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Full Length Research Paper

Food Safety and Consumer Perception to Irradiated Food Products in Ghana

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Food production processes have a number of critical control points that influence the quality assurance in production processes. In Ghana, foodborne illnesses reported in hospitals is about 420,000 per year, with an annual death rate estimated at 65,000 costing $ 69 million to the Ghanaian economy. This research therefore assessed the knowledge level of food safety and consumer perception for irradiated food in the greater Accra region. The combination of data obtained from workshops and interviews gave overview of food safety and consumer perception to irradiated food products. Data were analysed with SPSS and to map the mental models of those involved in the workshop, a Vensim software program was used. The survey report showed that even though respondents were told of the sterility assurance level of food irradiation, about 80 percent of them rejected irradiation processing until educated. All respondents have experiences food borne illness before. Majority of the interviewed respondents (85%) express some degree of concern over the safety of the food supply and some are willing to pay 10% premium for irradiated foods. The mental model revealed that demand for safer convenient food emphasised the need for refining food policy and increasing critical control point's inspection by the standard authorities. This will lead to Good Manufacturing Practices (GMPs) and safer foods than it would otherwise be and hence promote public health. It is suggested that there is a need to refine food safety policy to include irradiation processing, which can respond to both domestic and global challenges.

Keywords; Food vendors; Food irradiation; Mental model; Willingness to pay; Sterility assurance level; Food borne illness

INTRODUCTION

Food products and production processes have a number of specific critical control points that influence food safety standards and quality assurance in production processes. These points include; quality variation along the value chain due to biological and production variation, perishability, handling, storage and safety standards (Trienekens and Zuurbier 2008). These factors have led to stringent food safety assurance systems not only in developing countries but also in the developed once to enhanced, both real and perceived, food safety harms

(Henson and Caswell 1999). This is happening through alterations in both international (stringent quality standards certification) and national(direct regulation and product liability) quality control systems(Henson and Caswell 1999). National safety control systems, standards, and certification programs are responding to higher consumer requirements, needs for safety controls throughout the vertical chain of distribution, and changes in regulatory and tort liability requirements. Access to export markets may be limited where producers are not able to comply with international food safety requirements (for example FAO/WHO Codex) and those of importing countries. The traditional food control systems in most African countries do not provide the concerned agencies with a clear mandate and authority to prevent food safety problems(FAO 2005). Besides, food legislation that is in line with international requirements (Codex) is lacking in many African countries and the existing food legislation is outdated and inadequate as shown in Table 1, and can be found in various statutes and codes, creating an evitable confusion among food control enforcement agents, producers and distributors and food vendors.

These have resulted in insufficient consumer protection against fraudulent practices and contaminated food products, leading to the importation and domestic production of substandard food items (Wagacha and Muthomi 2008; Bankole and Adebanjo 2004; Meng et al. 2014).

In Ghana, foodborne illnesses reported in hospitals is about 420,000 per year, with an annual death rate estimated at 65,000 costing $ 69 million to the Ghanaian economy (Esena and Owusu 2013; FDA 2014).Food production and retailing in Ghana has become very complex involving an estimated 60,000 street food vendors in the Greater Accra Region alone (WHO 2006). Various stage of food production may allow routes of exposure, meaning that pathogen control is critical in the “farm and kitchen to fork” food production continuum (Ayeh-Kumi et al. 2009).Concerns over food safety challenges have been worsened by the increasing urbanisation exposing consumer health, particularly the urban strangers to the risk of food safety issues if not addressed. The outbreaks of *E. coli* O157, and the extensive use of artificial chemicals in food manufacturing have severely undermined the confidence of Ghanaians and expatriate respondents, not only in street food vendors, but in the restaurants in general (Kimmons 1999; Lyon and Porter 2010).

There is a need to define a standardised food safety regulation, which can responds to both global and national challenges(Banson 2014). Access to information on international food standards is considered difficult for many individuals and organisations in sub-Saharan Africa (FAO 2005).

