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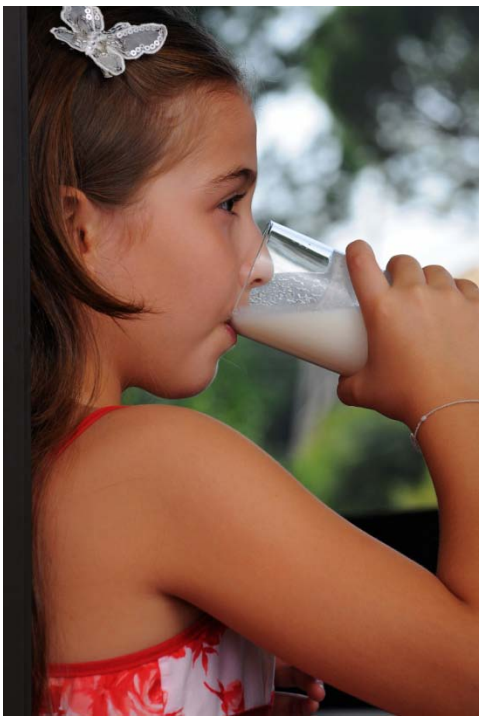
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org



RISK ASSESSMENT OF FOOD

Biological Risk Assessment of the Dairy Sector in Lebanon

UNITED NATIONS

INDUSTRIAL DEVELOPMENT ORGANIZATION

Biological risk assessment of Dairy Sector in Lebanon

An output of the project:

ASSISTANCE TO THE LEBANESE MEAT AND MILK PROCESSING SECTOR IN THEIR EFFORTS TO GAIN INCREASED MARKET ACCESS

Financed by the Government of Italy

This report is an outcome of the project” *ASSISTANCE TO THE LEBANESE MEAT AND MILK PROCESSING SECTOR IN THEIR EFFORTS TO GAIN INCREASED MARKET ACCESS” (UE/LEB/04/159)* carried out by UNIDO and the Ministry of Economy and Trade of the Republic of Lebanon. The report was prepared by the Agri-Business Development Branch of UNIDO.

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Abbreviations and Acronyms

CNRS	**National Council for Scientific Research**
CAC	**Codex Alimentarious Committee**
Cfu	**Colony forming unit**
EU	**European Union**
FSMS	**Food Safety Management System**
GHP	**Good Hygienic Practice**
GMP	**Good Manufacturing Practice**
HACCP	**Hazard Analysis Critical Control Point**
ISO	**International Organization for Standardization**
Lab	**Laboratory**
MD	**Medical Doctor**
MOPH	**Ministry Of Public Health**
NFSC	**Nutrition and Food Science**
NSTE	**National Short Term Expert**
LFSA	**Lebanese Food Safety Authority**
PAP	**Pan Arab Project**
QMS	**Quality Management System**
SRP	**Site Risk Potential**
TAC	**Total Aerobic Count**
UNIDO	**United Nations Industrial Development Organization**
USNRC	**United States National Research Centre**
NHHEUS	**National House Hold Expenditure and Utilization**

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1 Introduction

The problems of food safety and quality are multidisciplinary in nature. The effective application of a National Food Safety System framework requires knowledge of current food safety problems and their magnitude.
Food legislation has evolved over the last fifty years with the establishment and maintenance of a high level of protection of human health. This is why new regulations establish the « PRECAUTIONARY PRINCIPLE » as an option to risk management, when a decision is to be made.
A food control system should therefore rely on scientific principles and on the assessment of the risk to human health. It is widely defined as a process consisting of three parameters. 1) Risk assessment (hazard identification, hazard characterization, risk characterization); 2) Risk management (selecting and implementing appropriate control options and regulatory measures); 3) Risk communication (the exchange of information between all parties, about risks).
The involvement of stakeholders is required and they are mandated to make effective contributions. This participation will provide a mechanism for interactive exchange of information and encourage collaboration among all concerned stakeholders. The involvement of stakeholders contributes to the enhancement of consumer confidence in the integrity of our food supply, and facilitates the risk management process. This confidence is an essential outcome of a successful food policy.
The present report which was elaborated under the guidance of Prof. H. Dib, Lebanese University, Faculty of Food Science and Technology, Beirut provides the necessary background for necessary interventions in an important sector of the Lebanese food sector and is intended to be used for continuous improvement of the food continuum.
At the time of the printing of this report some of the recommendations are already under implementation at a pilot level.
The fact that some changes and improvements are already under way does not lift the responsibility of the involved stakeholders along the whole value chain to fulfill their responsibilities.
Of mayor importance is the approval of the new Food Law which will create an international acceptable frame work for safe food produced and processed in Lebanon.

