SCIENCE AND TECHNOLOGY - Research Journal - Volume 6 - 2000
University of Mauritius, Réduit, Mauritius.

AN ASSESSMENT OF THE HYGIENE LEVEL IN ANIMAL PRODUCT PROCESSING PLANTS IN MAURITIUS

by

S. A. VYTELINGUM, D. GOBURDHUN and A. RUGGOO

Faculty of Agriculture

University of Mauritius, Réduit, Mauritius

(Received May 2000 – Accepted September 2000)

ABSTRACT

A study was carried out to assess hygiene level in the 20 local animal product processing plants. Questionnaire based interviews with managers and food handlers gave an overview of perception of hygiene and practices related to it. Checklists using a scoring system, were designed for objective hygiene inspection. According to the checklist, plants and food handlers were classified as "outstanding", "good", "average", "poor" and "very poor". The plants were mainly large to medium scale and sold their products locally. Six out of the 20 plants had outstanding or good hygiene level as they satisfied most hygiene parameters. The remaining 14 plants had average to very poor hygiene level. This study showed that factors like hygiene training, hazard control systems and other good manufacturing practices affect the hygiene status of a plant. Major problem areas identified were waste disposal, provision of facilities to staff, hazard control, training in hygiene, cleaning frequency and lack of mandatory control. These could represent hazard to public health and lead to financial losses. Some recommendations have been formulated at the industry's level, at the institutional level and at the consumers' level.

Keywords: Hygiene, animal product processing plants, checklists

INTRODUCTION

Food hygiene involves " all measures necessary to ensure the safety, soundness and wholesomeness of food at all stages from its growth, production or manufacture until its final consumption " (Codex Alimentarius, 1997). It includes thorough processing and protection of food from contamination risks (Hobbs & Roberts, 1990). Foods are handled as many as 18 to 20 times during processing; if conditions are unhygienic, food contamination occurs (Marriot, 1994). Microbial contamination is the most serious form and can result in food spoilage, food poisoning or even death (Sprenger, 1993). Bean *et al.* (1990) have also reported that 66% of all foodborne illness outbreaks are due to bacterial pathogens. The incidence of foodborne diseases is on the increase in developed countries (Sprenger, 1993). Although USA is considered to have the safest food supply in the world, foodborne diseases cause approximately 76 million illnesses, 325,000 hospitalisations and 5000 deaths each year. Known pathogens account for an estimated 14 million illnesses, 60000 hospitalisations and 1800 deaths (Mead *et al*, 1999). The situation highlights the vital role of hygiene as a component of any food manufacturing process (Schontaube, 1990).

Foodborne diseases have increased dramatically worldwide in the recent years and have hit industrialised countries and developing countries alike. Both newly industrialised countries and developing countries are experiencing a growth in agroprocessing both at the small scale and large scale level. Mauritius is a newly industrialised island with approximately 1.2 million inhabitants. Over the past 20 years, it has experienced a rapid economic and social transition. The contribution of agriculture to the Gross Domestic Product has declined from 16% to 10% over the last 20 years at the expense of the textile industry and the tourist sector. The consumption pattern of the Mauritian society is linked, as in other newly industrialised countries, to its state of development and rapid urbanisation. Changing lifestyles have brought new demands on the food industry; the Mauritian food industry has also undergone major changes such as changes in scale, in product variety and quality, as well as an increase in the number of fast food outlets. Mauritius, as a newly industrialised country, is not excluded from the effects of unsafe food, particularly that resulting from handling during production, processing and preparation.

Two salient indicators of hygiene are the number of contraventions given to food business and food poisoning cases (WHO, 1989). During 1998, 40 cases of food poisoning have been reported in Mauritius (MOH, 1998). However, this number need to be multiplied by a factor of 300 to 350 as many cases go unreported (WHO,

1997) due to a poor local disease surveillance system. Moreover, if other indicators related to the field of food hygiene are considered, there is cause for concern. From 1997 to 1998 only, there has been about a 262 % increase in the number of contraventions (300 - 1087) established by the local regulatory authority in the field of food hygiene, the Ministry of Health and of the Quality of Life (MOH, 1998). This indicates that hygiene might be a problem in the local food industry. In fact, certain problems such as the high microbial count of certain local food products or consumers' associations asking for the publication of data regarding the hygiene standards of premises, have recently made the headlines of local newspapers.

