

MANAGEMENT OF IMPORTANT PEST PROBLEMS IN FOOD HANDLING ESTABLISHMENTS IN THE KINGDOM OF SAUDI ARABIA WITH SPECIAL REFERENCE TO BAKERIES

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Abstract—Five representative types of bakeries were surveyed in the city of Riyadh, K.S.A. to ascertain pest situations and various schemes on pest control management. The principal pests include stored product pests (e.g., *Tribolium confusum* Duval, *Tribolium castaneum* (Hbst.), *Mus musculus* and *Rattus rattus*), *Blattella germanica*, Ants (*Camponotus* spp. and *Formica* spp.) and occasional *Musca domestica*. Except for *M. domestica* which occur in two distinct peak periods in a year-cycle (high peak during hot summer months from April to July and a lesser peak at the onset of the cold season from September to November), these principal pests occur all-year-round with relatively enhanced activity during Summer. These pest problems are more or less, similar in all food plants observed. All the food establishments surveyed have their own respective integrated pest management program in place – attaining the prescribed and acceptable standards of sanitation and hygiene. Both chemical and non-chemical methods of pest control were employed with more emphasis on non-chemical methods for control in food preparation, processing, show cases and store areas. Relatively less toxic chemicals (e.g., pyrethroids) are, however, used sparingly when required under strict supervision of the professional PCO's. Invariably, occurrences of re-infestation in the food establishments were traced to raw materials brought from outside – which were aptly minimized with appropriate preventive measure. The local professional Pest Control Operators, whose services are being availed by these establishments, play an important role as consultant and managers in the maintenance of these standards.

INTRODUCTION

Bakeries, the institutions that turn various grain products into consumer edible items, vary in size and structure from family owned enterprises, to donut shop, to the large and complex plants. Regardless of their size and structure all types of bakeries are prone to infestation of pests; insects, rodents, birds and other pests. Like any modern city Riyadh too has a large number and different types of bakeries ranging from small manually operated bakeries to most modern fully automatic plants.

Riyadh is situated in the central region of the Kingdom of Saudi Arabia. The average minimum and maximum temperature at Riyadh vary from 2°C to 46°C respectively. The average relative humidity is 18% in summer and 45% in winter. The average annual rainfall varies from 35 mm to 100 mm. The climate is hot and dry in summer and cold and fairly dry in the winter season. The temperature may drop below freezing point at night in the months from December to February (Buttiker, 1979).

No studies have been done on pest management in bakeries in the Riyadh region, and bakeries of different size were selected randomly for the purpose of this study. Studies were made of the pest problems, the government regulations and the methods being applied by the PCO in the Integrated Pest Management program.

METHODS AND MATERIALS

Intensive surveys were carried out to identify the pest problems in the bakeries. Sampling of the pests was done for the identification. For the degree of the infestation, as some of the plants are working overnight and it was not possible to access the exact population of the pest species, so we have relied on visual observations. Some relevant information was also collected from the in-house pest Management/Sanitation personnel of the bakeries.

The government regulations were studied as to what extent they were helpful for the implementation of the Pest Management Program. The physical conditions and internal environment were studied to make correlation between the pest proliferation inside and outside of the facilities. The extent of the pest infestation coming from outside with the raw material was correlated with the climatic pattern and the environmental factors effecting the developmental cycle of the insects. The average monthly temperature for the year 1995 is given in Table A.