2 Executive Summary

- *A qualitative or descriptive biological risk assessment for the dairy sector in Lebanon was carried out. Description was based on available data extracted from various research studies and surveys. Data was not sufficient to cover every segment or code in the dairy production chain. Hazards identification carried out by UNIDO scientific committee in Lebanon was very supportive.*
- *Estimation and description of food borne diseases and infections were established based on data released by the Lebanese Ministry of Public Health (MOPH),, medical reports, and field surveys carried out in hospitals in Tripoli, northern part of Lebanon; Hermel – Kaá, north of Bekaá; and Ain-w-Zein in Shouf-Mount Lebanon. According to research and data obtained from the Department of statistics in the Ministry of Public Health, the surveys carried out in various hospitals, food poisoning cases (hospitalized) range from about 800 to 5000 cases per year.*
- *Dairy facilities are mostly subject to external environmental contamination. Also the poor hygienic conditions in the sites surroundings, specifically the rural areas and subsequently increased organic dumping and accelerated fermentation contribute to microbial contamination.*
- *Due to the high cost of land in Lebanon, most industrial buildings are composed of multistory state, except for the few newly built large size enterprises. Also the majority were established small then have gotten larger by the time. The extensions were gradual with unplanned industrial planning. The area of various operations become crowded and does not allow enough space to protect food products and provide safe maneuver of operation control. These conditions together with the lack of knowledge about the principles of food hygiene and good manufacturing practices have led to difficulties in the prevention of cross contamination.*
- *It was evident that water used in the various processing and cleaning operations had a significant effect on the level of product contamination. Only few sites were found using biologically clean water.*
- *The biological risks in the dairy sector in Lebanon have also been assessed by UNIDO scientific committee in 2005 - 2008. Identified risks were also alarming. Major causes of contamination were industrial water, poor hygiene, transport and milk collection conditions, and inferior quality raw milk.*
- *There are 15.6 % of locally produced cheeses are contaminated with Listeria monocytogens, of which 28.57 % are known as Baladi Cheese with an average count of 30 cfu/g. The average consumption of Baladi cheese is 37.1 g/day per capita i.e the average ingestion of bacterial cells will be 1113 per portion per day. The highest portion of Baladi cheese consumed per day was recorded to be 200 g which is equivalent to $7.42x10^3$ cfu/day/capita. The infectious dose of Listeria ranges from 100 – 1000 cfu/g i.e the whole portion of population that consume Baladi cheese may be infected by the pathogen. Southern male of age 30 and over are more vulnerable than others.*
- *In Lebanon, the control barriers related to hygienic requirements and GMP are still insufficient to control the prevalence and concentration of pathogens in food products throughout the food chain.*
- *General water supply has a first priority risk with E. coli and Salmonella as first priority ranking pathogens. This was followed by meat, then dairy sector. There was a distinguished appearance of Staphylococcus aureus in meat and poultry products, whereas Listeria was abundant in dairy products.*

3 Scope

The scope of this mission is to descriptively assess risks associated with various dairy operations along the dairy production chain i.e. from "farm to fork". As risk assessment necessitate a certain degree of specificity and pre-determined information and credible data, the undergoing study is characterized by the term "descriptive", "qualitative" or "crude" risk assessment because it is almost impossible at this stage to establish quantitative risk assessment due to data and commitment limitations. Though, semi-quantitative risk assessment is considered for some local product-pathogen.