The Ministry of Health and of the Quality of Life, (MOH) is the main regulatory agency locally. Control of hygiene in food plants is normally done through regular inspections of food premises, microbiological sampling of food for analysis and through the issue of building permits for food businesses and medical certificates for food handlers. Laws and regulations for consumer protection help to ensure that the food industry follows hygienic practices, but locally, outdated laws have hampered food hygiene control for a long time. However, the MOH has made a leap forward by replacing the outdated Food and Drugs Act of 1940 with the Food Act 1998. Inspection is an aspect that needs to be revamped to ensure hygienic conditions in food industries.

Recently in Mauritius, there has been an increased interest in animal products: from 1993 to 1996, there has been a 51.3% rise in the consumption of meat products, while the revenue generated from the export of fish and fish preparations has increased by about 90% (Central Statistical Office (CSO), 1997). However, protein-rich animal products may support the multiplication of harmful bacteria like *Staphylococcus aureus*, especially when process control is poor, and are thus, frequently implicated in outbreaks of food poisoning. Sprenger (1993) has reported that in Scotland, about 60% of the foodborne disease outbreaks is due to animal products. Furthermore, processing plants manipulate a large volume of produce compared to other food businesses, and any contamination occurring during their processing can affect a large number of people.

Locally, there has also been an increase in entrepreneurial spirit and hence, in the number of food processing plants. This study has thus been carried out to assess the hygiene level in food processing plants dealing with animal products.

METHODOLOGY

Methods of data collection

Since plant hygiene status depends on the management philosophy, on the food handler, the plant and its processes, the instrument to collect data on these aspects were:

1 Questionnaire-based interviews of plant managers and of food handlers.
2 Checklists for objective inspection of food handlers and plants.

The checklists were designed from international standard inspection manuals, namely the Codex Alimentarius (1984; 1997). Aspects covered in the checklist included plant and equipment design, control of operations, structural facilities, waste storage and disposal facilities, cleaning schedule and toilet facilities. Hygiene could also be assessed through Good Manufacturing Practices (GMP) which include temperature control, cleaning and disinfection, pest control, control systems. The questionnaires for managers and food handlers were carefully designed in which issues pertinent to the study were addressed. It was pretested accordingly to avoid any unforeseen problems in field work before launching the full study. Data was collected by face-to-face interviews of the food handlers and managers.

Selection of target population

Only animal product processing plants (A.P.P.P) registered with the MOH and dealing with all animal products (including fish, poultry, beef, pork) except dairy products were chosen. They were 20 in number and all were studied. Plants were classified as small, medium and large according to the cost incurred in setting up the plants which were respectively less than Rs 1,000000, Rs 1,000000 - 5,000000 and more than Rs 5,000000. These plants were visually assessed using the objective checklist, and their managers were interviewed.

In each plant, two food handlers (involved in processing, cleaning and packaging) were randomly selected for the food handler's questionnaire and checklist. Forty food handlers thus participated in the study.

Statistical analysis

The level of hygiene of the plants and the food handlers as assessed by checklists, was quantified following a merit system. This system is currently used locally by British Airways Limited when it carries out hygiene inspections at Plaisance Catering Limited, which prepares food to be served in flights departing from the local airport. 1 or 0 mark was given depending on the presence or absence of a particular parameter in the checklists. The hygiene scores of the different plants and food handlers were calculated and summarised as percentages. Based on these percent-

ages, plants were classified as "outstanding", "good", "average", "poor" and "very poor" (Table 1). Data was processed and analysed using the statistical software SPSS. Cross-tabulations were also performed to investigate any relationship between variables of interest.

RESULTS

Profile of local A.P.P.P.

Most plants (14 out of 20) produced on a large to medium scale. Eleven out of 20 plants have monthly turnovers going above Rs 1,000,000 (£1 » Rs 42).

Only four plants exported their products while others marketed their products locally. All four plants exporting their products observed specific hygiene criteria established by the importing company.