The following measures and areas were taken into consideration while performing the surveys:

Measures

- a. General Facility Information
- b. Product Information
- c. Sanitation Program
- d. Current pest Control Program
- e. Purchasing Program

Areas

- a. Exterior Areas
- b. Receiving Areas
- c. Interior Areas
- d. Processing Areas
- e. Raw Material Storage (Refrigerated or non- Refrigerated)
- f. Product Storage Area
- g. Returned Merchandise Area
- h. Shipping Areas
- i. Lunch and Locker Rooms Areas
- j. Office Areas

The following selected bakeries were surveyed:

1. *Al-rashed Bakery*: This bakery belongs to the Oberio Group of Establishments in the Kingdom. It is a fully automatic bakery. Different types of cakes and pastries are produced here. The production work goes on round the clock on seven days week basis. The sanitary standard is effectively maintained.
2. *Fesh Fash Snack Food Pro. Co.*: It is a semi- automatic plant, producing different types of snacks. The problem areas are warehouse stores, material receiving areas and the garbage skips. Mainly the pest problem is out side the factory. The warehouse is open type. They are importing the raw material like Corn Grit from other countries.

Table A. Average Monthly Temperature (Max. & Min.) of Riyadh (Station K.K.I.A.) for 1995. Based on Information of the Meteorological & Environmental Protection Administration (MEPA, Jeddah)

Month	Maximum Temp. (°C)	Minimum Temp. (°C)	Mean Temp. (°C)
Jan	22.2	6.3	14.2
Feb	23.3	10.5	16.9
Mar	25.5	12.6	19.3
Apr	31.7	17.6	24.8
May	38.8	22.7	31.6
Jun	42.6	24.6	34.6
Jul	42.6	25.6	35.0
Aug	44.0	25.3	35.7
Sep	39.8	21.7	31.8
Oct	35.8	18.0	27.6
Nov	26.2	9.6	18.0
Dec	18.1	9.3	14.0

3. *Jehan Bakery*: It is a medium sized bakery preparing various types of food materials. Situated at the main road, the bakery is semi-automatic.
4. *Domino's Pizza*: Different types of pastries and cakes are made and sold to retailers. It has a service show room, one office, two bathrooms, one baking area. It is a small establishment.
5. *Cone Zone*: This establishment is engaged in the production of the sweets and ice creams. We surveyed and could not find any problem in the facility. We observed few ants near outside gate. The sanitation is good. The storage area consists of walk-in-freezers.

RESULTS

Areas with potential pest problem

Bakeries provide optimum conditions for the proliferation and development of different pest. Varieties of raw food materials are present and some spillage is also there. The flour and sugar both are very nourishing to the growth of the pests. The storage of food also gives some opportunity for the pest to develop. The areas that were given due attention during survey are mentioned in Table 1.

The residence of the workers of all the bakeries studied were also found infested with German cockroaches. This may influence the infestation in the work place (Cornwell, 1976).

Pest problem in Al Rashed Bakery

German Cockroach, Indian Meal Moth and House flies were seen during the inspection. The house flies vary in number according to the fluctuation in the temperature. In very cool and very hot weather their population becomes negligible. The German cockroach was observed in inside areas where the temperature of the facilities do not fluctuate much. So their population remains more or less same depending upon the pest management measures adopted. The infestation of Indian meal moth is mostly concentrated in the stores. Some flies were seen only near waste bin area.

Pest problems in Fesh Fash

Outside the plant the major pests are house flies, ants and cats. During the surveys flour beetles, rodents and few house flies were observed. Loading unloading area where the raw potato is being unloaded has house fly problem. Many house flies are being attracted to it. Ants were found on the pavement of the factory. Inside the store and warehouse some sparrows were observed feeding from the stocks.

Pest problems in Jehan Bakery

The main pests present are German cockroaches, ants, and occasional house flies.

Table 1. Showing the potential areas of the bakeries having pest problems

S. No.	Potential Pest Areas	Bakery	Pest Problem	Comments
1.	Racks and Shelves	-	-	No Insects or Rodents
2.	Warehouse	Fesh Fash	Rodents	House Sparrow
3.	Back Room Storage Area (loading and unloading of the materials)	Al-Rashed, Jehan Bakery, Domino Pizza	House Flies, Ants, Indian meal moth	Pests coming along with the goods
4.	Doors Windows and Other Openings	-	-	Rodent Proofing
5.	Showcases	-	-	No Cockroaches
6.	Baking Equipment, Mixing Trays, Baking Trays	Domino Pizza, Fesh Fash	Cockroaches	-

Pest Problems in Domino Pizza

Cockroaches are the main problem in this bakery. The observations showed the German cockroaches near the dish washing area, water pipe junction, and inside the crevices in the tiles. The office area is not clean too many harborage for cockroaches, behind the drawer cabinet and file cabinets. The main pest problem is the presence of the cockroaches. The structure of the building is helping the proliferation of the pests.

