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Street-Vended Foods Improvement: Contamination Mechanisms and Application of Food Safety Objective Strategy : Critical Review

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Abstract: Data collected from street-vended food enterprises and on vendors in west African countries revealed that, they provide a variety of ready-to-eat foods to a high proportion of the populations. Nevertheless, their handling and trading practices are not permit to obtain safe food. While, street-vended foods are easily contaminated by food borne pathogen and others chemicals compounds. The street-vended foods contamination mechanisms were identified and improvement pathways were suggested. Indeed, Food Safety Objective (FSO) concept developed by FAO and WHO, can be used as ideal strategy for safe street food production. However, to reach this goal, the Critical Control Points (CCP), Microbiological and Risks Assessment (MRA), and hygienic status during street food production and sale were gathered. By assembling and analyzing the data, the safety assurance for safe street food obtaining was evaluated at every step of production chain. The data were juxtaposed to FSO concept frame work and applied along the street-vended food production chain. We applied Performance Objective (PO) and Control Measure (CM) respectively at operational levels, measure at relevant points of risk and points, that permit reduction of all contamination risks along the chain, to enhancing safe food obtaining. The FSO concept could help government to elaborate guidance for street foods production, vending and consumption, producers and vendors, training about HACCP pre-requisites and information for global view on safe street-vended food (SSF) production. This will be an important task for the primary health care system aiming at "health for all".

Key words: Contaminants, safe street-vended food, improvement, food safety objective

Introduction

Food borne illness of microbial origin are a major international health problem associated to food safety and an important cause of death in developing countries (Rehydration Project, 2004; WHO, 2002a; 2002b). The problems of food safety in the developed countries differ considerably from those of developing countries. Whereas, in developing countries traditional methods of processing and packaging, improper holding temperature, poor personal hygiene of food handlers are still observed during food marketing and technology (Barro *et al*., 2002a; 2002b, Collins, 1997; Mensah *et al*., 2002). These observations refer to street-vended foods. The street food industry plays an important role in developing countries (Canet and N'Diaye, 1996; Ohiokpehai, 2003; Muinde and Kuria, 2005; Mwangi *et al*., 2002; van't Riet *et al*., 2003). They feed millions of people daily with a wide variety of ready-to-eat foods and beverages sold and sometimes prepared in the streets or public places, relatively cheap and easily accessible (Mensah *et al*., 2002; Barro *et al*., 2002b; FAO, 1989). The consumers who depend on such food are more interested in its convenience than in question of its safety, quality and hygiene (Barro *et al*., 2002b; Collins, 1997; Mensah *et al*., 2002).

According to street foods studies carried out in Africa, their tremendous unlimited and unregulated growth have placed a severe strain on city resources, such as water, sewage system and interferences with the city plan through congestion and littering adversely affecting daily life (Barro *et al*., 2002a; Canet and N'Diaye, 1996). FAO and several authors stipulated that street-vended food raise concerns with respect to their potential for serious food poisoning outbreak (Estrada-Garcia et *al*., 2002; 2004; Collins, 1997; King *et al*., 2000; Tjoa *et al*., 1977; Umoh *et al*., 1984), due to improper use of additives, the presence of pathogen bacteria, environmental contaminants and improper food handling practices based on unrespect of good manufacturing practices (GMPs) and good hygiene practices (GHPs) (Barro *et al*., 2002b; Canet and N'Diaye, 1996). Vendors are often poor level education,

unlicensed, untrained in food hygiene, technology and work under crude unsanitary conditions (Barro *et al.*, 2002a; 2006a; Muinde and Kuria, 2005). The hygienic aspects of street food processing and vending operations are a major source of concerns for food control. Street food safety management need a Hazard Analysis Critical Control Points (HACCP) and the pre-requisite system as good manufacturing practices (GMP) and good hygiene practices (GHPs) to instil professional face to street food operators (Bryan *et al.*, 1988; 1992). *Codex Alimentarius* Commission (CAC, 2004) formulated a concept of Food Safety Objective (FSO) argued by Gorris (2005) applicable to all food facilities for production of safe food. An attempt was made to apply this strategy to street food industry. The present paper aimed to determine the major problems that militating against the production of delivery of Safe Street Foods (SSF) and how to apply FSO for preventive measures, improving the sector and the products.