Management philosophy

All managers recognised the importance of food hygiene, mainly for public health reasons (18 out of 20). Many were also aware of the local laws related to hygiene. However, the Food Act 1998 (Anon, 1999) was still unknown to 11 out of the 20 food processors. 15 out of 20 managers claimed that their employees were given training on hygiene.

Visual assessment of hygiene using checklists

Based on visual assessment of plants, 11 out of 20 plants had an average hygiene level or above, while the others had poor to very poor hygiene level (Table 2). Plants usually had average scores on aspects such as design. On the other hand, the waste disposal system, plant environment, toilet and hand-washing facilities were usually in a poor state (Table 3).

As for the food handlers, almost 15 out of 40 had poor to very poor level of hygiene (Table 4).

Good Manufacturing Practices (GMP)

1. Temperature control: twelve out of 20 plants carried out processing activities at room temperature. The rest worked at temperatures between 8-15 °C. Three slaughtering plants did not even have a refrigeration system to allow for the cooling of their freshly slaughtered product before sale.
2. Cleaning was done once daily in 11 of the plants. The other plants were cleaned twice to thrice daily. Five plants did not include a disinfection step during cleaning operations.

3. Fifteen out of 20 plants practised pest control regularly.
4. Thirteen plants had systems for controlling hazards and quality, but only 4 had certified quality systems like HACCP and ISO 9000 series.

Plant operations were also monitored by staff specifically responsible for the maintenance of hygiene in the plant in eight out of 20 plants and by managers in the rest. Thirteen out of 20 managers were trained in hygiene (mostly through informal training).

THE PERSONNEL

The personnel of a plant also influences its hygiene status. Most (29) food handlers had only a primary level of education, 13 of them were trained in hygiene while nine of them did not have medical certificates.

Facilities were also provided for the maintenance of personal hygiene of food handlers. For instance, separate toilets were available in 14 out of 20 plants and protective clothing was given in 19 out of 20 plants, but only six plants offered hygiene training to food handlers.

Fifteen out of 40 food handlers were given a hand sanitizer, and only four food handlers used disposable towel to dry their hands after washing.

External control of hygiene by the MOH

Two plants did not receive the visit of Health Inspectors at all. Out of the remaining 18 plants, nine received visits thrice yearly, three plants once a year, and the remaining six twice a year by the Health Inspectors.

Associations between variables of interest

Several variables seemed to be linked to the hygiene status of the plant, namely

- Scale of manufacture (Table 4)
- Market (Table 5)
- Systems for hygiene maintenance (Cleaning frequency, Hazard or quality control) (Table 6)
- Hygiene training of managers (Table 7)

The hygiene status of a plant does seem not to be dependent on the fact that officers of local regulatory bodies visited plants (Table 8). Food handler hygiene was also linked to plant hygiene status (Table 9) as well as aspects such as the handler's educational level (Table 10) and access to training (Table 11), but was not linked to his task in plant. This parameter had some bearing on contamination.

Table 1. Categories of plants and their definitions
(Adapted from Plaisance Catering Service Ltd., Jawaheer, F. pers. comm., 1999)

Hygiene Scores (%)	**Definition**
Outstanding (85-100)	Total commitment of management and employees to hygiene and even beyond (food handlers usually with good hygiene scores); design, environment, equipment, waste disposal system and operations under control; toilet and hand-washing facilities in working condition and well-equipped; refrigeration systems present; may export.
Good (70-84)	Commitment of management and employees; design, equipment in working order; operations well controlled; some problems with respect to waste disposal system or plant environment.
Average (55-69)	No full commitment to hygiene; problems at level of plant environment, waste disposal, toilet and hand-washing facilities; generally hygiene status of food-handler satisfactory, operations well controlled and equipment well designed; basic system present, but some improvements required.
Poor (40-54)	No commitment of management and employees; environment, waste disposal, design of storage and preparation rooms not taken care of; control of operations good; food handlers given little facilities and have poor hygiene level; require many improvements
Very poor (< 40)	No refrigeration system in some plants, poor environment, design, toilet and hand-washing facilities, waste disposal system; storage and preparation rooms poorly designed; satisfactory control of operations; employees with poor hygiene level and not given facilities; possible defects in equipment design; may receive closing orders.

