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Full Length Research Paper

Diagnosis of food safety management systems performance in food processing sectors for export and domestic markets

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ABSTRACT

This study provides the comparison of the performance of current food safety management systems (FSMS) of food processing companies for export (fish) and domestic markets (dairy). The FSMS-diagnostic instrument was applied to assess the levels in context riskiness, FSMS activities, and food safety performance of 14 fish and 22 dairy companies in Tanzania. Fish companies revealed average FSMS and medium-good food safety performance, while dairy companies indicated basic FSMS and poor food safety performance. However, the FSMS of both sectors operated in moderate-risk context. Both sectors need specific measures to improve their FSMS and reduce the risk-level of the context to guarantee food safety. The measures to reduce context riskiness include putting high and specific requirements on operators' competence level, describing all activities in standard operating procedures, and setting requirements on product use by major customers. The measures to enhance FSMS performance include use of industrial cooling facilities, hygienic design, strict raw material control, specific sanitation programmes, and analysis of critical control point. Dairy companies need to set-up assurance activities including validation, verification, documentation, and record-keeping system. However, enabling regulatory environment is required for the food industry, particularly the domestic market sectors, to improve FSMS and guarantee food safety.

Keywords: Fish industry; Dairy industry; food safety performance; context factors; food safety management systems; export.

INTRODUCTION

Current food safety problems in the agri-food chain imply that performance of food safety management systems (FSMS) is not yet satisfactory. Governments in industrialised countries, the major export markets for developing countries, have set stringent food safety standards to safeguard consumers (Kadigi et al., 2007; Trienekens and Zuurbier 2008). Food imports from developing countries are subjects to stringent sanitary and phytosanitary (SPS) measures and heavy scrutiny at the point of receipt (Henson and Jaffee 2007; Ouaouich 2007). Besides compliance at the national levels by developing modern food control systems and designating competent authorities to oversee, inspect, and audit food exporting companies; individual companies should also have hygienically designed equipment and facilities, improved processes, and risk-based FSMS (Jaffee et al., 2005; Kadigi et al., 2007). Exporting sectors including fish have implemented various export market demands to improve their food safety performance and access the export market (World Bank 2005). However, exported products including fish, meat, fruits, and vegetables are still rejected over time (Jaffee et al., 2005; Rapid Alert

System for Food and Feed 2009; World Bank 2005), which signifies that despite the efforts to improve FSMS, their food safety performance is not yet sufficient.

At local levels, increase in affluent population and subsequent improved living standards are the foremost drivers behind the demands for good quality and safer food supplies (Francesconi et al., 2010; Nishiura 2010; Weatherspoon and Reardon 2003). However, the performance of FSMS in sectors targeting the domestic market is still inadequate (Kivaria et al., 2006; Molins and Masaga 2006; Swai and Schoonman 2011). Food processing companies including dairy, often fail to meet quality and/or safety demands of local niche markets like the supermarkets, hotels, and restaurants. The problem is further amplified by the co-existence of formal and informal (traditional) food supply systems, and availability of two food control systems; an advanced one for the export market, and a weak, neglected/nonexistent system for the domestic food supply (Food and Agriculture Organisation 2007; World Bank 2005). While safety and quality of food products for the export market are guaranteed, those targeted for the domestic market are not adequately controlled. This results into manufacture of inferior/variable quality products for the local market. Therefore, the purpose of this study is to compare the performance of implemented FSMS in food processing sectors for export (like fish) and domestic market (like dairy). The FSMS-diagnostic instrument (FSMS-DI) developed by (Luning et al., 2008; Luning et al., 2011b; Luning et al., 2009) and (Jacxsens et al., 2010) was used to analyse the FSMS performance in food processing sectors for export and domestic markets.

MATERIALS AND METHODS

Characteristics of participating companies

The FSMS diagnostic instrument (FSMS-DI) was applied in 38 (14 fish and 22 dairy) processing companies allocated in 11 regions including Arusha, Coast, Dar es Salaam, Iringa, Kagera, Kilimanjaro, Mara, Manyara, Morogoro, Mwanza, and Tanga in Tanzania. These regions are the major producers of fish and/or milk and contained the majority of milk and fish processing companies in the country. Fish companies composed of 10 small (10-49 employees) and medium (50-249 employees)-sized enterprises (SMEs) and 4 large (≥250 employees) companies. All fish companies used the pre-requisite programmes (PRPs) and Hazard and Analysis Critical Control Points (HACCP) guidelines to design their FSMS; and most implemented International Standard Organisation (ISO) 22000 (ISO 2005), ISO 9001 (ISO 2008), and British Retail Consortium (BRC) standards (British Retail Consortium 2008). Moreover, they had Quality Assurance (QA) managers and departments (with 4-30 personnel). Dairy companies consisted of 12 micro-enterprises (<10 employees) and 10 SMEs (10-49 employees). None of the dairy companies had used HACCP or other QA standards to design their FSMS. Moreover, 11 of 22 dairy companies did not have QA departments; the rest had small QA departments (with 1-7 personnel).