Organization of street-vended food enterprises, CCP and HACCP pre-requisites violations observed along production chain: Various safety assurance measures are implemented in throughout the food production chain to prevent street-vended foods from being contaminated with bacteria and viruses. The data that are generated from the implementation of these measures are dispersed and heterogeneous. While data were collected from street food enterprises in eleven towns belonging to ten west African countries (Burkina Faso, Mali, Cote d'Ivoire, Ghana, Guinea, Benin Niger, Nigeria, Senegal and Togo). It was identified eight main steps in street-vended foods general production chain. Street food enterprises tend to be satisfied with what they have achieved. Fig. 1 reports current hazards, CCP and Good Practices (GPs) violations observed at the main steps along the street food production chain. The others violations specific to one's steps are also described in Fig. 1. However, violations of these aspects means presence in food production chain, a risk that leads to direct or indirect contamination of food: the hazards of significance depend of the nature of the food, its intended use and production step. Steps 1, 3, 5, 6 and 7 are most important during uncooked foods processing and for cooked foods, steps 5, 6 and 7 are the main critical control points. Many small-scale food enterprises like street food industries, operates under a simple organizational structure, consisting of the manager-owner assisted by a few workers, who do not know modern techniques of management, including book-keeping and maintaining proper records. Street foods are processed generally by traditional methods of beverages and snack foods production. A poor manufacturing practices and personal hygiene of food handlers, a lacks of good-quality raw foodstuffs materials vegetables for processing are the main characteristics.

Holding cooked and uncooked foods at ambient temperature for 6 h or longer without any appropriate holding temperature (reheating in case of cooked food), constitute a major critical control point of street-vending (cook/hold) operations surveyed. In addition cooked foods were subjected to cross-contamination and contamination from various sources such as utensils, knives raw foodstuffs, flies that sporadically landing on the foods, by vendors bare hand serving and occasional food handling by consumers. Street food producers and vendors neglect food safety practices providing to population unsafe foods.

Street-vended foods contamination mechanism pathways: Hazards analysis consisted of existing microbiological assessment data processing, observing foods preparation, vending, serving and storage practices to identify sources and mode of contamination. The risk characterization and assessment, were carried out according to Lammerding, 1997; McKone, 1996, methodology. Their potential impact on the consumers were assessed and described as recommended by Vose, 1998; Marks *et al.*, 1998. We also took the principles of Risk Assessment as describe by *Codex Alimentarius* Commission (CAC, 2004), the FAO/WHO (FAO/WHO, 1997); Gorris (2005) and Woteki *et al.*, (2001). Diagram was built according street food process and risk points, as describe by Marks *et al.* (1998), Cassin *et al.* (1998) to determine the level of exposure of street foods to the hazards. In other, data on different vectors of street food contamination, were analyzed by using the interaction criterion to establish diagram of contamination complete routes from the raw foodstuffs, materials, transport, processing and storage to consumption. It allows to estimate the various levels of the hazard in various situations / circonstances. Fig. 2 shows the causes, routes and vectors of various contaminations of street-vended foods. Four main vectors can be distinguished. The first vectors include insects and animals, the second is constituted by environmental conditions (weather, dust, rains, winds, urbanization), the third vectors include peoples which acting in street food areas (government and his specific services low actions, hygiene controllers producers, growers, transporters, consumers and vendors). Finally, the last vectors is represented by natural contaminants as toxins contain in some raw foodstuffs and seafoods. The street-vended food improvement for sustainable quality are need the management at the level of these different vectors.

Several studies on street foods was done, but none report clearly an complete representative diagram of contamination mechanisms. In addition, early studies on improvement were targeted a specific street food. Ours finds are the first complete study identifying step by

step the mains problems discrediting street food as well, propose an improving through a global view of safe food production by using international concepts. Interestingly, in light of the attention, street food safety has received in media in recent years, consecutive to apparison of many diarrhoeal diseases as Cholera, Enterobacteriosis and Enterovirosis (Cardinale *et al.*, 2005; Estrada-Garcia *et al.*, 2004; Kuzuya *et al.*, 2003). Women in west Africa and other parts of the world are involved in a wide variety of food-processing activities. In the street food processing and vending activities there was a high illiteracy rate among women (Barro *et al.*, 2002a; Mensah *et al.*, 2002; Canet and N'Diaye, 1996; FAO, 1989). Action along educational line appeared as appropriate strategy to reach ALOP and it can be expected to improved the safety of street foods and thereby to heighten consumer protection (Abdussalam and Kaferstein, 1993).

