food borne illnesses and transmission of diseases among vast consumers of street foods [2].

2.5. Hygiene practices

Several studies on hygienic practices of street food vending confirmed WHO [48] report that most street food vendors have knowledge of hygienic practices but concluded that majority of them do not put the knowledge into practice [11,15,23]. Although street vendors were reported to exhibit good personal cares, however, they were negligence to compliance with adequate hygiene practices at the preparation and vending sites. Inadequacy or near absence of basic facilities at the vending sites were mostly attributed for non-compliance with basic hygiene principles. In the study on the hygienic practices by street food vendors in Trinidad, West Indies, Benny-Olliviera and Badrie [49] reported that most of the vending sites observed did not have pipe borne water, 97.5% did not have drain to channel waste water and toilet facilities. The report was not different for street food vending sites in Kingston, Jamaica [50], Lima, Peru [51], Philippines [52] and Uganda [11]. Lack of toilet and lavatory facilities at the vending sites forced most street food hawkers to seek secluded areas within the vicinity like bushes and uncompleted buildings for excretion. Idowu and Rowland [47] reported that majority of the street food vendors studied in Abeokuta, Nigeria used dung hills and nearby bushes in place of toilets and clean up with sheets of paper.

Open bins were commonly used for garbage collection. However, Muyanja et al. [11] reported that 92.8% of vendors in Kampala, Ugandan used gunny bags for waste collection. Several studies reported that overflowing of garbage bins was a common site in most vending points while the final garbage disposals are usually far away from vending sites. Heaps of garbage around the vending sites could serve as breeding points for rodents, insects and flies which promote proliferation of

microorganisms and increase the risk of contamination of foods and transmission of diseases [14,30].

2.6. Knowledge and attitude of street food vendors to food safety practices

Majority of disease outbreaks related to street foods were linked to negligence of food handlers [53]. About 15 cases of foodborne disease outbreaks monitored in Zhapo, a coastal resort of Guangdong, China, from 2008 to 2011 were traced to the negligence of food vendors [54]. Researchers from different parts of developing world have made efforts to study the depth of food safety knowledge, disposition to food safety issues and practices of street food vendors [3,11,23,55,56]. Their reports identified education, food safety training, race and vending environment among the factors that affect knowledge and attitude of food vendors to food safety practices. Toh and Birchenough [56] established interdependence of knowledge and attitude of street food vendors to food safety practices with strong linear relationship ($r=0.000$, $p<0.01$). Though several authors reported that education and training enhanced hawkers knowledge and attitude to food safety practices [56–58], Choudoury et al. [3], however, reported that education had no significant impact on knowledge and attitude of vendors in Guwahati, Assam, India to food safety practices such as procurement of fresh foods, food adulteration and management of leftover foods. It was also reported by Liu et al. [55] that more than 66% of the vendors in Shijiazhuang, China that have basic food safety knowledge were still negligent of food safety practices.

Summary from different studies on the safety perception of street food vendors is that vendors are not completely ignorant of basic food safety practices. For examples, studies reported that most vendors knew that they must bath regularly and not attached bath to visible dirt or objectionable odor [23], washed their hands during food preparation, serving, after using the toilet, sneezing, coughing and handling contaminated materials like exchange of money [11], smoking is not good for their health and should not engage in it while serving foods [58]. However, the reality on the ground showed that all these were mere rhetoric and statements of the minds which were rarely put into actual practices by most vendors due to some factors [59]. Convenience and economic factors were the main reasons why most vendors were not implementing their knowledge of safety practices. Vendors in Malaysia regarded wearing of head covering, apron and glove as cumbersome and their regular removal as time wasting. They also preferred selling their products by the roadsides to designated places with adequate safety facilities because of better patronage which came with nearness to consumers [57]. In addition, all of the street food vendors interviewed by Lues et al. [15] in Bloemfontein, South Africa, confessed that they had prepared food for public consumption at some point while sick probably because their sustenance depended on daily returns from the trade. These attitudes greatly expose street food consumers to food borne illnesses which could lead to epidemic if not promptly controlled. An alarming 52.5% of consumers interviewed by Surujlal and Badrie [60] in Trinidad, West Indies had

experienced some form of perceived illnesses traceable to street food consumption.