Pest problem in Cone Zone

Few ants were observed during the survey near the gates. During peak seasons the house flies were seen near garbage collection area. This bakery has a pest control contract with a company for the food establishment premises as well as for the residence of the workers. The residential area of the workers has severe cockroach infestation.

All these bakeries have contracts with PCO's and Integrated Pest Management is being practiced (Table 2). The in-house pest management only concentrates on non-chemical means of pest management. The trend is to select a Pest control Contractor who will charge less money. Some of the bakeries have the in-house pest control but all of them have contracts with outside firm for pest control. Unlike the survey of food plants (N=23) by Holcomb (1995), where he found that the smaller food processing plants are not being services by professional pest control firms.

The house fly problem is mainly concentrated outside the bakeries specially near the garbage containers. Occasionally, the house flies get entry into the bakery. The Pest Control treatment is being done weekly as well as every month. The number of garbage containers of each bakery are given in Table 3.

RULES, REGULATIONS AND THE PEST CONTROL OPERATOR

There are Government laws governing the food industry that act as a guide and make the job challenging to the pest control operator. The product should be free from harmful and poisonous

Table 2. Showing the in-house and PCO run pest control of the Bakeries

S. No.	Bakery	In house Pest Management Program	Contract with outside PCO
1.	Al Rashed Bakery	y *	y
2.	Fesh Fash	y	y
3.	Jehan Bakery	y	y
4.	Domino Pizza	n	y
5.	Cone Zone	n	y

y = yes, n = not present

* Specialized and Professional Personnel present for sanitation and pest management

Table 3. Showing the number of garbage drums and skips outside the bakeries

S. No.	Bakery	No. of Garbage Drums *	No. of Skips *
1.	Al Rashed Bakery	3	1
2.	Fesh Fash Snack Food Pro. Co.	2	1
3.	Jehan Bakery	3	0
4.	Domino Pizza	2	0
5.	Cone Zone	2	0

*All the skips and the garbage drums are situated at the back side of the bakeries. Skips are away near the back entrance of the premises.

products. The product should be free from insects, parts there of and their larvae it shall be also free from fungal contamination (SASO, 1991). The workers of the bakeries are also required to follow the 'Hygienic Regulations for Food Plants and their Personnel'. During storage the flour should not be contaminated with and pesticide or poisonous chemical. The storage should be safe from toxic materials. Transport vehicles previously used for transport of the pesticides should not be used (SASO, 1981, 1983). The storage of the flour should be in such a way that can prevent the infestation of food by the insects and other pests. For this the food industry must have the services of the PCO. The rodent and insects are the potential threat for the infestation of the food materials. The technical aspects and the complexities of the environment pose a challenge for the facility to have an in house service. Mostly the bakeries (60%) have their in-house pest control program along with the contract with the outside PCO (Table 2). One bakery has specialized teams to do pest management. Generally the in-house program concentrates on preventive and non chemical methods and try to develop solutions.

Management of the important pest

The first consideration for the treatment of the specialized facilities such as bakeries are the rules and regulations for the treatment in such areas and the application of the pesticides in the food industry. It requires utmost care to avoid any contamination of the food. In the Kingdom, the use of pesticide is governed by Saudi Arabian Standards Organization (SASO). In food handling areas those pesticides and methods can be applied which do not contaminate food materials. The food plants have strict regulations for use, transportation and storage of the pesticide.