Table 2. Overall hygiene scores obtained by the 20 plants.

Hygiene scores (%)	**Number of plants with score**
Outstanding (85-100)	1
Good (70-84)	5
Average (55-69)	5
Poor (40-54)	4
Very poor (<40)	5
Total	20

Table 3. Hygiene scores of A.P.P.P on different hygiene parameters

Hygiene scores (%)	Number of plants with						
	Plant environment	Design and facilities	Equipment	Toilet and hand-washing facilities	Control of operations	Storage and preparation rooms	Waste disposal
Outstanding (85-100)	3	3	7	0	8	1	4
Good (70-84)	0	6	4	5	2	6	2
Average (55-69)	6	5	3	3	5	3	1
Poor (40-54)	0	4	3	4	3	4	1
Very poor (< 40)	11	2	3	8	2	6	12
Total	20	20	20	20	20	20	20

Table 4. Hygiene status of plant and scale of manufacture

Level of hygiene in the plant	Scale of manufacture			Total
	Small	Medium	Large	
Outstanding	0	0	1	1
Good	0	0	5	5
Average	0	1	4	5
Poor	3	1	0	4
Very poor	3	1	1	5
Total	6	3	11	20

Table 5. Type of market and plant hygiene status

Level of hygiene in plant	Sales outlet[1]					
	Export	Hotel*	Fair*	Shops*	Super-Markets*	Direct Selling*
Outstanding	1	0	0	0	0	0
Good	3	1	1	3	5	3
Average	0	3	1	3	5	2
Poor	0	1	3	4	3	0
Very poor	0	1	5	2	2	3
Total	4	6	10	12	15	8

*: All are local outlets

[1] Multiple responses allowed

Table 6. Type of control system and hygiene status of plant

Level of hygiene in the plant	Control system in plant				
	HACCP	Self-audit	ISO 9000	No system	**Total**
Outstanding	1	0	0	0	1
Good	2	2	1	0	5
Average	0	5	0	0	5
Poor	0	2	0	2	4
Very poor	0	0	0	5	5
Total	3	9	1	7	20

Table 7. Effect of having a manager trained in hygiene and hygiene status of plants

Level of hygiene in the plant	Manager trained in hygiene		
	Yes	No	Total
Outstanding	1	0	1
Good	5	0	5
Satisfactory	3	2	5
Poor	2	2	4
Very poor	2	3	5
Total	13	7	20

Table 8. Visits of sanitary officers and hygiene status of plants

Level of hygiene in the plant	Visits from sanitary officers		Total
	Yes	No	
Outstanding	1	0	1
Good	5	0	5
Average	5	0	5
Poor	4	0	4
Very poor	3	2	5
Total	18	2	20

Table 9. Food handler's hygiene as related to plant hygiene

Level of hygiene in the plant	Hygiene status of food handler					
	Outstanding	Good	Satisfactory	Poor	Very poor	Total
Outstanding	1	4	1	0	0	6
Good	0	0	1	0	0	1
Average	0	1	1	0	1	3
Poor	0	0	1	2	1	4
Very poor	0	0	1	2	3	6
Total	1	5	5	4	5	20

Table 10. Education level of food handler and hygiene level of food-handlers

Level of hygiene of food handler	Level of education			Total
	Primary	Secondary	Vocational	
Outstanding	4	5	1	10
Good	2	0	0	2
Average	5	2	0	7
Poor	4	1	0	5
Very poor	14	2	0	16
Total	29	10	1	40

Table 11. Training and hygiene level of the food handler

Level of hygiene of food handler	Training of food handler		**Total**
	Yes	No	
Outstanding	9	1	10
Good	0	2	2
Average	2	5	7
Poor	0	5	5
Very poor	2	14	16
Total	13	27	40

DISCUSSION

Information from the checklists and questionnaires has been integrated to give a better picture of hygiene in local A.P.P.P and to measure the implications of weaknesses. Factors affecting the hygiene status of a plant, such as management philosophy, the plant's profile, its design, controls, processes, and personnel's philosophy of hygiene, have also been discussed.