The urbanization of west Africa towns and the associated dietary lifestyles, social and structural changes have caused and increased demand for street foods (Canet and N'Diaye, 1996). In the context of poverty, street food accounts for a part of the family income, daily diet and so contributes towards meeting nutritional requirements (Chakravarty and Canet, 1996; van't Riet *et al.*, 2003). This contemporary way of food consumption acts as impacting factor on food safety (Fig. 2). It is agreed that today, consumers are "time poor" and time spent preparing food is not considered quality time. Kurth (2000) reported that the two main issues that arose out were convenience and health. However, consumers could be a great of vendors behavior change the must exigi a right to basic good services which ensure quality of life: adequate food, clothing, shelter, health care, education and sanitation. Following the example of most developing countries urbanization, in west Africa generates many concerns as the difficult access to potable water, presence of different waste everywhere, lack of efficient drainage system. Indeed in most countries organic wastes and sewages are discarded on street. This healthiness provide harborage for insects and others animals and promote microorganisms growth. Under cover of flies, rain, wind wastes are dispersed and can be transported to uncover street-vended foods and cause the physical and microbiological contaminations. Considering the number of daily consumers of street foods, the number of diseased people will be important in case of consumption of contaminated foods. Thus, street food importance has consequence such as is association to epidemic and diseases outbreak in case of microbiological quality failure (Barro et *al.*, 2005; Cardinale et *al.*, 2005; Estrada-Garcia et *al.*, 2004; WHO, 2002b).

Many small-scale food enterprises operate as backyard industries located the owner's house, near the wastes, sewages, under trees without any sanitary system. They need better premises with a proper drainage and sewage system. The lack of appropriate site constitute a risk for food contamination. Small-scale food enterprises operators with an elementary school education are less receptive to new technologies compared to their counterparts who have a college education. This has made it difficult to transfer new technology to improve productivity and quality. Food stalls often lack the necessary storage, refrigeration and cooking facilities to prevent contamination with bacteria such as *Salmonella spp*, *E. coli*, which in warm, moist conditions, can duplicate into many disease-bearing organisms. A limited access to running water and waste disposal increases the potential for passing the problem on to many customers through street foods.

Safe Street Food production by application of FSO strategy: To perform a better understanding of the microbiological and hygienic problems associated to street-vended foods, hazard analyses and risks assessment data collected, were processed using FSO approach. By assembling and analyzing the data systematically, the safety assurance level can be evaluated at every step of the street-vended food production chain. This method allows the detection of strengths and weaknesses of the street food current safety system used. According to the risk assessors methodology (CAC, 2004; Lammerding, 1997; McKone, 1996; Reij and Van Schothorst, 2000) and in the Food Safety Objectives frameworks (Gorris, 2005; CAC, 2004; Woteki *et al.*, 2001). The data were processed to identify possible application points of HACCP pre-requisites as Performance objectives (PO) and control measure (CM) as describe by Gorris (2005), *Codex Alimentarius* (CAC, 2004), ILSI (ILSI, 2004) and ICMSF (2002). Fig. 3 shows how to apply FSO concept step by step during street-vended foods processing and exposure/vending. To reach this goal, street food production chain eight steps were considered including primary production step to serving step. At each steps advised good practices recommended by FAO/WHO (WHO, 2002a), CAC are indicated as well as HACCP pre-requisites. Fig. 3 also indicates sequential intervention of good practices, in accordance with quality assurance guidelines including HACCP and risk analysis to ensure safe street food (SSF). However, SSF obtaining through FSO concept need also Performance Objective and Control measure concepts. Their application points are located at steps 1, 4, 5, 6, 7 and 8. The street food safety actors responsible, for assistance to this sector by controlling the specific hazards, unhygienic aspects, risk possibly associated, need more guidance from food safety workers. To that end, within the Risk Analysis framework, vectors of contamination routes and setting the generic existing concepts as GAPs, GMPs, GHPs,