Reducing the risk of foodborne pathogens in foods is especially important to children and people with compromised immune systems, such as the elderly, patients and expatriate. Thermal pasteurization of liquid foods is well established and satisfactory as a decontamination treatment however it does not suit solid foods and dry ingredients well. Chemical decontaminations have problem with residues and environmental pollution. Food (liquid, solid or powered) irradiation been studied extensively for more than 50 years and has been proven safe and effective reducing the risk of food borne illnesses (NCBA 2002; Farkas 1998; Radomyski et al. 1994). Food irradiation is the process of exposing food to controlled amount of ionising energy to decontaminate food by killing harmful bacteria and other organisms, and to extend shelf-life (Mossel and Drake 1990; Farkas 2006; Banson 2015).Food irradiation is one of the effective methods of reducing the risk of food poisoning and preserve foods as long as the package remains intact without detriment to health and with minimal or no effect on nutritional quality (Farkas 1998). However, respondents and food processors have given less concern to food irradiation technology than other food processing methods in Ghana. Applications to different foods, such as meats, seafood and vegetables, have been recommended to improve microbiological safety and reduce spoilage or sprouting (Mossel and Drake 1990; Farkas 1998). According to EFSA (2011) and Kume et al. (2009), the quantity of food irradiated in 2005 around the world was 405,000 tonnes and comprised 186000 tonnes (46%) for disinfection of spices and dry vegetables, 82000 tonnes (20%) for disinfection of grains and fruits, 32000 tonnes (8%) for decontamination of meat and fish, 88000 tonnes (22%) for sprout inhibition of garlic and potato, and 17000 tonnes (4%) of the food items that included health foods, mushroom and honey among others.

Irradiation increases the sterility assurance level to 10^{-6} compared to 10^{-3} conventional methods for food decontamination (Saleh et al. 1988). Since 1970, The Ghana Atomic Energy Commission (GAEC) through the Biotechnology and Nuclear Agriculture Research Institute (BNARI) begun a full scale commercialization in the area of food irradiation processing (Abraham Adu-Gyamfi et al. 2011; Banson 2015).

The Food and Drugs Authority (FDA) of Ghana whose mandate is to provide Ghanaians with the right to quality and safe food in collaboration with the GAEC/BNARI can define a new standardised food safety regulation process for foods vendors and restaurants before they are allowed on the market. The new standardised food safety regulation can set out specific food handling protocols in relation to receipt, storage, processing, display, packaging, transportation, disposal and recall of food. Other requirements will be to provide training related to the skills and knowledge of food handlers and their supervisors, the

Table 1: Basic Food Legislation and Enabling Regulations

	Country	Legislation	Ministries, Departments and Agencies involved in enforcement and monitoring*
1	Benin	Law 84-009. Basic Law governing the control of staple food	Ministry of Agriculture
		Regulations on food imports and exports, Street food, food hygiene and labelling	Ministry of Health and Food, Applied Nutrition Directorate
2	Burkina Faso	Food Hygiene Law 23-94/ ADP	Standardization & Quality Promotion Dir. & National Public Health Lab
		Law no. 022-2005/AN regarding a Code on public Health	Ministry of Health
		Decree n° 2003-670 on the establishment of a general cooperation framework on food safety between the government/partnerships	
		Control of Pesticide Law 041-96	Ministries of Agriculture and Health
		Standards Decree 98-296	
3	Ghana	Food and Drugs Law (P.N.D.C.L. 305B, 1992)	Food and Drugs Board
		Standards Decree (N.R.C.D. 173, 1973)	Ghana Standards Board
		General Labelling Rules, 1992 (L.I. No. 1541, 1992)	Food and Drugs Board
		Ghana Standards Board Certification Mark Rule, LI 662,1970	Ghana Standards Board
		Pest and Plant Disease Act 307, 1965 (L.I. No. 1541, 1992)	Plant Protection and Regulatory Services
		Pesticides Act 528, 1997.	Ministries of Health, Food & Agriculture & Trade
4	Mali	Decree n°01-175/pm-rm on capacity building against poverty	Ministry of Agriculture, Ministries of Heath, Trade
		Decree n°00-183/p-rm on the ruling of the public services of the water for respondents	Ministry of Public Health

Source: adapted from (FAO 2005)

health and hygiene of food handlers, and the cleaning, sanitising and maintenance of the food premises and equipment within the premises. If complied with, these requirements will ensure that food does not become unsafe or unsuitable.