3.1 Methodology

As previously mentioned, risk assessment is significantly dependant on the availability of scientifically credible data together with approved reference research results. Therefore, heavy work was carried in the first phase of this mission to collect data from various sources. Field surveys were carried out to collect data related to food borne diseases and outbreaks, and another one was carried out to assess the level of local dairy product consumption in order to investigate risk exposure as an example supporting the descriptive risk assessment. The former survey was carried out in the town of Tripoli (North Lebanon), the town of Hermel (including) Kaá in the northern part of Bekaá and in Shouf-Mount Lebanon. The selection of these three areas was based on availability and suitability for assessment experimental design.

Data of biological risk assessment associated with various Lebanese food products/sectors were extracted from previous work carried out by UNIDO/Lebanon in 2004 and 2005. The results were then analyzed and interpreted to be used as realistic reflection of the current status of food contamination in Lebanon. Data obtained from an undergoing research carried out by Dib and Hajj (2008) were analyzed and statistically studied to determine risk exposure and dose response in association with other results.

Also, on-site inspection results of numerous Lebanese food establishments carried out by Dib et al (2005) were used to describe the nature of GMP/GHP violations and its association with food contamination.
In the second phase, a logic frame work was established using figures and illustration to cover all requirements of descriptive risk assessment starting by risk analysis and ending with potential dose response (end point).

3.2 Limitations and constraints

Major limitations were faced in the process of collecting data on food poisoning cases and outbreaks. The ministry of Public Health provided some data on hospitalized cases that are only covered by the ministry. Still, others

(about 52% of the population) are not addressed officially any where. Even so, it was very difficult to determine on the number of cases that are caused by the ingestion of contaminated food and water. Fore example, they report intestinal infection diseases or abdominal disorder rather than stating the exact case and cause. Only recently the ministry has distributed a specific form to hospitals that is specifically designed to address food poisoning infections and outbreaks.
Surveying hospitals, however, was also difficult and rely on personal relations. This is mainly due to two reasons; first unavailability of records, and second they were worried about official investigation of individual or group food poisoning cases, which may lead to legal complications they do not like to be involved with.

4 Recommendations

1. Quantitative risk assessment for the various food sectors in Lebanon should be carried out to reveal all hidden segments of the food chain that may present a real threat to human health and life. Also, such assessment is vitally important to enable risk managers to establish strategies and programs of inspection and determine on types and levels of legislative enforcement and program delivery.

   Risk managers should clearly define the scope and purpose of the risk assessment, including the exposure assessment before it is commissioned. That should take place during the risk evaluation step. The possibilities of using modular processes approach for exposure assessment in primary production and consumption should be explored.

   2. More work and efforts should be given to collect Data on all types of risks that may threaten consumer's health and life. Particular attention and seriousness should be given to food poisoning diseases and outbreaks. Detailed information about barriers to bacterial infectious diseases that are related to the consumption of contaminated food should be further investigated.

   Data collection strategies for exposure assessments should be changed or elaborated to address missing gaps and generate the required information and data. Risk assessors should communicate data needs to risk managers and risk managers should prioritize current surveillance programs to meet these threats.

   3. Set-up a national communication network module to initially circulate, discuss and conclude on emergence and re-emergence of various risks along the food chain. The network could be an introduction to a rapid alert system.

   Risk assessors will have to do their best to work with the available data and communicate the uncertainties and limitations associated with exposure assessments based upon these data.

4. Setting-up a food safety expert pool to promote expertise and harmonize concepts and definitions in the risk assessment paradigm at all levels. The food safety pool should be based on a voluntary contribution and represent a national source for advisory, support, expertise and guidance on food safety issues.

Risk analysis in its three components should be transmitted in the country from its descriptive and qualitative approach toward quantitative approach. Adequate resources for the peer review process should be made available as an integral part of the exposure assessment. The results of peer review should be accessible to all concerned bodies.

5. All efforts should made to disseminate and extend knowledge, technical specifications, know how and awareness about Good Hygienic and Manufacturing Practices (GHP/GMP) together with continuously improved and updated food safety management systems, particularly, HACCP approach.