In bakeries Integrated Pest Management System (IPM) is being practiced which also includes sanitation, construction and exclusion in the program (Table 4). This helps as a first line of defense against the pests. Pesticide is considered as the second line of defense. The problems in the bakeries can not be solved by pesticide alone therefore IPM is practiced. The in-house pest management of the bakeries maintains good sanitation, proofing, harborages removal and exclusion. The incoming material is also regularly checked and necessary action is taken in case any pest is seen.

PESTS FOUND IN THE BAKERIES

The pests observed in bakeries and their stores are given in Table 5.

German cockroaches

The Bakeries provide abundant harborages for German cockroaches and they are the established pest in the bakeries. It is being managed by integrated pest management without contaminating the food materials. Insecticides having repellent effects are not much effective as demonstrated by Ebeling *et al.* (1968). Residual spraying in the infested areas of the office and at suitable places is being done. Glue and other traps and baits are set up put at sensitive locations. In some bakeries the wheels of the carts for carrying the trays and other equipment are regularly washed to avoid infestation.

Table 4. Integrated Pest Management Methods of Control being applied

S.No.	Bakery	Sanitation	Mechanical	Physical	Chemical
1	Al Rasheed Bakery	y	y	y	y
2	Fesh Fash Snack Food Pro. Co.	y	n	y	y
3	Jehan Bakery	y	y	y	y
4	Domino Pizza	y	y	y	y
5	Cone Zone	y	y	y	y

y – yes; n – no

Table 5. Showing the different types of pests present in the bakeries

S. No.	Name of the Bakery	Pests Problem*
1	Al Rashed Bakery	House Flies (<i>Musca domestica</i>), German Cockroaches (<i>Blattella germanica</i>), Indian Meal Moths, adults & larvae; (<i>Plodia interpunctella</i> (Hbn.)
2	Fesh Fash Snack Food Pro. Co.	House Flies (<i>M. domestica</i>), Red flour Beetle, <i>Tribolium castaneum</i> (Hbst.); Ants (<i>Camponotus</i> spp. and <i>Formica</i> spp.), Rodents (<i>Mus musculus</i>), House Sparrow
3	Jehan Bakery	German Cockroach (<i>B. germanica</i>), House fly (<i>M. domestica</i>), Ants (<i>Formica</i> spp.)
4	Domino Pizza	German Cockroach (<i>B. germanica</i>),
5	Cone Zone	Ants, (<i>Camponotus</i> spp. and <i>Formica</i> spp.)

* The pest problem is under control at most of these places because of the pest management being done

Flour beetle

The most important pest of flour is flour beetle. They constitute 80% or more of the flour mill insects, (Cotton and Gray, 1948). According to Willis and Roth (1950) *T. castaneum* is attracted to the flour of high moisture content. They attack the flour more easily. The maize flour used by Fesh Fash was found infested by this beetle.

To control the flour beetles regular spray of synergized pyrethrines, or spot spray with residual insecticide after cleaning is applied. Bissell and DuPree (1946) reported that jute bags are more vulnerable than the cotton bags. The beetle can infest the cotton bags also as observed in this study. Flour beetles are also controlled by fumigation of the stocks in the warehouses and stores. The stocks are generally in closed warehouse so it is safely fumigated with phosphine.

Flies

The management of the house fly is being done by baiting, spraying and thermal fogging (outside of the bakeries). The program also includes the sanitation, exclusion and other physical methods. Weekly fogging is done during the peak season in the outside areas. Weekly spraying in inside areas is practiced by few bakeries during peak season. In skip where the empty cans and cartoons are thrown show a continuous activity of the house flies.

Ants

Ant control is done by residual spray outside and using non-residual spray inside. Ant-bait are also being used.

Rodent

Anticoagulants or other rodenticides can not be used in the food handling, processing, and storage areas so non-chemical methods are resorted to. Glue Traps and mechanical traps are being used effectively. The rodent baits are placed in the food manufacturing plant at the end of the operation and picked up and thrown the next morning similar to what is mentioned by Meehan (1984).