Diagnosis of food safety management system performance

The FSMS diagnosis involved offsite and onsite assessments, which took approximately 2-3 hours. An offsite session comprised of intensive face-to-face interviews with the quality responsible personnel and/or company directors, followed by document analysis (like equipment maintenance and calibration documents, HACCP manual, good manufacturing practices and complaints registration). The onsite session involved personal visitation to the food production floors whereby cleaning materials, processing equipment, plant lay-out, washing facilities, and personal clothing were assessed. Furthermore, some operators were interviewed to confirm the assessment. Interview questions for both sessions were derived from the FSMS-DI (Jacxsens et al., 2010; Luning et al., 2008; Luning et al., 2011b; Luning et al., 2009). The FSMS-DI is a tool that enables a systematic analysis and assessment of a company specific FSMS regardless of the QA standards or guidelines that have been used to develop the system (Jacxsens et al., 2010; Luning et al., 2008; Luning et al., 2011b; Luning et al., 2009). It consists of comprehensive lists of 58 indicators representing core control (like preventive measures design, intervention system design, monitoring system design, and actual operation of control strategies) (Luning et al., 2008) and core assurance activities (such as setting system requirements, validation, verification, documentation, and record-keeping system) (Luning et al., 2009) addressed in the company specific FSMS, which context factors (including product, process, organisational, and chain-environmental characteristics) could affect FSMS performance (Luning et al., 2011b), and indicators of food safety performance (like internal and external system evaluation) (Jacxsens et al., 2010).

Closed-end questions with descriptions of 3 levels of risk involving low (score 1), moderate (score 2), and high-risk situations (score 3) were used to analyse the context riskiness. These situations indicate levels of riskiness for decision-making in the FSMS activities (Luning et al., 2011b). The criteria underlying riskiness are ambiguity, uncertainty, and vulnerability. The description for low, moderate, and high-risk situations for product and process characteristics refers to low, potential, and high likelihood of contamination, growth and survival of pathogens (Luning et al., 2011b). For organisational characteristics, low, moderate and high-risk situations corresponds to supportive, constrained/restricted, and lack of administrative conditions to support appropriate decision-making in the FSMS. Concerning chain environment characteristics low, moderate, and high-risk situations refers to low, restricted, and high dependability on other chain actors resulting into a more vulnerable decision-making situation (Luning et al., 2011a; Luning et al., 2011b).

Likewise, closed-end questions with 4 different levels including low (score 0), basic (score 1), average (score 2), and advanced (score 3) were used to assess the performance levels of core control and assurance activities in the FSMS. A low level represents that an activity is not possible/applicable in the given production circumstances (like physical intervention processes in the manufacture of raw fish fillets), or is not done, or when information is not known. The basic level for control activities is typified by use of own experience, general knowledge, ad-hoc analysis, incomplete, not standardised, unstable, and regularly problems (Luning et al., 2008). For assurance activities, the basic level is characterised by problem driven, only checking, scarcely reported, and no independent opinions. The average level for control activities is characterised by being based on expert (supplier) knowledge, use of (sector, legislative) guidelines, best practices, standardised, and sometimes problems. For assurance activities, average level corresponds with active, additional analysis, regular reporting, and experts support (Luning et al., 2009).

In addition, closed-end questions with 4 levels such as not applied (score 0), poor (score 1), moderate (score 2), and good (score 3) food safety were applied to assess the food safety performance. Level 0 (no indication of food safety performance) refers to absent, not present, not conducted. It shows for example, absence of FSMS evaluation and lack of insight in actual microbial and hygiene performance of the system (Jacxsens et al., 2010). Level 1 (poor performance) is associated with aspects like ad-hoc sampling, minimal criteria used for FSMS evaluation, and having various food safety problems due to different problems in the FSMS. Level 2 (moderate performance) represents regular sampling, several criteria used for FSMS evaluation, and having restricted food safety problems mainly due to one (restricted) type of problem in the FSMS. Level 3 (good performance) pertains to a systematic evaluation of the FSMS using specific criteria and having no safety problems (Jacxsens et al., 2010).