The estimated 60 000 street food vendors in Accra have a combined annual turnover of US$ 100 million and a profit of 24 million (WHO 2006). These vendors provide cheap meals and the only chance of a square meal for thousands of Ghanaian citizens. However, salads, re-heated soups and sauces, and dishes served with bare hands contained high levels of potentially dangerous enteric bacteria. Street foods are of growing importance in developing countries across the world and they assure the food security of the poor, provide employment and service the tourist trade by providing traditional foods. Street food vendors are considered a useful segment of the economy; however there is a big problem about consumer awareness. Food

vendors usually have minimal or no formal education, and mostly untrained in food hygiene or sanitation and worked under insanitary conditions. In 2006, the Government of Ghana spent 17M US Dollars for the treatment of foodborne illnesses in Ghana(FDA 2014).

Ghana needs to develop and adopt irradiation technology to decontaminate food as a way of ensuring total food safety management in the Ghanaian food supply chain. This research was therefore conducted to assess the knowledge level of food safety and consumer perception for irradiated food in the greater Accra region of Ghana.

METHODOLOGY

Study area and sampling procedure

The combination of data obtained from workshops, literature review, and interviews and through the administration of questionnaire gave overview of food safety and consumer perception of irradiated food products in Ghana. Data collection was conducted by the Technology Transfer Centre (TTC) of BNARI in the process of creating a marketing strategy for the Radiation Technology Centre (RTC) of Ghana Atomic Energy Commission (GAEC) in 2011, 2012 and 2013 with relevant stakeholders. A multi-stage stratified sampling procedure was used to select sampling units. In the workshop (2011), purposive sampling was used to select potential group of respondent whom irradiation technology will be of relevance used to them. This involved respondents from major hospitals, agricultural industries, the pharmaceutical industries and food processing industries. Random sampling was used in the questionnaire administration, within the Greater Accra regions of Ghana and covered three Metropolitan Assembly, namely Accra, Adenta and Tema in 2012 to 2013 covering the major concentrated food vendor areas to draw a sample of 110 respondents.

The questionnaire began with introductory to the purpose of the research as to determine the attitudes of Ghanaians towards food irradiation processing, which has high sterility assurance level compared to other food processing technologies used to eliminate pathogens from foods in many countries such as European Community, USA, and Canada, and the Soviet Union. The questionnaire starts with asking for some general information like age, whether respondent had had any education in food safety and also experience any food poisoning before, frequency of food type purchased from vendors, and sources of food contaminations. After asking about concerns on food safety issues, a question was asked whether they were aware of food irradiation and the sources of the information. This was followed by asking whether they find irradiation safe or not; and if they want food irradiation be commercially practiced. Next, the following information was given: ‘‘raw red meat and poultry products may contain pathogenic micro organisms. These food products can cause diseases if not properly cooked. Irradiation can eliminate these pathogens from raw red meat and poultry products’’. They were then asked whether they would purchase irradiated food. Next, they were asked if they would purchase irradiated products produced by companies they trusted. Finally, respondents were asked if they would purchase irradiated foods at 10% higher premium compared to un-irradiated foods or never purchase at all. They had the option to indicate more than one price level in this question.

Evaluation of the questionnaire

Data from 110 completed questionnaires were coded and entered into an SPSS worksheet and analysed. Casual Loop Diagrams (CLD) were used to map the mental models of those involved in the workshop into a systems structure using the Vensim software program (Ventana Systems UK 2002). Mental models are used to develop an understanding of what a system looks like (Banson et al 2015). Causal loop diagrams (CLD) are useful tool for integrating and interpreting the mental models of stakeholders (Kwamina E Banson et al. 2014). The purpose of this model is to give understanding of the direct and indirect feedback loops to enhance effective policy formulation and utilization of irradiation processing as a safety protocol in the food systems in Ghana. This will allow the Food and Drugs Authority of Ghana and the GAEC to put in measures to mitigate the challenges of food safety and identify business opportunities that directly or indirectly will improve the overall public food safety. It is also important to note that ‘capacity building’ and awareness creation was an integral part of all the steps of data collection.