Management's philosophy

An explanation for the existence of these problem areas in many local plants, is an absence of management commitment to hygiene. All managers recognise the importance of hygiene, associating it with diseases, though only a few exploit it as a strategy to attract the niche market of hygiene-conscious consumers. Few know of the Food Act 1998; this may imply either a lack of concern about the laws regulating their businesses or a poor flow of information between the food industry and regulatory bodies. Also, not all plants employ managers formally trained in hygiene. This is desirable to provide in-house understanding of hygiene, of the product and the processes (Jouve *et al*. 1999).

The plant and its processes

The processing plant, its facilities and its equipment must be properly designed to allow proper cleaning and disinfection (Sprenger, 1993). Badly designed surfaces may act as vectors of meat contamination (Manzanera *et al*. 1995). Locally, many plants lack essential design criteria, like ventilation and fly-proofing and thus represent a threat to food hygiene (Table 3). Possibly, the plants had been constructed when design criteria were ill defined.

Though the authority issuing development permits or trade licenses have set guidelines for plant design, they are not strictly adhered to. It is also difficult to get building contractors specialised in the construction of food processing plants, for instance, skilled flooring mechanics. The construction materials themselves are unavailable on the local market and must be imported. The high prices and the tax paid certainly are disincentives and prevent processors from observing hygienic design criteria.

Many food manufacturers focus their attention on increasing production and neglect aspects such as plant environment and waste disposal (Table 3). These can act as breeding sites to pests, which often carry diseases transmittable to food and create public nuisance due to foul odours (Marriot, 1994). In this study, the waste disposal systems in place are either not appropriate for the size of the plant, the nature of the business or the volume of operations. A centralised waste treatment plant is desirable to alleviate the problem but its associated high cost is a deterrent

for food industries to invest on. The government can help on this issue by providing the necessary support and logistics as in the long term such a system in place would be beneficial to the environment.

Another problem area is temperature control. Animal products should be stored at low temperatures to prevent microbial proliferation (Sprenger, 1993). This ensures the hygienic and profitable operation of any food business. In Mauritius, most plants store raw materials and end-products at chilling or freezing temperatures, except for three slaughtering plants where the products are processed and sold at ambient temperatures. This is detrimental to product quality, especially to microbial quality. Depending on the initial microbial load of the animal product, spoilage can occur or certain microorganisms can multiply rapidly and cause diseases, especially that Mauritius has a tropical climate. This can be dangerous as under unsanitary conditions and improper temperature control, *Pseudomonas spp*. doubles in number every 20 minutes (Marriot, 1994).

The temperature in the processing room must be lowered to reduce bacterial growth while processing foods, especially food which are not meant to be thermally processed subsequently. Many plants do not observe this practice, probably because it costs money or is inconvenient for food handlers. It can be dangerous for high risk foods requiring much handling, like burgers which can support microbial growth while they are being prepared. Cleaning and disinfection allow the disruption of contamination routes and prevent waste accumulation to levels that expose the food to contamination risks. But the rate of cleaning in local plants is inadequate and poor. Since processing occurs usually at room temperature, microorganisms on the plant surfaces, possibly pathogenic ones, multiply and after one to four hours, they start to contaminate other animal products (Codex Alimentarius, 1994).

Monitoring and control are essential for hygiene maintenance. One control strategy is Hazard Analysis Critical Control Point (HACCP), which is cost-effective and reduces public health and spoilage risks (Baird–Parker, 1989). Costs of HACCP over 20 years for food processing plants are insignificant compared to benefits made when such systems are implemented (Crutchfield *et al*. 1997). Many local plants have tried to adopt some form of quality or hazard control system, but few use certified systems like HACCP. Currently food laws do not require that food industries in Mauritius are HACCP compliant. Yet it is very interesting to note that some food industries, especially large ones, are proactive in the process of its implementation. Nowadays, consumer attitudes towards food safety have started to evolve and both the local and export market are becoming increasingly stringent about food quality and safety. It is thus important for those with a self-audit system to achieve a demonstrable success (Shapton & Shapton, 1993) to remain competitive.