Data processing and analysis

The overall mean scores were calculated and transformed to assigned overall scores to obtain a first indication about context riskiness, levels of FSMS activities, and food safety performance as previously described by (Jacxsens et al., 2010; Luning et al., 2011a). The assigned scores provide an overall indication of context riskiness, FSMS and food safety performance. For the FSMS activities and food safety performance indicators, assigned score 1 is given if the average level is between 0 and 1.2. Assigned score of 1-2 attributed when the average level is between 1.3 and 1.7. Assigned score of 2 is defined when the average level is between 1.8 and 2.2. Assigned score of 2-3 is given when the average level is between 2.3 and 2.7. Lastly, assigned score of 3 given when the average level is between 2.8 and 3.0. For the context riskiness if the average risk-level is between 1and 1.2 then score 1 is assigned, when average risk-level score is between 1.3-1.7 then score 1-2 is assigned, if average risk-level is between 1.8 and 2.2 then score 2 is assigned, if average risk-level is between 2.3 and 2.7 then score 2-3 is assigned and when the risk-level is between 2.8 and 3.0 score 3 is assigned.

Then, statistical analysis involved Statistical Package for Social Sciences (SPSS) version 16.0 for Windows (SPSS Inc., Chicago, IL, USA). An independent T-test was performed to compare the mean scores of FSMS activity levels, context riskiness, and food safety performance between the food companies in the exporting and domestic market sectors. The statistical significance was established at $P<0.05$.

RESULTS AND DISCUSSION

Overall context riskiness, food safety management systems and food safety performance

The basic principle behind the FSMS-DI is that companies operating in a high-risk context (overall score 3) require a more advanced FSMS (overall score 3) to achieve a good FS performance (overall score 3). Companies operating in moderate-risk context require an average FSMS (overall score 2) to achieve a good FS performance (overall score 3), while for those in a lower risk context (level 1) more simple systems (overall score 1) could be sufficient for good FS performance (overall score 3) (Luning et al., 2011a; Luning et al., 2011b). In general, each sector operated in moderate-risk context (Table 1). The significant difference ($P<0.05$) was observed in FSMS activity levels; fish companies had an average level (overall score 2) while dairy companies showed a basic level (overall score 1-2). The level of FSMS in dairy companies is insufficient to deal with the moderate-risk context to ensure good food safety performance. Consequently, dairy companies indicated moderate food safety performance (overall score 2), while fish companies had relatively good performance (overall score 2-3) (Table 2). However, the majority of dairy companies were micro-enterprises lacking hygienically designed equipment and facilities and quality workforce or expertise.

Table 1. Number of companies per score and statistical analysis of mean scores of context factors

Context factors	Fish				Dairy				T-test
	Number of companies per score			Mean scores	Number of companies per score			Mean scores	P-value
Risk level of context[a]	1	2	3		1	2	3		
Product characteristics									
Risk of raw materials	0	0	14	3.0(3)[b]	0	0	22	3.0(3)	1
Risk of final product groups	0	5	9	2.6(2-3)	0	17	5	2.2(2)	0.012
Safety contribution packaging concept	0	13	1	2.1(2)	1	14	7	2.3(2-3)	0.212
Process characteristics									
Extent of intervention steps	0	1	13	2.9(3)	0	22	0	2.0(2)	0.000
Level of production process changes	1	7	6	2.4(2-3)	5	10	7	2.1(2)	0.279
Rate product/process design changes	9	4	1	1.5(1-2)	14	5	3	1.5(1-2)	0.926
Organisational characteristics									
Lack of technical workforce	6	8	0	1.6(1-2)	0	10	12	2.6(2-3)	0.000
Degree of variability in workforce composition	5	8	1	1.8(2)	16	6	0	1.3(1-2)	0.006
Insufficiency operators' competence	8	6	0	1.4(1-2)	1	14	7	2.3(2-3)	0.000
Lack of management commitment	11	3	0	1.2(1)	0	10	12	2.6(2-3)	0.000
Deficiency of employee involvement	5	7	2	1.82(2)	3	16	3	2.0(2)	0.306
Absence of formalisation	10	3	1	1.4(1-2)	6	7	9	2.1(2)	0.005
Insufficiency supporting information systems	10	4	0	1.4(1-2)	5	7	10	2.2(2)	0.001
Chain environment characteristics									
Degree safety contribution in chain position	2	11	1	1.9(2)	0	0	22	3.0(3)	0.000
Lack of power in supplier relationship	13	1	0	1.1(1)	11	9	2	1.6(1-2)	0.580
Lack of authority in customer relationships	5	8	1	1.7(1-2)	4	15	3	2.0(2)	0.197
Strictness of stakeholders requirements	1	9	4	2.2(2)	22	0	0	1.0(1)	0.000
Context riskiness				1.9(2)				2.1(2)	0.000

[a] Risk level of context (score 1: low, score 2: medium, score 3: high-risk context)
[b] Numbers in brackets are the assigned mean scores
[c] Mean scores with P-values <0.05 are significant different between fish and dairy sector