RESULTS AND DISCUSSIONS

Consumer Perception towards Food Safety

The data analysis revealed that participants involved included 25 passenger drivers, 15 unemployed household members, 20 food vendors, 30 shop keepers in the study vicinity, and 20 students within the Greater Accra region of Ghana (Table 2). The sampled population is relatively young. The age of these interviewed participant’s ranges from 22 to 65 years. Approximately 80% of them are 20 and 44 years, 13% are from 45 to 49, and 6 percent are 50 years and above with a median age of all participants as 37 years.

Table 2: Categories of Respondents

Producers	Number	Percentage
Passenger drivers	25	22.73
Unemployed household members	15	13.64
Food vendors	20	18.18
Shop keepers	30	27.27
students	20	18.18

The survey report showed that even though respondents were told of the sterility assurance level of food irradiation, about 80 percent of reject irradiation processing until educated. It should be noted however that research have revealed that the attitude of respondents towards irradiation technology is due largely to their understanding and knowledge of the radiation process(Wilcock et al. 2004). The studies demonstrated that a high percentage (95%) of respondents are willing to buy, and prefer, irradiated foods after provided with scientific information(Bruhn et al. 1986; Gunes and Deniz Tekin 2006).

Consumer experience with food-borne illness

High microbial loads have always been a concern when it comes to public retail outlets for food such as "Waakye" macronni, rice, and boiled yam with associated sources(Adu-Gyamfi and Nketsia-Tabiri 2008; A Adu-Gyamfi and Nketsia-Tabiri 2008). All interviewed respondents who have purchased convenient foods from food vendors and some restaurants have experiences food borne illness such as diarrhoea, cholera, dizziness etc. However, 10% of these groups have stopped patronising vendor food for fear of experiencing food borne illness again.

10 percent of the respondents mostly students have significantly higher attitudes toward food safety than other respondents with minimal primary or secondary education ($P \leqslant 0.05$). Those within the age group of 45 and above rely on wife or family meals and sometimes carry packaged food to their work places. However they complained that, they are not exonerated from food borne illness as a result of lack or unreliable refrigeration due to frequent electricity cut-off and un-stabilized voltage couple with high tropical temperatures which promote rapid microbial proliferation(Adu-Gyamfi and Nketsia-Tabiri 2008).

The Studies suggest that most respondents (78%) were not confident that the food they purchased was safe to eat. However, the largest group (60%) of respondents considered processing and preparation of foods the entry point of contamination and therefore the greatest threat to food safety(Bryan 1992). While others spoilage (22%) and freshness as a result of expiration dates of food (18%) as threats.

Willingness to purchase irradiated foods

Bacterial proliferation pose a greater challenge to food safety because potentially harmful micro organisms have the ability either to grow rapidly from very low numbers in food or to proliferate in the human body once ingested (Akinbode et al. 2011). The results on a Likert Scale about the level of food safety concern of respondents averaged 9.80 on a scale of 1–10, where 10 were interpreted as "very important". Majority of the interviewed respondents (85%) express high degree of concern over the supply of safer food and some are willing to pay 10% premium for foods that are irradiated and proven safe. According to Shin et al. (1992)respondents are willing to pay an additional 55 cents to eliminate salmonella for any type of meal that might be contaminated while others are willing to pay an additional 81 cents more for pesticide-free produce if standards can be assured.25% of respondents mostly aged 45 and above also expressed concern about the extensive use of pesticides and chemical fertilizers in vegetables food production and this have severely undermined the confidence not only in fresh foods, but also concern about the presence of pesticide residues in foods (Ntow et al. 2006; Brewer et al. 1994; Banson 2014).