Food safety management systems and its pre-requisite programs should be established to suit Lebanese food environmental conditions. This is to be based on the specificity of each food sector and determination of critical factors of Site Risk Potential (SRP). Manuals and technical guidelines are necessary and should be put down in Arabic. Although, previous and present activities of training and guidance are very helpful, yet they should be promoted to address and respond to the results of risk assessment and management.

6. A public awareness program should be established to, especially to consumers, through non-governmental organizations in order to raise pressure on officials and accelerate the legislative wheel which is necessary to apply and maintain the outcome of risk assessment-management-communication.

5 Food-Borne Microbial Pathogens in Lebanese Food Chain

5.1 Background

Probably, over 95 % of food poisoning is caused by microbial pathogens. Some of these pathogens are well known to general public such as *Salmonella* and *Escherichia coli*, and many others are less familiar. There are viruses and fungal toxins which have been poorly studied and their contribution to the general incidence of food poisoning is not well recognized. Micro-organisms causing food poisoning are found in a diverse range of foods. They have a wide range of virulence factors and may elicit a wide spectrum of adverse responses that may be acute, chronic or intermittent. Some bacterial pathogens, such as *Salmonellae*, are invasive and may cause bacteraemia and generalized infections. Other pathogens produce toxins that cause severe damage in susceptible organs such as the kidney (for example *E.coli O157:H7*). Medical opinion reported that complications may also arise by immune-mediated reactions e.g. reactive arthritis and Guillain-Barre syndrome, where the immune response to the pathogens is also directed to the host tissues. The complications from enteritis normally require medical care and frequently hospitalization. There may be a substantial risks of mortality in relation to sequelae, and not all patients may recover fully but may suffer from residual symptoms which may last for a lifetime. Generally speaking such alarming consequences are not quite familiar to Lebanese society. The majority of the population, including a significant part of educated segment, think that the extent of food poisoning may end at an acute abdominal pain and intestinal infections leading to diarrhea or constipation and similar symptoms. Scientific research have revealed an approved relationship between micro-organism, particularly bacterial and viral pathogens, and health complications as seen in Table 1.

Because consumers are unaware that there is a potential problem with the food, a significant amount of contaminated food is ingested and hence they become ill. Various research works have revealed an alarming contamination level in diverse foods in Lebanon particularly meat and dairy. This will be discussed later in the report. Consequently, it is hard to trace which food was the original cause of food poisoning because consumers will not recall noticing anything appropriate in their recent meals. They are likely to recall food which smelt "off"or looked "discolored"; however, these changes are related to food spoilage and not necessarily food poisoning. On the other hand, professional investigators hardly carry out detailed investigations on food-outbreaks cases. This situation makes it very hard and confusing to determine on causes and health side-effects of food-borne out-breaks.

Thanks to scientific research and scientists who discovered food microbial associated risks, which have facilitated risk assessment through defined and pre-determined trials and known pathogens. As a result, food poisoning

micro-organisms were divided into two main groups; infectious such as *Salmonella* serotypes, *Campylobacter jejuni* and pathogenic *E. coli*, and intoxications such as *Bacillus cereus*, *Staphylococcus aureus*, and *Clostridium botulinum.*

The first group multiplies in the human intestinal tract, whereas the second group produces toxins either in the food or during passage in the intestinal tract. This division is very useful to help recognize the route of food poisoning. An alternative grouping would be according to severity of illness. This approach is useful in setting microbiological criteria and risk analysis. Both divisions were used in this study report.

Table 1: Food-Borne Diseases and Associated Complication (Forsythe,2002)

Disease	Associated complication
Brucellosis	Aotitis, orchitis, meningitis, pericarditis, spondylitis
Campylobacteriosis	Arthritis, carditis, chloecystitis, colitis, endocarditis, erythema nodosum, Guillan-Barre syndrome, haemolytic uraemic syndrome, meningitis, pancreatitis, septicaemia
E.coli (EPEC & EHEC types) infections	Erythema nodosum, haemolytic uraemic syndrome, seronegative arthropy
Listeriosis	Meningitis, endocarditis, osteomyelitis, abortion and stillbirth, death
Salmonellosis	Aortitis, cholecystitis, colitis, endocarditis, orchitis, meningitis, myocarditis, osteomyelitis, pancreatitis, Reiters syndrome, rheumatoid syndromes, septicaemia, splenic abcess, thyroiditis
Shigellosis	Erythema nodousm, haemolytic uraemic syndrome, peripheral neuropathy, pneumonia, Rieters syndrome, septicaemia, splenic abcess, synovitis
Taenisis	Arthritis
Toxoplasmosis	Fœtus malformation, congenital blindness
Yersiniosis	Arthritis, cholangitis, erythema nodosum, live rand splenic abcess, lymphadenitis, pneumonia, pyomyositis, Reiters syndrome, septicaemia, spondylitis, Stills disease