Staff recruitment and training

Recruitment of food handlers is not governed by educational level. This may be a major limiting factor in the implementation of programmes like HACCP. Besides, there is no emphasis on in-house training. It would seem that training is not common locally, possibly due to cost or to rapid labour turnover. Few food handlers are really trained in hygiene, though a large number of managers claim that their employees are trained.

Large scale industries should invest in some form of formal training to increase staff efficiency. Small scale industries do not have the means to invest on training programme. In such cases, Ottaway (1991), recommends that it should be the government's initiative to launch such a programme on a national scale.

With the Food Act 1998, a food handler will have to undergo medical examination and follow a course on food hygiene to be allowed to work in the food sector. However, training might meet with some obstacles such as:

- The literacy level of the food-handler
- The language used by the trainer
- The different nature of work

The health status of food handlers is very often overlooked. The MOH has taken a laudable initiative by designing and running tailor-made courses for food handlers. Some workers may be handling food even if they suffer from diseases transmitted by food. People with illnesses or injuries can contaminate animal products with *Staphylococcus*, while those with diarrhoea contaminate the food with *Salmonella* or other gastro-intestinal pathogens (Snyder, 1992).

Provision of facilities

By providing facilities such as protective clothing, hand-washing facilities to food handlers, managers contribute to the maintenance of the hygiene in a plant (Snyder, 1992). However, the state of these facilities is most important and this is in fact the main weak point locally: the hygiene status of food handlers seems to be affected by this lack of facilities. A food handler having access to facilities such as toilets, hand-washing, is likely to use these, and this might explain why the hygiene status of a plant influences that of the food handler. Also, a hygienic working environment has a positive influence on staff's morale (Sprenger, 1993).

Plant profile and hygiene

The hygiene status has been shown to depend on certain plant characteristics like the scale of manufacture (Table 4) and the type of market (Table 5). Large scale industries have high economies of scale, larger rates of production and can capture

a greater share of the market. They have a larger revenue than small scale industries and are able to invest more on hygiene and thus capture the market by using it as a marketing tool.

Plants exporting their products have efficient hygiene systems which they are compelled to maintain as they regularly receive external auditors. Any breakdown in their hygiene system can cause them to lose contracts, reputation on the world market and hence, money. Probably, most local companies are shied by such criteria, or are unable to bear costs associated with hygiene, marketing and freight. They market their products locally, where the emphasis is on cost rather than on hygiene. But, Mauritian consumers are becoming more hygiene-conscious and have started to react via their consumers' associations. To stay on the market, local processors will have to improve their hygiene level.

Surprisingly, plants selling to hotels do not necessarily have a high hygiene standard (Table 5). Not all hotels are stringent on the hygiene status of the plant from which they buy their products. They are perhaps more concerned with price considerations. In plants with a poor hygiene status, product contamination and food borne diseases outbreak is possible and this could be very bad publicity for the local tourist industry which is a major revenue for Mauritius. In fact, many countries miss out a potential income from tourism because of the prevalence of foodborne illnesses (Jacob, 1989).

Mandatory control

Codex Alimentarius (1984) recommends the following frequencies for plant inspection.

- Slaughterhouses: weekly
- Meat and meat product plants: fortnightly

Still, locally visits are not frequent enough. Mandatory control might be poor due to the lack of trained inspectors to cover the whole island and a lack of coordination among local regulatory agencies. Possibly the implementation of the 1998 Food Act will improve mandatory control and thus hygiene in local A.P.P.P.

Lack of objective inspection tools like checklists also hinder proper control. Specific checklists working according to a merit system (Ministry of Environment, 1993) could also be introduced. Selective microbiological examination to support a system of standardised inspections for monitoring food hygiene standards could be used (Tebbutt & Southwell, 1989).

CONCLUSIONS AND RECOMMENDATIONS

This study has allowed an assessment of hygiene in local A.P.P.P through the plants and their processes, their management philosophy & manufacturing practices and their employees.