GMO food production is currently under trials in Ghana; however, consumer acceptance of foods produced through GMO remains an important yet controversial issue in Ghana in the presence of GMO antagonist(Alhassan and Adekunle 2014).

Casual Loop Diagrams (CLD) of Food irradiation system

Food irradiation appears to be gaining exporters acceptance in Ghana (Ferrier 2010), but it is slow to gain support within the local food retail industries. The study revealed that many respondents have misconceptions about irradiation technology in the sense that irradiation could make the food radioactive as portray by the news media on harmful effects of radioactive leakages (Mossel and Drake 1990; Brewer et al. 1994). Interestingly, when respondents were given information on the irradiation process during the study and later asked if they will try irradiated products, as in vendor and restaurant food safety protocols, they were much more likely to accept this technology. Irradiation is a means that accompanies Good Manufacturing Practices (GMPs) and recommended as a safe and effective food processing method that has the capacity to eliminate pathogens from already packaged meals (Adu-Gyamfi and Nketsia-Tabiri 2008; Wilcock et al. 2004; Banson 2015). During the workshop organised by

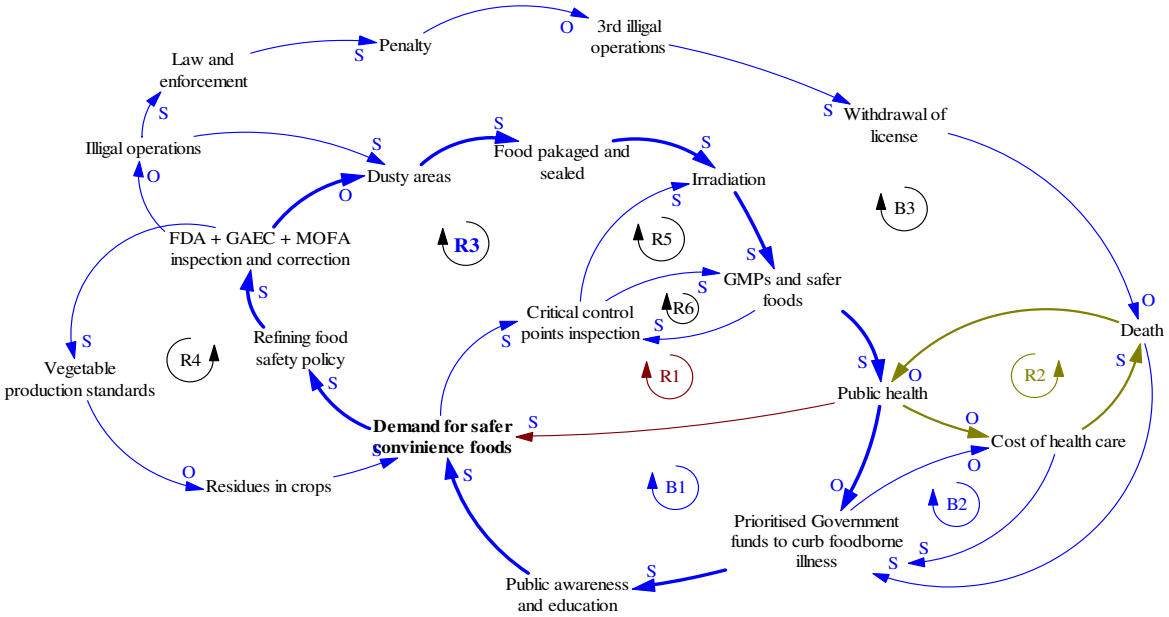

Figure 1: Mental model of food safety systems and control

GAEC/BNARI, among 75 participants across the Greater Accra Region of Ghana, the mental model of individuals and organization's concerning the food safety systems and irradiation were constructed as shown in Figure 1.

The empirical model and its application are framed in the context of systems thinking using the CLDs models for managing complex systems (Banson et al. 2015; Sun et al. 2014). Irradiation are apply to different foods, such as meats, seafood and vegetables, packaged convenience foods and have been recommended to improve microbiological safety and reduce spoilage or sprouting (Wilcock et al. 2004; Mossel and Drake 1990).Respondents indicated in focus group discussions that the most important information on food irradiation was the safety and wholesomeness of irradiated food, the effectiveness of the process to destroy bacteria and decontaminate foods.