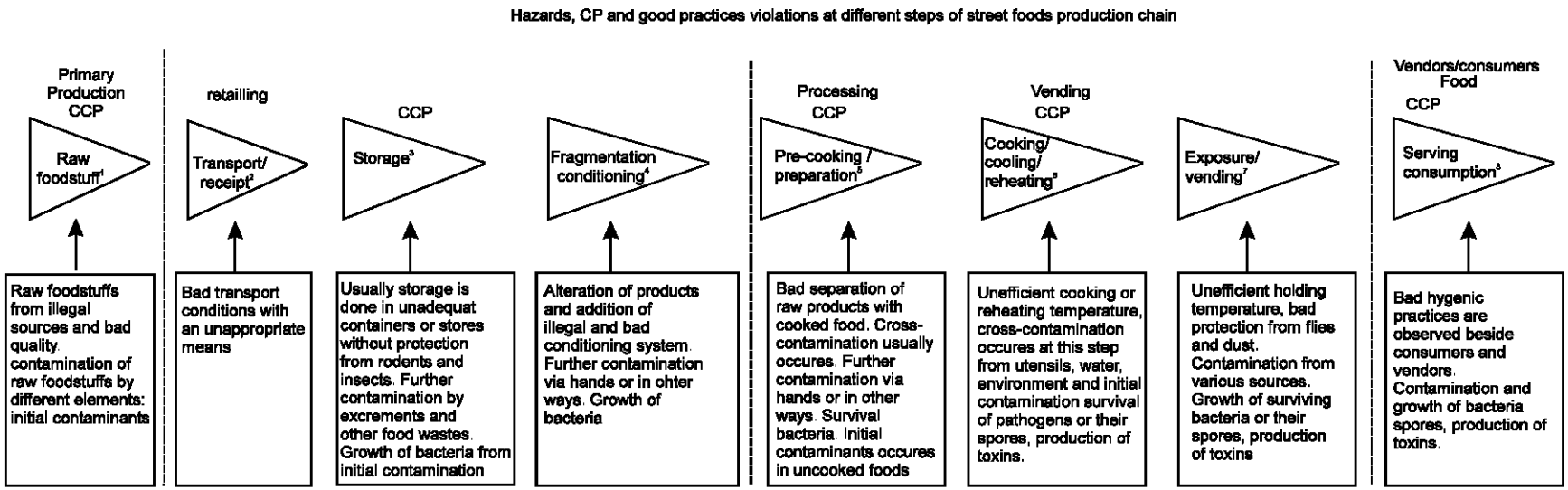

Fig. 1: Identification and description of Hazards, CP and Good Practices violations at different steps of street food production chain in reference to Advised Good Practices recommended by FAO /WHO along the street food chain of production. 1, 2, 3, 4, 5, 6, 7 and 8, indicate different steps in street food production chain. CCP = Critical Control Points

HACCP along the food chain of production, it was applied that when deemed appropriate, call Food Safety Objective (FSO) for street food safety and quality enhancing as detailed in Fig. 3.

Enforcement of the law banning street vendors, didn't work in the past and will not reach the core of problem, which is the lack of understanding of hazards and safe practices. A lack of knowledge of definition and causes of diarrhoea were important risk factors (Mensah *et al.*, 2002). The remedy is education: education of street food producers, vendors, food service personnel and education of public who either purchase street-vended foods. This constitutes a basic Performance Objective at the level of food operators, for enhancing street-vended food quality. Microbiological hazards and their solution, food processing and preparation technology, critical points, practical control measures and monitoring procedures (WHO/ICMSF, 1982) as well as the principles of food microbiology and food safety need to be incorporated into training programs for safe street food preparation. All these data should be sough and used to give direction for Food Safety Objective approach application to street food enterprises.