5.2 Food-borne pathogens and food poisoning cases

Despite an increasing awareness and understanding of food- and water-borne micro-organisms, these diseases remain a significant problem and are an important cause of reduced economic productivity. While everyone is susceptible to food-borne diseases, there are a growing number of people who are more likely to experience such diseases, often with more severe consequences. These people include infants and young children, pregnant women, those who are immunocompromised and the elderly. Children in developing countries, including Lebanon, suffer two or three episodes of diarrhea per year, and some cases as many as ten episodes. Up to 70 % of such episodes in children under 5 years of age have been attributed to food. Weaning foods contaminated with pathogenic strains of E. coli are considered to be the cause of 25 – 30 % of diarrhea disease episodes in developing countries. A serious consequence of diarrheal disease is the effect on the nutritional status and immune systems of infants and children. Repeated episodes lead to a reduction in food intake, aggravated by loss of nutrients due to mal-absorption and vomiting, fever and impaired resistance to other infections (often respiratory); hence the child become caught up in a vicious cycle of malnutrition and infection. Many do not survive under these circumstances, and some 13 million children under 5 years old die annually in this way.

The exact annual number of food poisoning cases is almost impossible to be determined exactly, particularly in developing countries including Lebanon. In many instances, only a small proportion of cases seek medical help and not all are investigated. It has been assumed that in industrialized countries less than 10 % of the cases were reported, while in developing countries reported cases probably account for less than 1 % of the total. In the USA, it has been estimated that 76 million cases of food-borne diseases may occur each year, resulting in 325 000 hospitalizations and 5000 deaths. The UK study similarly estimates that the proportion of the public experiencing gastroenteritis due to food borne pathogens is 20 % each year and perhaps up to 20 people per million die. More recent study in the Netherlands estimated the number of microbial food-borne illnesses to be 79.9 per 10 000 person years.

In Lebanon, according to the Ministry of Public Health (2004), intestinal infectious diseases accounted for 2166 cases out of 93672 registered during 11 months period. It is worth mentioning that the Ministry covers about 48 % of the Lebanese population i.e. the number may be double. El-Zein (2004) reported that intestinal infectious diseases were the second leading cause of non-emergencies in infant and children up to 9 years old. The author (2002) also reported that such diseases accounted for the top cause of hospitalization in those aged less than one year with 21.2 % and 13.1 % for respectively those aged 1 to 17 years old. A house hold survey carried out by Pan Arab Project (PAP, 1996), examined 4600 house-holds of which 2156 less than 5 years old children revealed that prevalence of diarrhea was 5.4 % in males and 3.7 % in females. Also, deaths due to diarrhea in children less than five constituted 9.9 % of all deaths. Another survey carried out by the

National House Hold Expenditure and Utilization (NHHEUS, 1999) included 6544 households representative of Lebanon. The survey revealed that 5.2 % of outpatient visits and 5.5 % of hospitalized cases were due to infectious and parasitic causes. By statistical calculation the over all percentages of infectious diseases will be 10.7 %. If 90 % of infectious diseases are due to ingestion of contaminated food and water, then 9.6 % of the sample are food poisoning cases. According to MOPH figures, the probable number of treated cases at the expense of the Ministry is about 2739 for the year 2004. The number may be multiplied by 2 because the ministry covers only 48 % of the population i.e. the number will be about 5479 cases per year.