2.7. Attitude of consumers to the hazards of street food

Consumers are the major risk bearers of the consequences of street food safety [7]. The attitude of consumers to safety of street food varied and is dependent on some socio-economic factors [4]. While some are cautious of where and how they purchase the street foods because of their knowledge of the hazards attached [7,61]; others are beclouded with the urgency to satisfy their culinary drive and enjoy the gustatory attributes attached to the street foods [4,62]. A typical scene of consumer preference for appetite satiety over vending environment is shown in Fig. 1.

Consumers' attitude and perception of hazards in street foods is often driven by their level of education, income, knowledge of food safety, age and gender. Literature reported varied effect of these factors on the attitude of consumers to safety of street food and their perception of hazards inherent in its consumption. For instance, while Alimi et al. [4] and Bekerroum [62] separately reported that education and income positively affected perception of consumers on the hazards of street foods in Nigeria and North Africa, respectively; reports of Liu et al. [55] and Samapundo et al. [63] were to the contrary for street food consumers in China and Haiti. Alimi et al. [4] had reported in their study that consumers with higher education were more conscious of possible health risks inherent in street food because of the information at their disposal while those with higher income would rather patronize regulated fast food outlets and supermarkets though expensive. Liu et al. [55], Samapundo et al. [63] and Asiegbu et al. [64] reported a surprising trend where barely literate consumers had higher food hazards consciousness than highly educated consumers in China, Haiti and South Africa, respectively. It could be inferred from these reports that higher level of education and income most often do not imply good food safety consciousness and habit. However, it was unanimously reported that young males within 20–35 years age bracket were the most negligent group to the hazards of street foods. Their occupations and lifestyles were cited as the major factors for this careless disposition [4,7,64].

Street food consumers in developing countries are generally more concerned about microbial hazards [7]. Pathogens of significant public health importance such as *Salmonella*, *S. aureus*, *Listeria monocytogenes*, *Campylobacter jejuni* and *E. coli* have been isolated in some street foods in developing countries [4,54]. Reports in literature show that consumers are aware that microorganisms especially bacteria are responsible for foodborne diseases but have very little knowledge about their pathogenesis. Knowledge of consumers on these microorganisms and their pathogenesis was diverse. Asiegbu et al. [64] reported that street food consumers in Johannesburg, South Africa were aware that certain microorganisms can cause diseases and even lead to death but knew very little about specific pathogens. Prior outbreak of foodborne diseases linked to bacteria that attracted extensive mass media coverage was cited as the reason for their awareness [65]. Samapundo et al. [63] also reported that over 80% of consumers interviewed in Port-au-

Prince, Haiti were not aware that *Salmonella* spp., hepatitis A virus and *S. aureus* are major pathogens responsible for food related diseases outbreak.

3. Recommended approaches to ensure safe street food practice

Street food vending is an important component of socio-economic activities in developing countries. Its significance is appreciated by the volume of trade involved, provision of ready-made meals and employment for the teeming populace along the chain of the business. The benefits and contribution of street food trade to the economy of developing countries elicited recommendations from researchers on ways to mitigate the hazards in its consumption and safeguard the health of consumers. Alimi et al. [4] recommended that safety approach to hazards of street foods should start from good agricultural practices and permeate the whole chain of the business. It was recognized that policies and regulations for safe street food trade are very weak and poorly enforced in most developing countries [55] and even non-existent in some countries [63]. Therefore, strengthening of the policies and proper enforcement would undoubtedly ensure significant reduction in the hazards of street food consumption [7]. These would involve active participation of all stakeholders in street food trade such as governments, street food vendors, consumers' associations, civil society groups and development partners. Raising the awareness on the treat of unwholesome practices in street food trading through dissemination of information in mass media and audience participatory programs was further recommended. Engagement of professionals in food and health related disciplines to draw-up guidelines for the management of street food practices, implementation of Hazard Analysis Critical Control Points concept along the entire chain of the business, education of vendors and consumers on hygiene and safe food practices were canvassed by Alimi et al. [4], Liu et al. [55], Badrie et al. [66] and WHO [53].