Several authors report, increasing in mesophilic aerobic bacteria when the duration of holding was prolonged, indicating microbiological deterioration of food (Bryan *et al.*, 1988; Bryan, 1978; El-Scherbeeny *et al.*, 1985). Cooked foods were subjected to cross contamination and contamination from varous sources (Fig. 2). The outbreak itself, is always associated with the initial contamination of a ready-to-eat food such as street-vended foods and re-contamination by inappropriate handling after cooking, consequently, in most cases , the street-vended food is subject to inadequate refrigeration during an excessive shelf-life. The responsibility of the food industry and the consumer is clearly engaged during this scenario of food borne diseases. The question is how to avoid the introduction of the contaminants in the food chain ? If a ready-to-eat, potentially hazardous food is improperly held or cooled, the potential for spore or toxin-forming bacteria growth increases. Some bacteria form spores that survive can germinate and grow if food is improperly held after cooking. Reheating is a "magic step" for eliminating hazards resulting from improper holding (Bryan *et al.*, 1988; 1992; Mensah *et al.*, 2002; Mosupye and van Holy, 2000; WHO, 1992). Reheating at 75°C for 15 seconds in important action to ensure the food's safety. Some risk factors or contamination routes might not have been directly linked to food preparation. The containers in which the food was served

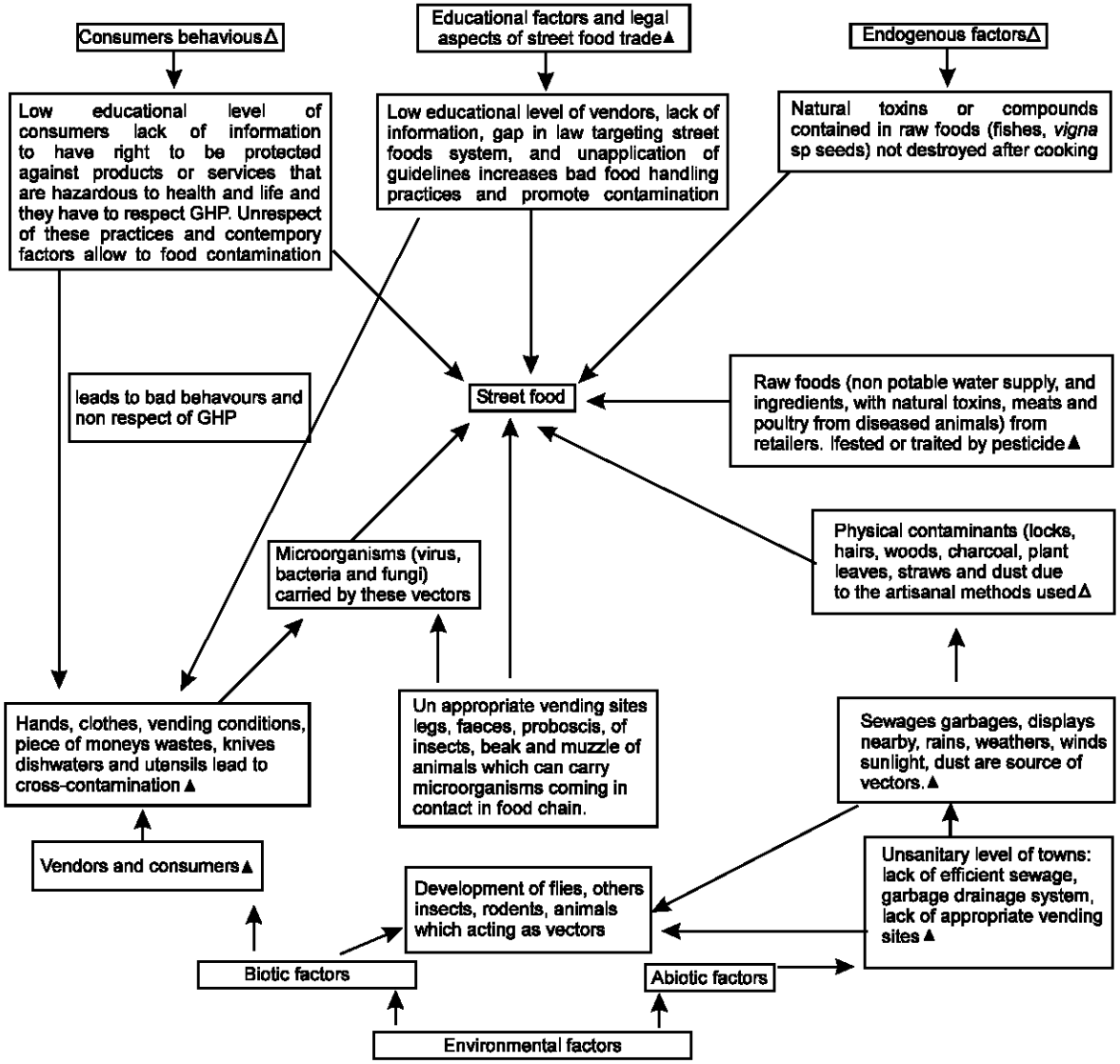

Fig. 2: Mechanism of street-vended foods microbiological and physical contamination vectors and their routes diagram. Arrows indicated contamination routes, dotted arrows indicate indirect routes. (▲) major factors and (Δ) minor factors of contamination