Figure 1 has 6 reinforcing loops and 3 balancing loops. The signs O & S on the arrow heads have a special meaning (Banson and Egyir-Yawson 2014; Kwamina E Banson et al. 2014; Kwamina Ewur Banson et al. 2014; Nguyen and Bosch 2013). The sign "S" means that a change in one variable has an effect in the same direction on the other. Thus demand for safer convenient food emphasised the need for refining food policy and increasing critical control point's inspection by the standard authorities. This result in increased GMPs and safer foods than it would otherwise be and hence promote public health (Figure. 1). The sign O means that a change in one causes a change in the opposite direction in the other. Public health tends to reduce prioritised government funds to curb food borne illnesses (Figure. 1)(Wegener et al. 2003; Organization 1995).

For example starting with the demand for safer convenient foods as illustrated in Figure 1, and tracing the effect through all the elements of the loop to public health through the red-line back to demand for safer convenient foods is call reinforcing loop "R1". It is a reinforcing loop "R" because it reinforces the original dynamic; "demands for safer convenient foods". A reinforcing loop tends to cause exponential growth in all variables in the loop. A positive reinforcement involves the addition of a reinforcing stimulus following a behaviour that makes it more likely that the behaviour will occur again in the future(Banson and Egyir-Yawson 2014; Banson et el. 2015).

Balancing loops tend to be self-regulating. Balancing feedback loops, or negative feedback loops, are circles of cause and effect that counter a change with a push in the opposite direction. The harder the push, the harder the system pushes back. Balancing feedback loops bring stability or stubbornness to a system (depending on how it is perceived), so they are essential and pervasive. From Figure 1, demand for safer convenient foods will put pressure on standard authorities to check and inspect critical control points, which will ensure GMPs and safer foods than will otherwise be. This will promote public health and reduced prioritised government funds to curb food borne illness and promote public awareness and education. This will later lead to relaxation in law enforcement by the standard authorities and lead to illegal operation and outbreak of food borne illnesses: balancing the initial increase in demands for safer convenient foods.

Figure 1 also illustrates that, standard authorities such as FDA, GAEC and MOFA can co-ordinate their activities. Thus MOFA in co-ordination with FDA can design vegetable production policy to ensure standardised and safe vegetables without chemical residues. Access to information on international food standards was considered difficult for many individuals and organisations in sub-Saharan Africa (Henson and Loader 2001; FAO 2005). FDA in co-ordination with the GAEC can design food production and safety protocols which will ensure that food prepared in dusty areas are well package and irradiated to promote GMPs and safer foods in Ghana. These will reduce food borne illness and death and promote public health.

CONCLUSION

The studies revealed that, after respondents were educated about irradiation processing as a means to decontaminate and promote food safety, a high percentage of them reverted and suggested irradiation to be among the standard requirement by the Food and Drug Authority (FDA) to protect people from food safety challenges. Thus, there is a role for the Ghana Atomic Energy commission in collaboration with the Food and Drug Board of Ghana to educate the general public on the safeties and wholesomeness of irradiated food to ensure informed and rational decisions about utilization and consumption of irradiated food.

It is suggested that there is a need to refine food safety policy, which can respond to both domestic and global challenges. Sensitisation of consumers and food handlers about food safety is important. The informal food processing sector (for example, street food vendors) should receive specific attention with respect to legislation since it provides a significant proportion of food consumed in many of regions of Ghana. Coordination between local authorities and food standards and regulatory bodies was considered necessary. In support of the required regulatory framework, it is important to ensure that national staffs are trained and that their working conditions are sufficient to reduce the risk of bribery.

Irradiation technology can be used by food vendors and restaurants, processing industries (such as Nestle, Tema Food Cannery, Uniliver Ghana Ltd., and Cocoa Processing Company), pharmaceutical industries, hospitals, agricultural institutions (seed companies and veterinary clinics), and beverage companies among others.

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