Light traps

The electric light traps that use Ultraviolet light to attract the flying insects also have an electric grid to electrocute the insect. Some insects explode and drops in the collecting tray. These are fixed at good height in each Bakery. Generally, these are fitted inside the facility just above and away to the entry gates. These traps are always installed at a height It is not much effective to hang the trap with the ceiling in open product area and it should not be installed just above the door similar to that suggested by Shaheen, (1992). In big Establishment like Al Rashed Bakery it is fixed even in storage areas. Generally ceiling hung traps are in use.

Glue Traps

Glue traps were also observed for the control of the house fly in the trash area where the empty can, cartoons are thrown. Many dead flies were observed sticking the glue traps during the surveys.

Inspecting the incoming shipments and stocks are crucial in preventing and pest infestation. Food spillage to some inaccessible areas sometimes becomes difficult to detect and may cause some problem. Generally, in the big establishments the equipments are elevated and away from the wall, the area is spacious which allows the cleaning beneath. The conveyers and forklift can spread some pests anywhere in the facility. The use of pesticides is restricted, sanitation and food protection is the primary concern

DISCUSSION

The German cockroaches (*B. germanica*) are the most established pest in the bakeries. According to Mallis (1990) the water is the most limiting factor for the cockroaches that is why heavy infestation is confined near bathroom and kitchen. Same was found in this study that wash basin areas and kitchen were found infested with cockroaches in all the establishment surveyed. The presence of food and the darkness in cracks and crevices makes this site a more prone to heavy infestation. With good sanitation the population of the German cockroach can be reduced to some degree. When the population has once established itself inside the bakery, sanitation alone can do very little. The comparison between smaller bakeries and bigger bakeries showed that there is no relation with the presence of the German cockroaches and the size of the facility. Some smaller establishments have more problems than the bigger ones. In bigger bakeries where the lights are on twenty-four hours curtail the activity of the German cockroaches that remain hidden inside the trolleys or cooking equipment. Whereas in the facilities that stop their work at night the cockroaches have time to run here and there at night. It can be postulated that if the food is in abundance and the cockroaches are thriving in the dark crevices, inside the wheels of the trolleys, and other equipment; their population will grow. To solve this problem caulking and crevices treatment with dusting powder and aerosol is being done to control cockroaches that are hiding inside. The pest control operators open the panels of the cooking, baking and other equipment and treat them inside. The cockroach baits and traps are used along with the insecticides.

Generally the pesticides permitted in the food handling establishment are being used for the management of the pests. Mostly pyrethroids; wettable powders, dusting powder and baits are being used for the Integrated Pest Management of cockroaches. Dusts are used in the crevices and electrical rooms. The use of dust and the cockroach traps effectively supplements the insecticide spray. The need is to take into account all the factors that can effect the management of the pests.

The house flies (*M. domestica*) are present throughout the whole year, concentrating near the area of the food wastes in the drums. The population of the house flies increases during two peak seasons. The first major peak starts after March (from April to July) and second at the onset of cold season from September to November. The temperature of the environment during these two periods are favorable for the development of the flies. Then just after these peaks the temperature becomes unfavorable for the development of the house flies (Table A). At the end and after the month of July the temperature becomes too high (Average max. 44°C) and after the second peak which ends in November the temperature drops down (Average min. 9.3°C) stopping the developmental cycle of flies.

The number of the garbage and food waste collection drums and skips varies in facilities as shown in the Table 4. Some flies were always observed at these places. Although the chemical treatments are being given outside the facility (weekly fogging, baiting) the house fly problem continues. There seems mainly two reasons for this fly problem. One simple reason is that the flies are attracted from the nearby areas to the waste of the bakery. Secondly, it was also observed that some flies travel from the landfill area with the truck coming to bakery. The truck that carries the waste materials from the trash and garbage drums, daily and sometimes on alternate days. The loader truck empties the collected wastes inside the landfill area situated outside the city premises, and comes back. Some house flies are also coming with the truck from the landfill areas. Inside all the bakeries the fly Electrocuter installed at important places help to manage the problem. For the

flies the chemical control can not be applied daily, so some of the PCO's are resorting to use the glue-traps and other types of fly-traps. This way they are managing the problem effectively.