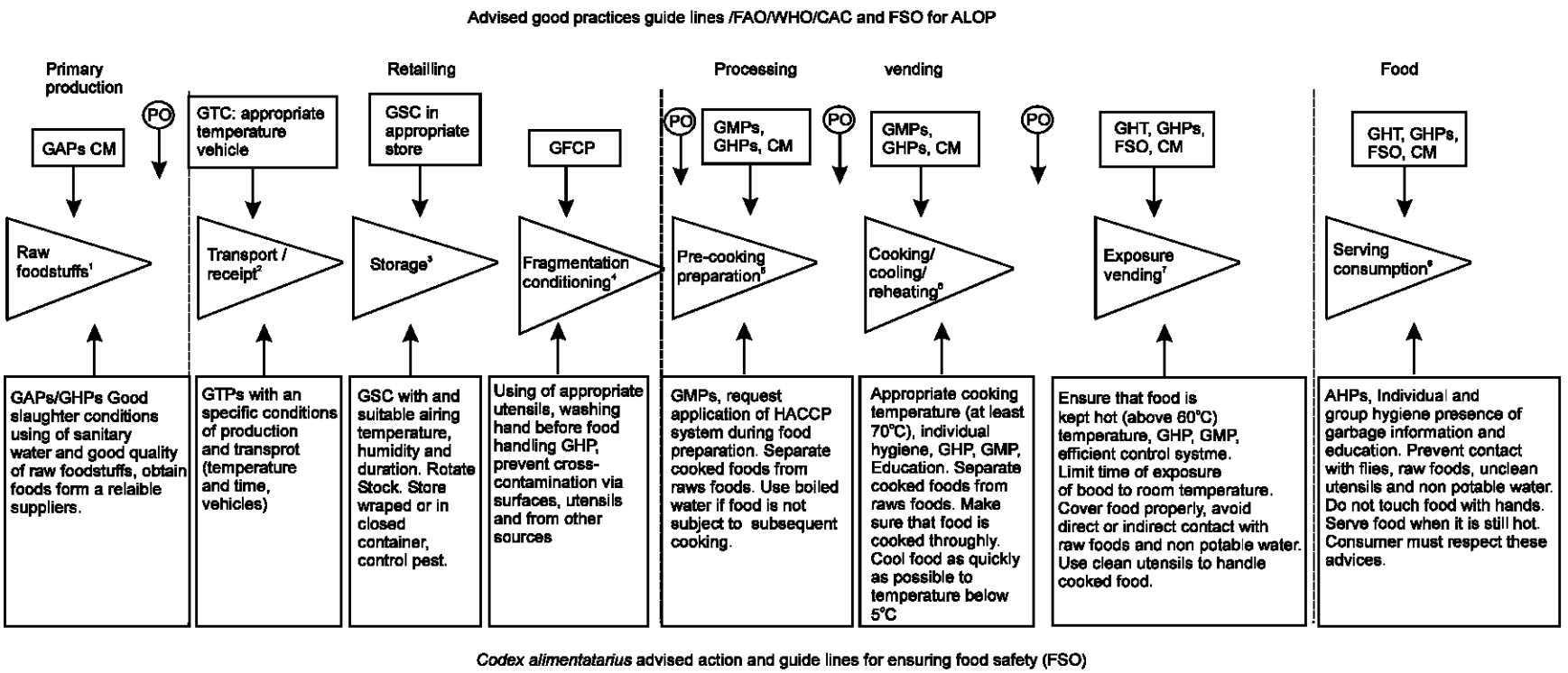

Fig. 3: Diagram of FSO concept and FAO (*Codex alimentarius* Commission) guidelines application for safe street foods guidelines. GAP= Good Agricultural Practices. GHP= Good Hygiene Practices, GMPs = Good Manufacture Practices, GSC = Good Storage Conditions; AHT = Appropriate Holding Temperature; GTC = Good Transport Conditions; GFCP = Good Fragmentation and Conditioning Procedure; GCC = Good Comportment of Consumers, ALOP = Appropriate Level of Protection, SSF = Safe Street Food, PO = Performance Objective, CM = Control Measure; 1, 2, 3, 4, 5 , 6, 7 and 8 indicate different steps in street food production chain.

are also important and the use of non-adequate wrapping paper and leaves increased the risk of contamination. The paper used for holding food was usually newsprint of questionable origin. Leaves were wiped with a piece of cloth and there was no disinfection (Mensah *et al.*, 2002). In this connection it should be noted that the handling of food at ground level may lead to the contamination because dust could easily be blown on food thus handled. Pathogens can be passed mechanically by flies which are carried various microorganisms (Barro *et al.*, 2006b; Khalil *et al.*, 1994; Sulaiman *et al.*, 2000; Sukontason *et al.*, 2000). There is a real risk of contamination associated with exposure of street foods.

Viruses are somewhat resistant to heat and given their low infectious dose may not be reduced to safe levels using the reheating parameters in the Food Code. Several studies gave information on bacterial assessment, street food contamination risk factors or associated illness, while few data reports implication of viruses in street food contamination and associated diseases. Viruses can contaminated during processing and caused diarrhoeal diseases, toxi-infection as bacteria (Allwood *et al.*, 2004; Barro *et al.*, 2005; Borchardt *et al.*, 2003; Nicand *et al.*, 1998). Enteroviruses detection must be incorporated