Context factors influencing performance of food safety management systems

For the product and process characteristics, 4 of 6 indicators were significant different (P<0.05) between fish and dairy companies (Table 1). Fish companies had relatively high-risk product groups (score 2-3) than dairy (score 2). However, all companies dealt with high-risk raw materials, the raw milk and fish (score 3), which require special storage conditions to prevent growth and multiplication of present micro-organisms. Fish companies produced fresh and frozen fish fillets, whereas dairy companies manufactured cheese, ultra-high treated (UHT) and pasteurised milk, which are ready–to-eat (RTE) products. In addition, fish companies had no intervention processes (score 3); while dairy companies had restricted processes (score 2). With the exception of UHT milk, other dairy products were pasteurised and/or fermented to eliminate or inactivate vegetative cells, but not spores. Compared to dairy (score 1-2), fish companies indicated relatively high-risk context (score 2-3) regarding product/process design changes due to frequent changes in product-package (Table 1). Lack or restricted use of intervention processes reveals strong dependency of food companies on their suppliers to ensure safety of the products. Thus strict control of raw materials and re-evaluation of supplier agreements/specifications and FSMS of suppliers are necessary for both sectors to assure quality/safety of raw materials (Luning et al., 2009).

For organisational characteristics, all indicators except one, the workforce composition, were significant different (P<0.05) between the two sectors (Table 1). Dairy companies have shown non-supportive organisational conditions (score 2-3) to decision-making due to lack of technical workforce, management commitment, and specific requirements on competence level of operators. Half of the analysed dairy companies lacked personnel with knowledge on food safety, food technology, and/or food science. Besides, there were no official quality/safety team, formalised meetings, and dedicated budgets for food safety. Moreover, there were no specific requirements on competence and experience of operators. This condition contributes to poor food safety performance. In contrast, fish companies indicated supportive organisational conditions (score 1 or 1-2) due

Table 2. Number of companies per score and statistical analysis of mean scores of FSMS activities

Core control activities	**Fish**					**Dairy**					**T-test**
	Number of companies per score				Mean scores	Number of companies per score				Mean scores	P-value
FSMS activity levels[a]	0	1	2	3		0	1	2	3		
Design preventive measures											
Sophistication hygienic design equipment/facilities	0	0	11	3	2.2(2)[b]	0	2	17	3	2.1(2)	0.294
Adequacy of cooling facilities	0	0	1	13	2.9(3)	2	2	5	13	2.3(2-3)	0.032
Specificity of sanitation programmes	0	0	3	11	2.8(3)	6	2	12	2	1.5(1-2)	0.000
Extent of personal hygiene requirements	0	0	4	10	2.7(2-3)	0	11	5	6	1.8(2)	0.001
Adequacy raw material control	0	0	8	6	2.4(2-3)	0	1	15	6	2.2(2)	0.268
Specificity of product specific preventive measures	0	0	2	12	2.9(3)	5	5	6	6	1.6(1-2)	0.000
Design intervention processes											
Adequacy of intervention equipment	14	0	0	0	0.0(0)	0	8	4	10	2.1(2)	0.004
Packaging intervention equipment	9	0	3	2	0.9(1)	5	5	8	4	1.5(1-2)	0.000
Maintenance and calibration programme for (intervention) equipment	0	2	4	8	2.4(2-3)	1	10	8	3	1.6(1-2)	0.004
Effectiveness intervention methods	13	0	0	1	0.2(0)	1	1	20	0	1.9(2)	0.000
Design monitoring system											
Appropriateness CCP/CP analysis	0	1	7	6	2.4(2-3)	21	1	0	0	0.1(0)	0.000
Standards and tolerances design	0	0	4	10	2.7(2-3)	8	1	7	6	1.5(1-2)	0.002
Analytical methods to assess pathogen levels	0	0	4	10	2.7(2-3)	2	2	1	17	2.5(2-3)	0.464
Measuring equipment to monitor process/ product status	0	0	6	8	2.6(2-3)	0	6	11	5	2.0(2)	0.009
Calibration programme for measuring and analytical equipment	0	0	2	12	2.9(3)	5	16	1	0	0.8(1)	0.000
Sampling design (for microbial assessment) and measuring plan	0	1	11	2	2.1(2)	11	8	2	1	0.7(1)	0.000
Extent of corrective actions	0	0	2	12	2.9(3)	5	10	1	6	1.4(1-2)	0.000
Operation control strategies											
Actual availability of procedures	0	0	12	2	2.1(2)	5	7	10	0	1.2(1)	0.000
Actual compliance to procedures	0	0	7	7	2.5(2-3)	5	6	5	6	1.6(1-2)	0.006
Actual hygienic performance of equipment and facilities	0	0	4	10	2.7(2-3)	1	0	21	0	1.9(2)	0.000
Actual cooling capacity	0	0	1	13	2.9(3)	4	1	5	12	2.1(2)	0.018
Actual process capability of intervention processes	14	0	0	0	0(0)	0	4	14	4	2.0(2)	0.000
Actual process capability of packaging equipment	9	0	1	4	1.0(1)	9	0	5	8	1.6(1-2)	0.258
Actual measuring equipment performance	0	0	1	13	2.9(3)	0	1	1	20	2.9(3)	0.640
Actual analytical equipment performance	0	0	0	14	3.0(3)	2	1	1	18	2.6(2-3)	0.122
Core assurance activities											
Translating of stakeholder requirements into own FSMS	0	3	5	6	2.2(2)	2	7	6	7	1.8(2)	0.223
Systematic use of feedback information to modify FSMS	0	0	2	12	2.9(3)	1	9	5	7	1.8(2)	0.000
Validation of preventive measures	1	1	4	8	2.4(2-3)	8	8	6	0	0.9(1)	0.000
Validation of intervention systems	10	1	1	2	0.6(1)	7	7	8	0	1.1(1)	0.234
Validation of monitoring system	1	0	5	8	2.4(2-3)	12	3	7	0	0.8(1)	0.000
Verification of people-related performance	0	1	8	5	2.3(2-3)	6	9	2	5	1.3(1-2)	0.004
Verification of equipment- and methods-related performance	0	1	5	8	2.5(2-3)	5	10	6	1	1.1(1)	0.000
Documentation system	0	0	7	7	2.5(2-3)	0	13	9	0	1.4(1-2)	0.000
Record-keeping system	0	0	10	4	2.3(2-3)	0	11	11	0	1.5(1-2)	0.000
FSMS performance					2.1(2)					1.7(1-2)	0.006