4. Conclusions

There is no doubt that street food trade is very important to the socio-economy of developing countries. However, informal nature of the trade gives room for unwholesome activities which could pose serious hazards to the health and safety of the practitioners along the chain. Several points of hazards also called risk factors were identified. The risk factors permeate the entire system and are mostly health and microbial/spoilage related. Proper management of the trade by all the stakeholders (farmers, vendors, consumers, governments, food and health professionals in academics and development partners) would ensure safe practices and engender safer and healthier society.

References

- [1] B.A. Alimi, T.A. Shittu, L.O. Sanni, Effect of hydrocolloids and egg content on sensory quality of coated fried yam chips, *J. Culin. Sci. Technol.* 12 (2014) 168–180.

- [2] E.O. Ekanem, The street food trade in Africa: safety and socio-environmental issues, *Food Control* 9 (1998) 211–215.
- [3] M. Choudhury, L. Mahanta, J. Goswami, M. Mazumder, B. Pegoo, Socio-economic profile and food safety knowledge and practice of street food vendors in the city of Guwahati, Assam, India, *Food Control* 22 (2011) 196–203.
- [4] B.A. Alimi, A.T. Oyeyinka, L.O. Olohungbebe, Socio-economic characteristics and willingness of consumers to pay for the safety of *fura de numu* in Ilorin, Nigeria, *Qual. Assur. Saf. Crops Foods* 8 (2016) 81–86.
- [5] I.O. Akinyele, Street foods and their contribution to the food security and nutritional status of Nigerians, *West Afr. J. Food Nutr.* 1 (1998) 6–20.
- [6] A. Draper, *Street Foods in Developing Countries: The Potential for Micronutrient Fortification*, John Snow, Incorporated, OMNI PROJECT, 1996.
- [7] B.A. Alimi, T.S. Workneh, Consumer awareness and willingness to pay for safety of street foods in developing countries: a review, *Int. J. Consum. Stud.* 40 (2016) 242–248.
- [8] T. Estrada-Garcia, J.F. Cerna, M.R. Thompson, C. Lopez-Saucedo, Faecal contamination and enterotoxigenic *Escherichia coli* in street-vended chilli sauces in Mexico and its public health relevance, *Epidemiol. Infect.* 129 (2002) 223–226.
- [9] R.J. Dawson, C. Canet, International activities in street foods, *Food Control* 2 (1991) 135–139.
- [10] A.M. Hiemstra, K.G. Van der Kooy, M. Frese, Entrepreneurship in the street food sector of Vietnam – assessment of psychological success and failure factors, *J. Small Bus. Man.* 44 (2006) 474–481.
- [11] C. Muanja, L. Nayiga, N. Brenda, G. Nasinyama, Practices, knowledge and risk factors of street food vendors in Uganda, *Food Control* 22 (2011) 1551–1558.
- [12] S.O. Akinbode, A.O. Dipeolu, P.A. Okuneye, Willingness to pay for street food safety in Ogun State, Nigeria, *J. Agric. Food Inf.* 12 (2011) 154–166.
- [13] M. Abdussalam, F.K. Käferstein, Safety of streets foods, *World Health Forum* 14 (1993) 191–194.
- [14] V.J. Umoh, M.B. Odoba, Safety and quality evaluation of street foods sold in Zaria, Nigeria, *Food Control* 10 (1999) 9–14.