in food microbiological risk assessment.

The natural toxins or antinutritional factors occurring in some raw foodstuffs can passed to food with is virulence during unappropriated culinary methods. In west African street food system, some food as "Benga" cooked seeds of *Vigna uniguiculata* "Souma" cooked seeds of *Voandzeia subterranea* (Nana *et al*., 2000), some cereal (*Penisetum sp*.) product as "Gapal", uncooked tubers of sweet potato (*Ipomea batatas*) and cassava (*Manihot esculentus*) contains antinutritional factors (ANFs) which cause bloating when improperly processing. Appropriate method of preparation reduce or elinate their negative impact of those contain in *Fabaceae* seeds (Nana *et al*., 2000).

Data described above were necessary to consider for FSO application to street food production chain. The relevant steps necessary to application of FSO in street food system derive from Appropriate Level of Protection (ALOP) approach (WTO, 1995). It acknowledged that street food production chain can be very different, but nevertheless should comply with a common target in this approach, the FSO applied to food facilities is as well as applicable specifically to street food production. FSO also become very important and deems necessary in street food system on the basis of public health goal, directed towards protecting a sub-population of illness. An epidemiological link between street foods and diarrhoea has been reported by several authors (Mensah *et al*., 1999; Estrada-Garcia *et al*., 2004; Heinze and Yackovich, 1988). One aspect interesting this FSO concept application in street foods system is his use as tool to reach ALOP without having an Microbiological Risk Assessment (Goris, 2005). Microbiological analysis are done rarely voluntarily by street foods vendors. Street foods risk and safety controllers may choice specific risk management measures as educating, hygiene code which seem to important in FSO targeting to specific food as street-vended foods.