[a] FSMS activity levels (score 0: not applicable, score 1: basic level, score 2: average level, score 3: advanced level)
[b] Numbers in brackets are the assigned mean scores
Mean scores with P-values <0.05 are significant different between the fish and dairy sector

to operational quality/food safety team with formalised meetings and budget, standard operating procedures, quality information systems accessible to all operators, and strict requirements on operators' competence and experience (Table 1). Compared to sectors for the domestic market, exporting sectors operate in more advanced food control systems (Food and Agriculture Organisation 2007; Jaffee et al., 2005). Majority of dairy companies were micro-enterprises with limited financial and human resources to create supportive organisational conditions. In comparison to big enterprises, micro- and small-scale food processors in Tanzania operate in an informal sector and use poor technology and low-skilled personnel (Ruteri 2009). Moreover, a study in Turkish dairy industry observed that small-scale companies lacked sufficient technical expertise in food safety (Demirbas and Karagozlu 2008; Demirbaş et al., 2006). Therefore, dairy companies should create supportive organisational conditions like recruiting skilled and experienced personnel, developing specific information systems, and training of operators and management on food safety to respectively enhance their competences and commitment. Effective implementation of QA standards and guidelines require full commitment and involvement of management and workforce (Panisello and Quantick 2001; Wilcock et al., 2011). Management commitment means that the personnel will get required materials and support to develop and implement QA programmes (Wilcock et al., 2011). Lack of dedicated food safety budget could result into specific and serious barriers for implementation of QA standards/guidelines like HACCP (Von Holy 2004). Moreover, adequate food safety training of employees could positively improve food safety and prevent food borne diseases (Rowell et al., 2013)

With regards to chain-environment characteristics, significant differences ($P<0.05$) were observed in safety contribution in chain position and severity of stakeholders' requirements (Table 1). However, not statistically different ($P>0.05$) fish and dairy companies had restricted authority in customer relationships. This shows that although the companies had ability to discuss product use of major customers, could not influence their FSMS, which may result into unpredictable storage conditions. In comparison to fish, dairy companies were at more critical chain position as they manufactured RTE products that require pathogen reduction to acceptable levels and strict storage and/or distribution conditions to prevent microbial growth and (cross) contamination. Moreover, dairy companies basically meet local legislative requirements (score 1), which in most cases are not strictly enforced. For fish companies, besides local legislative requirements, have to meet additional and sometimes conflicting requirements from various chain stakeholders (Table 1). Serving different markets with conflicting customers' food safety demands puts more pressure on the system (Luning et al., 2011b).