Integrated pest management which encompasses the sanitation, construction, maintenance and exclusion programs are considered as the first line of defence against the pests in the food industry. This has minimized the use of the pesticides in the food industry (Wright, 1984). Still it is not the same for all the pests. Stored grain pests were observed in some facilities and the infestation was found more in the big sized stores/ warehouse. If the area of the store is bigger more food grain is stored there and it becomes more prone to infestation. Further, in the big stores rodents and sometimes birds may also infest, as was seen in one bakery's store house. The raw materials come from outside the Kingdom from different countries (USA, Canada, England and India). These raw materials when packed are fumigated at the port of origin. There remain some eggs that start hatching in due course of time. As seen in one observation, adult Indian Meal moths were flying in one the storage facility of one bakery. The stored grain pests are controlled by fumigation of the stock.

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REFERENCES

- Bissel T. L and M. DuPree (1946) . Insects in shelled peanuts in relation to storage and bagging. *J. Econ. Entomol.*, 39(4): 551-552. in Hand Book of Pest Control by Mallis, A., Franzak & Foster Co., Cleveland , Ohio.
- Buttiker, W. (1979). Zoological Collections From Saudi Arabia. *Fauna Of Saudi Arabia*. Vol. 1.: 1-22.
- Cornwell, P.B. (1976). The Cockroach. Insecticides and Cockroach Control, The Rentokil Library, Vol. II. Associated Business Programmes, London.
- Cotton, R.T. and H.E. Gray (1948). Preservation of grains and cereal products in storage from insect attack. Preservation of grains in storage. Food and agriculture Organizations of the United Nations, pp. 35-71. in Hand Book of Pest Control by Mallis, A., Franzak & Foster Co. Cleveland, Ohio.
- Ebeling, W., Reiersen, D. A. & Wagner, R. E. (1968). The influence of repellency on the efficacy of blatticides. III. Field Experiments with German Cockroaches with notes on three other species. *J. Econ. Entomol.*, 61(3):751-761. in The Cockroach Insecticides and Cockroach Control by Cornwell P.B., The Rentokil Library, Associated Business Program, London.
- Holcomb, M. (1995). Food Plant Pest Control: In-House or Contracted? *Pest Control*, 63 (9): 92.
- Mallis A. (1990). Hand Book of Pest Control, The behavior, Life History and Control of Household Pests. (Seventh Edition). Franzak & Foster Co., Cleveland, Ohio
- Meehan, A.P. (1984). Rat and Mice , Their Biological Control. The Rentokil Library. Rentokil Limited, East Grinstead.
- Resetar, D. (1989). Blueprint for Success. *Pest Control.*, 57 (11): 24-26.
- Saudi Arabian Standards Organization (SASO), (1991). CAKES, pp. 3
- Saudi Arabian Standards Organization (SASO), (1983). Bread Prepared From The Various Kinds of Wheat Flour. PP. 6.
- Saudi Arabian Standards Organization (SASO), (1981). Enriched and Enriched Treated Wheat Flour. pp. 3.
- Shaheen, L. (1992). Light Traps Spark Focus on Prevention. *Pest Control* 60(5): 34-37
- Willis, E.R. and L.M. Roth (1950). The attraction of *Tribolium castaneum* to flour. *J. Econ. Entom.*, 43(6): 927. in Hand Book of Pest Control by Mallis, A., Franzak & Foster Co. Cleveland , Ohio.
- Wright, M.L. (1984). Management Guidelines Series, Marketing Pest Control Service in The Food Industry, VII. Bakeries. National Pest Control Association Publication.