Based on visual assessment, six plants out of 20 have good or outstanding hygiene level as they satisfy most hygiene parameters, for instance, plant environment, cleaning frequency, temperature and hazard control and provision of facilities for hand handlers. Most of these plants export their products, have hygiene-trained staff as well as food handlers with good hygiene scores. However, five of them have a poor waste disposal system. They should continuously improve their existing hygiene system as locally, consumers are becoming hygiene-conscious. Also, the tourist industry and the export industry require hygienically prepared foods. On the other hand, 14 plants have an average to very poor hygiene level. Plants with an average level (5 out of 14) lack many of the above mentioned parameters. However, they can improve their level by adopting more frequent cleaning, hazard control systems and by employing trained staff. Five out of the 14 plants have very poor hygiene level and lack basic hygiene components such as waste disposal, environment, proper design, adequate toilet and hand-washing facilities and temperature control. Moreover, they have bad cleaning practices and no quality systems. Their food handlers generally have low hygiene scores and there is no staff for hygiene control in the plant. Since these bad practices can have public health and financial repercussions, they cannot continue to operate. Possibly the MOH could put emergency closing down orders so as not to jeopardize public health. Plants with a poor hygiene level also lack most of the above-mentioned components, except that they have some form of quality control. For them to survive, they will require major improvements. They may be given a moratorium to upgrade their existing infrastructure. Else, closing orders can be envisaged for them too.

Generally, major problem areas in local A.P.P.P include waste disposal, plant environment, staff recruitment and training, provision of facilities, temperature, quality and hazard control. These affect the plant hygiene status and can thus represent hazard to public health. Only registered plants have been considered here, and risks associated with unregistered plants would certainly be higher.Though all plant managers reckon the importance of hygiene, few demonstrate hygiene commitment: many food processors are able to carry out their activities under unhygienic conditions with possible consequences on public health. The lack of organised consumer demand for food hygiene can possibly explain this. Also, no major food-borne disease outbreaks associated with unhygienically processed local animal products

have been publicised to cause public concern. This does not necessarily imply that the domestic processing industry is perfectly safe; very often, many foodborne diseases go unreported or are not even properly diagnosed. Plants with a good or outstanding hygiene level, should continuously improve their existing hygiene system as locally, consumers are becoming hygiene-conscious. Also, the tourist industry and the export industry are getting more stringent on the quality of prepared foods.

On the other hand, most plants with an average to very poor hygiene level can improve their level by adopting more frequent cleaning schedules, hazard control systems and by employing trained staff. Plants with a very poor hygiene level, lack basic hygiene components such as waste disposal, proper plant design and provision of facilities: they cannot continue to operate under these conditions.

Some recommendations are formulated at various levels to improve hygiene in local A.P.P.P. At the level of the food industry, internal hygiene control in the food industry can be implemented, especially through voluntary control programmes. At the institutional level, a food safety division with the specific task of controlling hygiene and inquiring on reported cases of food illnesses can also be created locally. The unit can revamp inspection as a tool for mandatory control, namely through standard working procedures and through objective methods such as checklists with scores, as has been done for this study. Research work on the perception and attitudes of consumers' and food industries on hygiene related issues must be carried out through surveys or censuses. Development of techniques for rapid evaluation of hygiene in food industries would also be highly desirable. At the consumers' level, consumer demands for hygiene level must be organised through the local consumers' associations. Consumers must also be educated on hygiene through leaflets, mass media, internet. This will ensure proper handling of products at the end of the food chain.

Similar studies can be carried out to collect baseline data on different categories of processing plants so as to constitute a national database on the hygiene status of the local food industry. This database will help the MOH to establish an action plan for hygiene control in the local food industry. Moreover, it can be used as a tool to establish the country's reputation as a safe (or unsafe) food supplier. Hence, both tourism policy makers and local exporting agencies will benefit from it.

ACKNOWLEDGEMENTS

The authors sincerely thank the various health inspectors of the Ministry of Health and Quality of life, the Hygiene Manager of the Plaisance Catering Service Limited and the managers and staff of the various processing plants for having participated in the study.