Fish companies are export oriented, serving several international markets with different legislative and customers' demands. They have implemented various QA standards with different certification requirements like the BRC and ISO 9001 (Ababouch et al., 2005). Degree of involvement in international markets influences the adoption of PRPs and QA standards/guidelines in the food industry (Bai et al., 2007; Holleran et al., 1999; Jacxsens et al., 2011). For instance, food exporting companies in India were more aware of the regulatory requirements to implement HACCP than those serving the domestic market (Jayasuriya et al., 2006). Moreover, Chinese food enterprises have implemented HACCP in order to access overseas markets (Bai et al., 2007). On contrary, dairy sector serves exclusively for the domestic market which has inadequate enforcement of food legislation and regulations accompanied by poor customers' food safety demands. Subsequently, none of the dairy companies have implemented any QA standards/guidelines (Food and Agriculture Organisation 2007; Kurwijila and Boki 2003; Molins and Masaga 2006). The country policy, regulatory environment, and business demands provide incentives for food companies to adopt QA standards and guidelines as well as other customer/business specific requirements (Holleran et al., 1999). Regulatory and market-based incentives were the major motives behind HACCP adoption in British and Canadian food industries (Henson et al., 1999; Jayasinghe-Mudalige and Henson 2007). Nonetheless, poor hygienic practices, outdated legislation, ineffective food control systems, and inadequate market demands could be the key factors perpetuating poor food safety performance in sectors serving the African countries' domestic market (Abegaz 2007; Henson et al., 2005; Oloo 2010; World Bank 2005). Particularly, Tanzania lacks regulation prohibiting sale of unprocessed milk; as a result 80-90% of households in Dar es Salaam still buy unprocessed milk from street vendors or via home delivery (Anonymous 2006). Therefore, similar regulatory conditions operating for the export sector could be applied to dairy to facilitate the adoption of PRPs and QA standards/guidelines and improve food safety performance. Besides, consumer awareness on food safety should be created through training and information campaigns, which will ultimately put more pressure on the entire food industry to improve food safety performance.

Performance of core control activities

For control activities, with the exception of hygienic design and raw material control, the rest of indicators of preventive measures were significant different ($P<0.05$) between the two sectors (Table 2). In overall, fish companies had relatively advanced preventive measures design (score 2-3) than dairy companies (score 2). Fish companies had cooling facilities, sanitation programmes,

Table 3. Number of companies per score and statistical analysis of mean scores of food safety performance indicators

Food safety performance	Fish					Dairy					T-test
	Number of companies per score				Mean scores	Number of companies per score				Mean scores	P-value
Food safety performance levels[a]	0	1	2	3		0	1	2	3		
External FSMS performance assessment											
FSMS evaluation	0	3	0	11	2.6(2-3)[b]	1	13	0	8	1.7(1-2)	0.011
Seriousness of remarks of the FSMS evaluation	0	0	4	10	2.7(2-3)	1	5	14	2	1.8(1-2)	0.000
Microbiological food safety complaints by customers	1	0	2	11	2.6(2-3)	0	0	14	8	2.4(2-3)	0.217
Hygiene-related complaints by customers	1	0	3	10	2.6(2-3)	0	0	8	14	2.6(2-3)	0.773
Internal FSMS performance assessment											
Product sampling to confirm microbiological performance	0	0	2	12	2.9(3)	1	20	0	1	1.1(1)	0.000
Judgment criteria	0	1	3	10	2.6(2-3)	1	10	3	8	1.8(2)	0.010
Hygiene and pathogen nonconformities	0	0	5	9	2.6(2-3)	0	2	19	1	2.0(2)	0.000
FS output					2.7(2-3)					1.9(2)	0.000

[a] Food safety performance levels (score 0: not applied, score 1: poor, score 2: moderate, score 3: good food safety performance)
[b] Numbers in brackets are the assigned mean scores
Mean scores with P-values <0.05 are significant different between the fish and dairy sectors

personal hygiene requirements, and product specific preventive measures at advanced level (score 3). Their cooling facilities were specifically modified for their specific production conditions. The cleaning agents (detergents and disinfectants) were modified and tested on their effectiveness for the fish processing sector. Moreover, fish companies had high and specific requirements for personal clothing handling (washing, drying, and storage), personal care and health, and tailored facilities (toilets, washing basins, and changing rooms) to support personal hygiene. Fish companies had product specific preventive measures which were tested for specific production circumstances. On contrary, 11 of 22 dairy companies applied basic (score 1) personal hygiene requirements (standard requirements on clothing and personal care, common washing facilities, and no specific hygiene instructions) and several had no (score 0) sanitation programmes (6) and product specific preventive measures (5). For instance, some dairy companies had toilets located several metres away from the processing building, without water or hand washing facilities. This could result into cross contamination and poor microbiological safety. Studies in Zimbabwe (Gran et al., 2003), Burkina Faso (Millogo et al., 2010), and Turkey (Karaman et al., 2012) observed that dairy companies lacked hygienically designed equipment and facilities (like building layout and cooling facilities) and had inadequate sanitation programmes and personal hygiene requirements. Moreover, several nonconformities in structure and design, and hygiene and cleaning were observed in ice-cream and cheese processing companies in Spain (Domenech et al., 2013). Dairy companies should re-design their facilities and equipment, develop specific sanitation programmes (as equipment, processing zones, toilets, surrounding environment), introduce strict personal hygiene requirements (including clothing and body cleanliness), and raw material control. Besides platform tests (for example, alcohol test and clot on boiling), other specific rapid tests like mastitis and antimicrobial residues could be also conducted. Severity of checks could depend on suppliers' previous performance; supplier with history of poor quality could either experience more severe checks or excluded altogether. Moreover, dairy companies could change the current supplier agreements and specifications.