- [15] J.F. Lues, M.R. Rasephei, P. Venter, M.M. Theron, Assessing food safety and associated food handling practices in street food vending, *Int. J. Environ. Health Res.* 16 (2006) 319–328.
- [16] C.A. Harris, The regulation of pesticides in Europe – Directive 91/414, *J. Environ. Monit.* 4 (2002) 28–31.
- [17] F.P. Carvalho, Agriculture, pesticides, food security and food safety, *Environ. Sci. Policy* 9 (2006) 685–692.
- [18] M.D. Taylor, S.J. Klaine, F.P. Carvalho, D. Barcelo, J. Everaarts (Eds.), *Pesticide Residues in Coastal Tropical Ecosystems: Distribution, Fate and Effects*, CRC Press, 2003.
- [19] Z.Y. Huang, T. Chen, J. Yu, D.P. Qin, L. Chen, Lead contamination and its potential sources in vegetables and soils of Fujian, China, *Environ. Geochem. Health* 34 (2012) 55–65.
- [20] G. Wang, M.Y. Su, Y.H. Chen, F.F. Lin, D. Luo, S.F. Gao, Transfer characteristics of cadmium and lead from soil to the edible parts of six vegetable species in southeastern China, *Environ. Pollut.* 144 (2006) 127–135.
- [21] N.D. Uri, A note on the development and use of pesticides, *Sci. Total Environ.* 204 (1997) 57–74.
- [22] M. Sharpe, Towards sustainable pesticides, *J. Environ. Monit.* 1 (1999) 33–36.
- [23] A.M. Omemu, S.T. Aderoju, Food safety knowledge and practices of street food vendors in the city of Abeokuta, Nigeria, *Food Control* 19 (2008) 396–402.
- [24] C.O. Obuekwe, A.O. Ogbimi, Prevalence of *Bacillus cereus* and some other Gram-positive bacteria in Nigerian dried food condiments, *Niger. Food J.* 7 (1989) 11–19.
- [25] I.Z. Yusuf, V.J. Umoh, A.A. Ahmad, Occurrence and survival of enterotoxigenic *Bacillus cereus* in some Nigerian flour-based foods, *Food Control* 3 (1992) 1491–1552.
- [26] R.J. Gilbert, *Bacillus cereus* Gastroenteritis. Foodborne Infections and Intoxications, Academic Press, New York, 1979, pp. 495–518.
- [27] I. Proietti, C. Frazzoli, A. Mantovani, Identification and management of toxicological hazards of street foods in developing countries, *Food Chem. Toxicol.* 63 (2014) 143–152.
- [28] I.C. Okoli, N.O. Aladi, E.B. Etuk, M.N. Opara, G.A. Anyanwu, N.J. Okeudo, Current facts about the animal food products safety situation in Nigeria, *Ecol. Food Nutr.* 44 (2005) 359–373.
- [29] L.K. King, B. Awumbila, E.A. Canacoo, S. Oforu-Amaah, An assessment of the safety of street foods in the Ga district, of Ghana; implications for the spread of zoonoses, *Acta Trop.* 76 (2000) 39–43.
- [30] P. Mensah, D. Yeboah-Manu, K. Owusu-Darko, A. Ablordey, Street foods in Accra, Ghana: how safe are they? *Bull. World Health Org.* 80 (2002) 546–554.
- [31] L.C. Kubheka, F.M. Mosupye, A. von Holy, Microbiological survey of street-vended salad and gravy in Johannesburg city, South Africa, *Food Control* 12 (2001) 127–131.
- [32] F.L. Bryan, S.C. Michanie, P. Alvarez, A. Paniagua, Critical control points of street-vended foods in the Dominican Republic, *J. Food Prot.* 51 (1988) 373–383.