On the other hand, the incidence rate of Brucellosis reported by the MOPH was 8.1 per 100 000 (8.6 per 100 000 in male and 7.6 per 100 000 in female). Reported cases for Brucellosis for two consecutive years; 1998 and 1999 were 286 and 191 respectively. It was also declared that Lebanon is endemic for Brucellosis. This has been approved by the chairman of medical committee at Hermel Public Hospital which is the only available one in that area (September 2008). In an Interview, Dr Muhyddin (GP) stated that Brucellosis is widespread in the area of northern Bekaá, particularly Kaá – Hermel Area. Cases range between 50 and 70 cases a year. Main reasons include infections of goat herds in the area, lack of extension and hygiene, and poverty. The hospital (Hermel) registered various poisoning cases caused by *Salmonella*, *Staphylococcus aureus, Escherichia coli,* and *Pseudomonas*. A major source of contamination in his opinion was water. According to the hospital records potable and service water are contaminated with E. coli causing urinary infections especially in female due to washing with such water. Infections by Salmonella come next due to the ingestion of contaminated food particularly, dairy and fruit and vegetables, irrigated with contaminated water. The sewage draining systems are almost absent and may come in touch with potable and service water. Highest cases were reported for typhoid (may reach 200 cases a year) due to cross contamination. Still, according to MD Muhyddin, the hospital recorded 13 cases of food poisoning caused by the ingestion of contaminated Baladi cheese (a locally produced variety sometimes from raw milk) due to *Staphylococcus aureus*. Main reasons include bad handling practices, hand bruises and lack of hygiene. The total number of food and water poisoning cases in the area (From Irsal to Kasr) were 263 i.e. approximately 97 cases per 1000, which is a very high rate.

Probably, the area under study, Irsal – Hermel, represent the situation of food-borne diseases and infections in all rural area of Lebanon. The type of case, microbe and disease may differ from one area to another depending on environmental conditions, socio-habits, food activities etc.

In parallel, a field survey was also carried out in Tripoli where food poisoning cases and outbreaks were investigated in six hospitals (Appendix 1). These are Monla, Hanan, Nini, Mazloum, Islami, and Haykalyeh. Tripoli, the capital of northern part of Lebanon, was chosen because it is easier to control when compared to Beirut which may receive huge number of patients from all over

Lebanon. However, registred cases of food borne diseases were very modest for the following reasons:

- Most of food poisoning cases are not registered either to skip legal and official investigations, especially in case of outbreaks, or cases are treated off the record in emergency wards.
- Unavailability of official reporting network and subsequently lack of commitment toward recording and registering cases.
- Cases are sometimes considered as negligible and therefore they are ignored.
- Cases are sometimes not diagnosed properly due to confusion with other complications and are registered as side-effect complication with no certainty about the original source of health problems.

Analysis of cases for three consecutive years, 2005 – 2008, showed that the top rank cause or source of contamination was due to water representing 49 % of cases (Fig. 1). This was followed by dairy products, especially Kashta (type of whipped cream), with 15 % and then meat products with 10 % of the total cases. Most of the water-borne cases were caused by viral infection, particularly Hepatitis A.

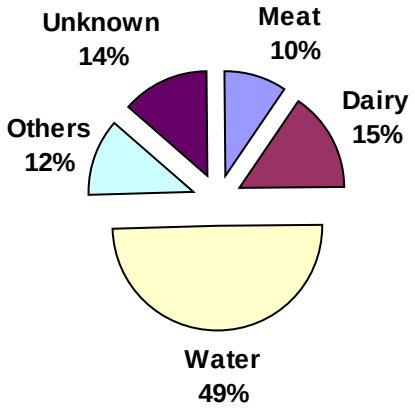


Fig. 1: Percentages of food poisoning cases in accordance with the source of contamination. *Others include Mayonnaise, sesame and Tahini based sweets.*

Major causes of contamination include lack of hygienic requirements, inferior food manufacturing practices, lack of technical and scientific education related to cross-contamination, and most importantly absence of official strategic control.

On the other hand, Salmonella spp occupied the highest score in causing food-borne diseases with about 52 % of the total cases (Fig. 2). This was follwed by Hepatitis A with about 36 % and then Brucella with about 12 %. Other organisms that have caused infections include *Escherichia coli* and *Staphylococcus aureus*. Unknown micro-organisms are too numerous where cases were registered by symptoms rather than microbe. Descriptions include terminologies such as vomiting, abdominal pain, diarrhea and nausea. It is worth mentioning that symptoms of food poisoning are almost similar in most of microbial infection types.