For the design of intervention processes, with the exception of packaging intervention, the rest of indicators differed significantly (P<0.05) between the two sectors (Table 2). Fish companies did not apply physical intervention (like drying and heating/cooking) and intervention methods (as fermentation), while dairy applied intervention processes to eliminate or reduce microorganisms to acceptable levels. Although the intervention methods were supported by scientific information and expert knowledge, their effectiveness were not yet tested. Fish companies had relatively advanced (score 2-3) maintenance and calibration programmes (specifically designed for the production process) than dairy companies (score 1-2) as they were initiated by problems and not documented. Previous studies in the dairy industry have also reported inadequate intervention processes like pasteurisation (Aaku et al., 2004; Belli et al., 2013) and maintenance and calibration programmes of the intervention equipment (Gran et al., 2002; Gran et al., 2003; Mhone et al., 2011). Since, no intervention processes were applied in fish companies, preventive strategies like cooling and raw material control should be at advanced levels to guarantee food safety. In addition, dedicated packaging interventions for the fishery sector could be adopted. The dairy companies should use automated intervention equipment, develop specific equipment maintenance programmes to ensure stable performance.

Except one indicator (the analytical methods) of monitoring system design, both sectors differed significantly (P<0.05) in 6 indicators (Table 2). Fish companies had advanced (score 2-3) analysis of critical control point (CCP)/control point (CP) because the allocation were executed by own and expert knowledge according to Codex Alimentarius Commission (CAC) guidelines, and the CCPs were tested for the production circumstances. None of the dairy companies have implemented HACCP; hence CCP/CPs were not analysed. Fish companies had relatively advanced level (score 2-3/3) in standard and tolerances specification (scientifically supported and adapted for production circumstances) and measuring equipment (automated and tested for the production process). Moreover, calibration programmes were specifically designed/adapted for the production condition; and corrective actions were based on causal analysis of own product and process deviations and were specifically differentiated (Table 2). Similarly, European Union (EU) inspectors found that fish companies have implemented quality and food safety requirements equivalent to the EU demands and are licensed for export (Food and Veterinary Office 2011). Furthermore, fish companies are regulated by the competent authority, the national fish quality control laboratory (NFQCL), which has adequately defined the sampling plan for the fishery sector. Therefore, fish companies use this sampling plan to ensure compliance (Food and Veterinary Office 2011). In addition, the fish industry in Tanzania experiences periodic EU audits, in which individual fish companies and the competent authority are inspected (Frohberg et al., 2006; Henson 2008). Inadequate stakeholders' demand could be among the impediments for adoption of best practices and HACCP in the dairy industry (Henson 2008; Weatherspoon and Reardon 2003). Studies in food industries in Poland and Canada found that export-oriented companies have greater possibilities to implement PRPs, QA standards/guideline and legal requirements than ones serving the domestic market (Herath et al., 2007; Konecka-Matyjek et al., 2005). Moreover, export sectors receive significant investments in food safety infrastructure and skills development than sectors serving the domestic market (Schillhorn van Veen 2005). Compliance of enterprises that are more domestic oriented would exclusively depend on the country's food regulations (Mensah and Julien 2011) and domestic market demands (Reardon et al., 2003; Weatherspoon and Reardon 2003). Hence, dairy companies could develop specific equipment maintenance and calibration programmes (indicating frequency, equipment, and responsible person). Small and micro-enterprises may basically implement the PRPs, whereas medium and big companies could further include HACCP to design their FSMS. Since, majority of the analysed dairy companies were micro-sized, use of regulatory microbiological sampling design and measuring plans would be sufficient. Food control authorities are however, recommended to increase their sampling frequency and ensure that all companies are timely audited.

With regards to operation of control strategies, the significant difference (P<0.05) was observed in 5 of 7 activities (Table 2). In contrast to dairy, fish companies have indicated relatively advanced level (score 2-3) in compliance to procedures, actual hygienic performance of equipment and facilities, and cooling capacity. This respectively shows that operators were aware of the existence and content of procedures and consciously follow them, hygienic performance tests conducted regularly, and performance of cooling facilities was stable. Dairy companies had basic (score 1) procedures which were often paper based. Besides, fish companies had no intervention processes (score 0), while dairy companies had intervention processes (including pasteurisation and fermentation), which could only eliminate vegetative cells but not spores (score 2). The majority of dairy companies were micro-enterprises often using non-hygienically designed equipment and buildings, simple technology (such as batch pasteurisation and fermentation, manual packet filling and sealing), and inadequate procedures (like instructions) (Jaffee et al., 2005; Kurwijila and Bennett 2011). Thus dairy companies should invest in equipment (like purchase of automatic pasteurisers and filling equipment) and buildings, and develop standard operating procedures for production and sanitation.