- [33] R.E. Black, G. Lopez de Romana, K.H. Brown, N. Bravo, O.G. Bazalar, H.C. Kanashiro, Incidence and etiology of infantile diarrhea and major routes of transmission in Huascar, Peru, *Am. J. Epidemiol.* 129 (1989) 785–799.
- [34] W.K. Amoa-Awua, P. Ngunjiri, J. Anlobe, K. Kpodo, M. Halm, A.E. Hayford, M. Jakobsen, The effect of applying GMP and HACCP to traditional food processing at a semi-commercial kenkey production plant in Ghana, *Food Control* 18 (2007) 1449–1457.
- [35] K. Kpodo, A.K. Sørensen, M. Jakobsen, The occurrence of mycotoxins in fermented maize products, *Food Chem.* 56 (1996) 147–153.
- [36] F.M. Mosupye, A. von Holy, Microbiological hazard identification and exposure assessment of street food vending in Johannesburg, South Africa, *Int. J. Food Microbiol.* 61 (2000) 137–145.
- [37] F.L. Bryan, M. Jermini, R. Schmitt, E.N. Chilufya, M. Michael, A. Matoba, E. Mfume, H. Chibiya, Hazards associated with holding and reheating foods at vending sites in a small town in Zambia, *J. Food Prot.* 60 (1997) 391–398.
- [38] N.D. Canini, J.J.O. Bala, E.N. Maragiot, B.C.B. Mediana, Evaluation of street food vending in Ozamiz city, J. Multidiscip. Stud. 1 (2013) 104–124.
- [39] E. Cardinale, J.D. Perrier Gros-Claude, K. Rivoal, V. Rose, F. Tall, G.C. Mead, G. Salvat, Epidemiological analysis of *Salmonella enterica* ssp. *enterica* serovars Hadar, Brancaster and Enteritidis from humans and broiler chickens in Senegal using pulsed-field gel electrophoresis and antibiotic susceptibility, *J. Appl. Microbiol.* 99 (2005) 968–977.
- [40] K. Sukontason, M. Bunchoo, B. Khantawa, S. Piangjai, W. Choochote, *Musca domestica* as a mechanical carrier of bacteria in Chiang Mai, north Thailand, *J. Vector Ecol.* 25 (2000) 114–117.
- [41] P. Mensah, K. Owusu-Darko, D. Yeboah-Manu, A. Ablordey, F.K. Nkrumah, H. Kamiya, The role of street food vendors in the transmission of enteric pathogens in Accra, Ghana *Med. J.* 33 (1999) 19–29.
- [42] P. Echeverria, D.N. Taylor, J. Seriwatana, U. Leksomboon, W. Chaicumpa, C. Tirapat, B. Rowe, Potential sources of enterotoxigenic *Escherichia coli* in homes of children with diarrhoea in Thailand, *Bull. World Health Org.* 65 (1987) 207–215.
- [43] N.A. Olasupo, S.I. Smith, K.A. Akinsinde, Examination of the microbial status of selected indigenous fermented foods in Nigeria, *J. Food Saf.* 22 (2002) 85–93.
- [44] S. Sefa-Dedeh, Traditional Food Technology. Encyclopaedia of Food Science, Food Technology and Nutrition, Academic Press, London, 1993, pp. 4600–4606.
- [45] R.M. Edelsten, Tuberculosis in cattle in Africa – control measures and implications for human health, in: R. Lindberg (Ed.), *Veterinary Medicine – Impacts on Human Health and Nutrition in Africa*, SIPATH, Addis Ababa, 1996, pp. 23–31.
- [46] V. Owusu-Kwarteng, F. Akabanda, D.S. Nielsen, K. Tano-Debrah, R.L. Glover, L. Jespersen, Identification of lactic acid bacteria isolated during traditional *fura* processing in Ghana, *Food Microbiol.* 32 (2012) 72–78.
- [47] O.A. Idowu, S.A. Rowland, Oral fecal parasites and personal hygiene of food handlers in Abeokuta, Nigeria, *Afr. Health Sci.* 6 (2006) 160–164.