Fig. 2a: Percentages of food and water borne diseases in accordance with the type of microbe (Tripoli, North of Lebanon).

It has been understood that most of the cases were identified according to symptoms rather than scientific investigation (lab testing). The main reason for that is the financial status of the patient where hospitals tend to skip lab analysis to save on cost. However, according to the number of food poisoning cases registered in 6 hospital in Tripoli, the calculated total number per year will be 2226.6 cases.

Furthermore, another survey study was carried out in Mount-Lebanon, Chouf area, at the hospital of Ain-w-Zein. Figure 2b shows the percentage of cases in two consecutive years, 2007 and 2008, together with causes of diseases. Gastroenteritis is the leading disease among all, which may be caused by viral and/or bacterial infections. There are many micro-organisms that can cause the disease, and therefore it is necessary to investigate each of the cases to determine the real cause. It seems that in all investigated hospitals the leading pathogens are similar. However, according to registered cases in Ain-w-Zein hospital, the total number of cases may be about 840 cases per year.

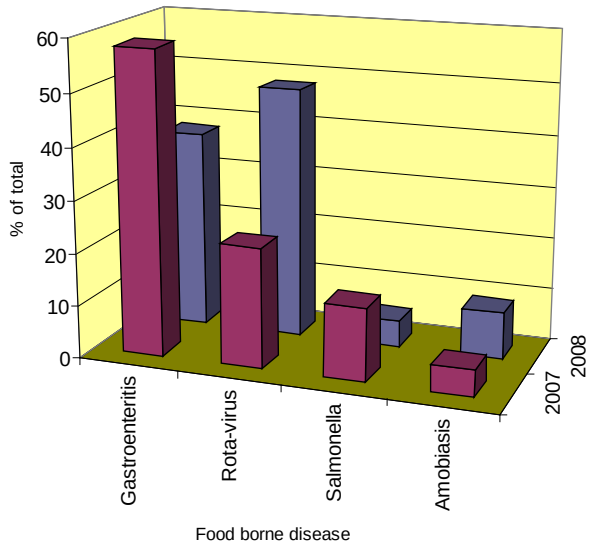


Fig. 2b: Percentage of food borne cases in accordance with the type of microbe (Ain-w-Zein, Mount Lebanon).

Registered outbreaks due to the ingestion of contaminated food include Kishta (dairy product), canned meat, and raw meat (liver).

Outbreaks that have been reported by the Lebanese media were those caused by dairy products (Kishta), contaminated by *Salmonella* and *E. coli*; cooked rice contaminated by Bacillus cereus; Kaák (baked dough stuffed with thyme and other herbs) contaminated with *Staphylococcus aureus*; water contaminated with E. coli and Salmonella due to cross-contamination from the sewage drainage system; Baladi cheese contaminated with *Salmonella*, *Staphylococcus aureus* and *Brucella; eclaire (sweet stuffed with egg product) contaminated by Salmonella, during which a child has died.*

Consequently, organisms that may be endemic in Lebanon include *Salmonella spp, Staphylococcus aureus, Listeria monocytogens, clostridium perfrengens, Escherichia coli, Bacillus cereus, Brucella spp.*, and *pseudomonas*. Whereas, water (potable, service and industrial) is a major source of contamination in Lebanon. Contaminated foods include, in order of risk, dairy products, particularly Baladi cheese and Kishta, meat products, particularly eaten-raw type, Tahini and Tahini products, fruits and vegetables, special bakery products (staffed type).

5.3 Emergence and re-emergence of food-borne pathogens and toxins in Lebanon

For various reasons, the number of identified food-borne pathogens has increased in recent years. Although, available data are not enough to determine on this matter, yet there is a public agreement that this is a fact. Emerging (and re-emerging) infections have been defined by the USNRC as "new, recurring, or drug-resistant infections whose incidence in human has increased in the last decades or whose incidence threatens to increase future". It is believed that this definition applies to Lebanon to a large extent.