REFERENCES

ANON (1999). Food Act 1998. *Government Gazette of Mauritius No 114*. December 1999. Republic of Mauritius

BAIRD-PARKER, A. C. (1989). HACCP and food processing. In *Proceedings of the World Association of Veterinary Food Hygienists,* 205-209.

BEAN, N. H., GRIFFIN, P. M., GOULDING, J. S. & IVEY, C. B. (1990). Foodborne illness outbreaks, 5-year summary, 1983-1987. *Journal of Food Protection* **53,** 711-712.

CODEX ALIMENTARIUS (1984). Manuals of food quality control and food inspection. *Food and nutrition paper* **14** (5). FAO, Rome.

CODEX ALIMENTARIUS (1997). *Recommended International Code of Practice and General principles of Hygiene for poultry and meat products***.** FAO, Rome.

CODEX ALIMENTARIUS (1994). *Joint FAO/WHO food standards programme*. FAO, Rome.

CRUTCHFIELD, S. R., BUZBY, J. C., ROBERTS, T., OLLINGER, M. & LIN, C. T. J. (1997). An economic assessment of food safety regulations: the new approach to meat and poultry inspection. *Agricultural Economic Report. Economic Research Service* **755**, 21.

CENTRAL STATISTICAL OFFICE (1997). Exports of fish preparations, food balance sheet, local production of animal products. *Digest of Agricultural Statistics*. Central Statistical Office. Mauritius.

HOBBS, B. C. & ROBERTS, D. (1990). Personal hygiene of food handler. In *Poisoning and Food Hygiene,* 143-150. (Eds EDWARD ARNOLD). London.

JACOB, M. (1989). Prevention of contamination. In *Safe food handling: a training guide for managers of food service establishments*, 30- 42. World Health Organisation, Geneva.

JOUVE, J. L., STRINGER, M. F. & BAIRD-PARKER, A. C. (1999). Food safety management tools. *Food Science and Technology Today* **13** (2), 82-92.

MANZANERA, P. C., MARIN, M. D. & PAREDES, G. P. (1995). Hygiene and sanitary conditions of the surfaces of meat industry of the third Health Area from the region of Murcia. *Alimentaria* **262,** 19-21.

MARRIOT, G. N. (1994). *Principles of food sanitation*. Chapman and Hall, New York.

MEAD, P., SLUTSKER, L., DIETZ, V., McCAIG, L., BRESEE, J., SHAPIRO, C., GRIFFIN, P. & TAUXE, V. (1999). Food -Related illnesses in the United States. *Emerging Infectious Disease*. **5**(5), 1-32.

MINISTRY OF ENVIRONMENT. (1993). *Points demerit system for food establishments and food centres*. Ministry of Environment, Singapore.

MINISTRY OF HEALTH & QUALITY OF LIFE. (1998). Sanitation, food hygiene and notifiable diseases. *Health statistics annual*. Ministry of Health & Quality of life, Mauritius.

OTTAWAY, P. B. (1991). The Food Safety Act: Implications for the small manufacturer. *British Food Journal* **8,** 14-16.

SCHONTAUBE, T. (1990). Safety when dealing with cleaning and disinfectant fluids. *Deutsche Milchwirtschaft Hildesheim* **19**, 632-633.

SHAPTON, D. A. & SHAPTON, N. F. (1993). Hygienic design. *Principles and practices for the safe processing of food,* 95-111. (Eds D. SHAPTON). Butterworth-Heinemann Ltd, New York.

SNYDER, O. P. (1992). HACCP-An industry food safety self-control programme. *Dairy, Food and Environmental Sanitation* **12** (230), 230-232.

SPRENGER, R. A. (1993). *Hygiene for management: a text for food hygiene courses*. Highfield publications, U.K.

TEBUTT, G. M. & SOUTHWELL, J. M. (1989). Comparative study of visual inspections and microbiological sampling in premises manufacturing and selling high- risk foods. *Epidemiology and infection* **3,** 475-486.

WHO. (1989). Evaluation of programmes to ensure food safety. *Technical report series*. World Health Organisation, Geneva

WHO. (1997). Foodborne diseases: possibly 350 times more frequent than reported. *Abstracts on Hygiene and Communicable Diseases* **72** (12), 1071.