- [48] WHO, WHO Technical Report Series, No. 705, 1984 (The Role of Food Safety in Health and Development): Report of a Joint FAO/WHO Expert Committee on Food Safety, 1984.
- [49] C. Benny-Olliviera, N. Badrie, Hygienic practices by vendors of the street food doubles and public perception of vending practices in Trinidad, West Indies, *J. Food Saf.* 27 (2007) 66–81.
- [50] D. Powell, E. Brodber, E. Wint, V. Campbell, Street Foods of Kingston, Institute of Social and Economic Research, University of the West Indies, Kingston, Jamaica, 1990, pp. 1–15.
- [51] R.V. Bhat, K. Waghay, Street foods in Latin America, in: A.P. Simopoulos, R.V. Bhat (Eds.), *Street Foods, World Review of Nutrition and Dietetics*, vol. 86, Karger, Basel, Switzerland, 2000, pp. 123–137.
- [52] M.P.V. Azanza, C.F. Gatchalian, M.P. Ortega, Food safety knowledge and practices of street food vendors in a Philippines university campus, *Int. J. Food Sci. Nutr.* 51 (2000) 235–246.
- [53] WHO, Global Surveillance of Foodborne Disease: Developing a Strategy and Its Interaction With Risk Analysis. Report of a WHO Consultation, WHO, Geneva, Switzerland, 2002, pp. 26–29.
- [54] S. Liu, Z. Liu, H. Zhang, L. Lu, J. Lingling, J. Liang, Q. Huang, Knowledge, attitude and practices of food safety amongst food handlers in the coastal resort of Guangdong, China, *Food Control* 47 (2015) 457–461.
- [55] Z. Liu, G. Zhang, X. Zhang, Urban street foods in Shijiazhuang city, China: current status, safety practices and risk mitigating strategies, *Food Control* 41 (2014) 212–218.
- [56] P.S. Toh, A. Birchenough, Food safety knowledge and attitudes: culture and environment impact on hawkers in Malaysia: knowledge and attitudes are key attributes of concern in hawker foodhandling practices and outbreaks of food poisoning and their prevention, *Food Control* 11 (2000) 447–452.
- [57] F. Pang, S.P. Toh, Hawker food industry: food safety/public health strategies in Malaysia, *Nutr. Food Sci.* 38 (2008) 41–51.
- [58] A.H. Subratty, P. Beeharry, M. Chan Sun, A survey of hygiene practices among food vendors in rural areas in Mauritius, *Nutr. Food Sci.* 34 (2004) 203–205.
- [59] T. Rheinländer, M. Olsen, J.A. Bakang, H. Takyi, F. Konradsen, H. Samuelsen, Keeping up appearances: perceptions of street food safety in urban Kumasi, Ghana, *J. Urban Health* 85 (2008) 952–964.
- [60] M. Surujlal, N. Badrie, Household consumer food safety study in Trinidad, West Indies, *Internet J. Food Saf.* 3 (2003) 8–14 www.internetjfs.org/articles/ijfsv3.3pdf (accessed 03.02.15).
- [61] I. Adam, S.E. Hiamey, E.A. Afenyo, Students' food safety concerns and choice of eating place in Ghana, *Food Control* 43 (2014) 135–141.
- [62] N. Benkerroum, Traditional fermented foods of North African countries: technology and food safety challenges with regard to microbiological risks, *Compr. Rev. Food Sci. Food Saf.* 12 (2013) 54–89.
- [63] S. Samapundo, R. Climat, R. Khaferi, F. Devlieghere, Food safety knowledge, attitudes and practices of street food vendors and consumers in Port-au-Prince, Haiti, *Food Control* 50 (2015) 457–466.
- [64] C.V. Asiegbu, S.L. Lebelo, F.T. Tabit, The food safety knowledge and microbial hazards awareness of consumers of ready-to-eat street-vended food, *Food Control* 60 (2016) 422–429.
- [65] A.J. Niehaus, T. Apalata, Y.M. Coovadia, A.M. Smith, P. Moodley, An outbreak of foodborne salmonellosis in rural KwaZulu-Natal, South Africa, *Foodborne Pathog. Dis.* 8 (2011) 693–697.
- [66] N. Badrie, A. Gobin, S. Dookeran, R. Duncan, Consumer awareness and perception to food safety hazards in Trinidad, West Indies, *Food Control* 17 (2006) 370–377.