Performance of core assurance activities

Moreover, Table 2 shows that 8 of 9 indicators of assurance activities differed significantly between the two sectors (P<0.05). Fish companies had significantly advanced level (score 2-3) in the design of assurance activities (P<0.05) than dairy companies, which were at basic level (score 1-2). The majority of dairy companies did not conduct (score 0) validation of monitoring systems and preventive measures as well as verification of people- and equipment-related performance. Lack of such crucial core assurance activities means that the effectiveness and execution of the FSMS is not evaluated (Luning et al., 2009). A study in Japanese dairy companies observed that smaller companies without HACCP approval did not conduct validation and verification activities (Sampers et al., 2012). Though in this study, few dairy companies conducted validation and verification activities, they were not independent or scientifically supported. Such activities were carried out by own people working in the system (often lacking proper knowledge and expertise) and not documented. Validation and verification by external experts provide independent opinions on the performance of the system

(Luning et al., 2009). Likewise, a study in the UK food industry found that most companies developed and implemented FSMS by their own employees (Mensah and Julien 2011). Moreover, in this study, the majority of dairy companies lacked structured documentation and systematic registration of record-keeping data. Previous studies also observed lack of proper documentation and record-keeping system in micro- and small-scale enterprises (Karaman 2012; Karipidis et al., 2009; Taylor and Kane 2005). In addition, a study in Spanish food industry found that HACCP plans lacked documented hazard analysis (Ramírez Vela and Martín Fernández 2003). Therefore, dairy companies need to establish assurance activities like using personnel from the food control authority, research institutions or universities for validation and verification purposes. Moreover, they could develop comprehensive documentation and record-keeping procedures. For instance, very small companies could use notebooks to keep records.

Food safety performance diagnosis

Although two indicators (microbial food safety and hygiene-related complaints) did not show any statistical significant difference ($P>0.05$), the rest of indicators were significantly different ($P<0.05$) between the two sectors (Table 3). For the external and internal evaluation of FSMS, fish companies revealed relatively advanced level (score 2-3). The FSMS were evaluated by several accredited third-parties including the competent authority, EU, and independent auditors for BRC and ISO standards. Nonetheless, no major remarks on the FSMS performance, indicating good food safety performance. In comparison to dairy, fish companies had structured sampling plans in raw materials, final products and environment, and use various criteria (like CAC, EU, and Tanzanian Bureau of Standards (TBS)) to interpret microbiological results. This could have been partly contributed by strict export market demands imposed on fish companies (Herath et al., 2007) as compared to inadequate domestic market pressure on dairy companies. Dairy companies may use sampling designs and measuring plans developed by the food control authorities (like TBS and Tanzania Food and Drugs Authority (TFDA)) or develop their own. Moreover, complaints registration procedures need to be developed and implemented. Food control authorities need to intensify their inspections to dairy companies and ensure that their recommendations for improvement are meticulously implemented.

CONCLUSIONS

Although both sectors operated in moderate-risk context, fish companies, the exporting sector, had average FSMS and relatively good food safety performance than dairy companies, the sector for the domestic market. All fish companies have implemented PRPs and HACCP, and the majority are BRC, ISO 9001, and ISO 22000 certified. However, each sector would require specific intervention measures for improvement on their FSMS and lowering the risk-level of the context. Specific areas for improvement of FSMS of fish companies are the preventive measures (like cooling facilities) and monitoring system (developing specific sampling design and measuring plans) as there were no physical intervention processes. For the dairy companies, the major focus could be on preventive measures (like development of specific sanitation programmes, strict personal hygiene requirements, and raw material control), intervention processes (use of automatic pasteurisation and packaging equipment), monitoring system (CCP/CP analysis, specific sampling design and measuring plan, develop standards and tolerances, and corrective actions) and establishing assurance activities (set system requirements, validation, verification, and comprehensive documentation and record-keeping system) and enhance their food safety performance assessments.

For the context characteristics fish and dairy companies could create supportive organisational conditions (develop information systems, improve quality of the workforce, and management commitment) to decision making and set up product-use requirements to prevent unpredictable use by the customers. However, government support in terms of expertise and resources would be required to enable smaller companies particularly dairy establishments to adopt good practices and QA standards and guidelines. Strengthen dairy organisations through information, education, and communication campaigns to create food safety awareness to consumers that could put more pressure to food companies to improve their food safety performance. Furthermore, dairy companies could use the experience of fish processing companies to improve performance of their FSMS and access the export market. However, similar level of enforcement of food laws and regulations, and other supply chain requirements applied in the export sector should be used to sectors serving the domestic market to improve food safety performance and guarantee supply of quality and safe products.

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