An other aspect deriving from HACCP concept and providing or contributing to FSO or to ALOP and food safety control, and applicable for street food quality enhancing, is the management of individual specific step through the Performance Objective (PO) and CM concepts (CAC, 2004). In food safety management, the importance of PO, CM were clearly established (CAC, 2004; ILSI, 2004; Goris, 2005) and their application steps are indicated in Fig. 3. In street food system, PO can be use as milestone to obtains safe street food and the CM applied as precaution to reduce risk along the chain. Early data on street foods are indicated quality failure of raw foodstuffs involved in food preparation (Barro *et al*., 2002b; Bryan, 1988; Canet and N'Diaye, 1996). Indeed, PO concept shows that, having a target early on the food supply chain may be much more relevant in terms of guidance to hazard control than one at the end of chain (Goris, 2005). PO is very important and easy to use at different steps during street food processing. An irrefutable example was gave in case of prevention of cross-contaminations at a point where food is prepared for final consumption. Occurrence of cross contamination is a generic issue affecting the safety of all street-vended foods. Pathogen microorganisms present on raw foodstuffs, spices seasoning salads, could be in the process to ready to eat foods through manual handling, knives for cutting, cooking utensils or other surface (Barro *et al*., 2006a; Bryan, 1988; Gorris, 2005).

Three others approaches were deemed necessary to improve street food quality. The first approach is the "First-In-First-Out" (FIFO). Product rotation is important for both quality and safety reasons. FIFO means that the first batch of product prepared and placed in storage should be the first one sold. The FIFO concept limits the potential for pathogens growth, cross contamination, encourages product rotation, and documents compliance with time/temperature requirements. The second is Standard Operating Procedures (SOPs) - Following standardized, written procedures for performing various tasks that ensures quality, efficiency, and safety criteria, are met each time the task is performed. The quality and the taste of the same food produce by the same producer are very variable. They are a variety of street-vended foods and they are generally processed with one's hands and traditional culinary methods and various unstandard operations. The SOP in street food enterprise seems difficult to applied because of financial aspect, traditional equipments used, education level of vendors, lack of processing book and enterprise profile. It one of reason that it is difficult to establish a certificate of compliances with the quality to approved street food products. To set up of SOP, needs are education of vendors on preliminary notion and importance of standardization in their trade. Finally, the third approach is Risk Control Plans (RCPs) is a concisely written management plan developed by the retail or food service operators with input from the health inspector that describes a management system for controlling specific out-of-control risk factors. An RCP is intended to be a voluntary strategy develops to promote long-term compliance for specific out-of-control risk factors. The goal of this RCP could help to street food quality enhancing and reduce street food associated diseases. An RCP can ensure that new procedures are established to adequately treatment of street-vended food in the future. By implementing basic control systems, it is likely that the new controls will become "habits" that continue. This system are necessary in street food enterprises. By implementing an RCP, the retail or street food service operators will have the opportunity to determine the appropriate corrective action for the identified problem and design an implementation strategy to best suit their

facility and operation. Since the RCP is tailored to meet the needs of the establishment, the operator takes complete ownership of the plan and is ultimately responsible for its development and implementation. Inspector is to consult with the operator by suggesting ways that the risk factor might be controlled. By creating an RCP, the operator realizes that a problem exists in their food safety management system and commits to a specific correction plan rather than merely acknowledging a single violation.

Conclusion: Looking the complexity and is importance, is recurrent link to illness of street food system, Education and Information of different actors specifically in street food safety management, need to be incorporated clearly in FSO concept and might develop a new concept called Street Food Safety Objective (SFSO). The different steps defining the role of FSO agree with the current objectives of street foods safety managers (researchers, government, producers, vendors, consumers etc.). Risk assessment, risk management and risk communication as a mean of organizing available information, identifying data gaps, quantifying risk for specific pathogens and foods, and presenting strategies for improvement are need for education. Food safety education is a critical part of the overall strategy to reduce the incidence of food borne illness and complements regulatory and other activities. Meeting the huge challenge of food safety in the 21st century will require the application of new methods to identify, monitor and assess food borne hazards. Both traditional and new technologies for assuring food safety should be improved and fully exploited. This needs to be done through legislative measures where suitable, but with much greater reliance on voluntary compliance and education of consumers and professional food handlers. This will be an important task for the primary health care system aiming at "health for all".

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