The emergence of certain food-borne pathogens and toxins in Lebanon is due to a number of causes:

1. Weakened or collapsed public health infrastructure for epidemic disease control due to economic problems, health policies, civil strife and war.
2. Poverty, uncontrolled urbanization and population displacements,
3. Environmental degradation and contamination of water and food sources,
4. Ineffective infectious disease programs,
5. Increased potential for spread of diseases through globalization of travel and trade, including that of processed and raw foodstuffs of vegetal and animal origin,
6. Dispersal by new vehicles of transmission
7. Newly appeared organisms in the microbial population, such as those resulting from inappropriate use of antibiotics, including antibiotics used in animal production which are responsible for the rise of resistance to antimicrobial drugs,
8. Diseases crossing from animal to human populations with increasing frequency, especially when humans exploit new ecological zones, and intensification of animal food production and industrialization of food processing and distribution become global practices.

It has been observed that the typhi-type of Salmonella has caused a significant number of food poisoning cases, which has been related to the use of antibiotics in animal management. Also, there is a serious concern about the emergence of *Campylobacter jejuni* in poultry, which need to be investigated.

5.4 The cost of food-borne diseases

In addition to human suffering, food borne diseases can also be costly. In the united states the medical costs and productivity losses are in the range of US$ 6.6 – 37.1 billion. The cost of human illness due to only six bacterial pathogens is US$ 9.3 – 12.9 billion annually. Of these costs, US$ 2.9- - 6.7 billion are attributable to the food-borne bacteria *salmonella serovars, C. jejuni, E. coli, L. monocytogens, St. aureus,* and *Cl. Perfringens*.

The impact of food losses due to microbial contamination is also considerable. Worldwide losses of grain and legumes are estimated to be at least 10 % of production, and for non-grain staples, vegetables and fruits, the loss could be as high as 50 %. Food contamination affects trade in two ways. Firstly, contaminated food may be rejected if the levels of contaminants are above the limits permitted by importing countries. Secondly, a country's reputation in food safety may cause a decrease in trade as well as in tourism e.g. the export of Lebanese Tahini products to Europe.

In Lebanon, It is still very difficult to calculate real figures about losses in food production, health expenditure and productivity. Yet, Officials (Prime Minister Seniora) announced that Lebanese health bill is amongst the most expensive in the world. According to the Lebanese Ministry of Health, the annual health budget is 360.3 billion L.P. for 2004. The national expenditure on health was 476.0 US$ per capita, representing about 11.3 % of the Lebanese GDP, compared to 7.1 % in Ireland for example. The total hospitalized cases for the same year were 106201 cases, not forgetting that the Ministry covers only 48 % of the Lebanese population.

Probably, a comprehensive study should be carried out to assess losses due to food contamination on all affected levels. An estimate of the cost required to implement modern approaches of food safety protection should also be carried out.

6 Risk Analysis

Risk assessment is one of three main pillars of risk analysis and form the base that other pillars namely; risk management and communication depend upon to draw control policy, strategies and programs. Thus, it was important to design the general frame work of pillars interrelations in order to clarify the road map which will lead to achieving mission objectives. The following illustrative chart (Fig. 3) shows the adopted design of such inter-relations of risk analysis components. This is to emphasize the total and best responding integration of risk management and communication to risk assessment outputs, following an overall evaluation of the Lebanese status of food safety under risk evaluation subtitle which is composed of the followings:

1. Identification of a food safety problem
2. Establishment of a risk profile
3. Ranking of the hazard for risk assessment and risk management priority
4. Establishment of risk assessment policy for conduct of risk assessment
5. Commitment of resources
6. Commissioning of risk assessment
7. Consideration of risk assessment result

Based on previous studies, Lebanese food safety problems can be summarized in one sentence: "there is no strategy and policy for effective food control". Therefore, the whole current ´control system´ need to be revised and reformed to suit the worldwide demanding development. As proceeding in this report, it is thought that the picture will be clearer to understand, and requirements will be more insisting. Probably, the most relevant topic encountered in the illustrative chart is risk assessment

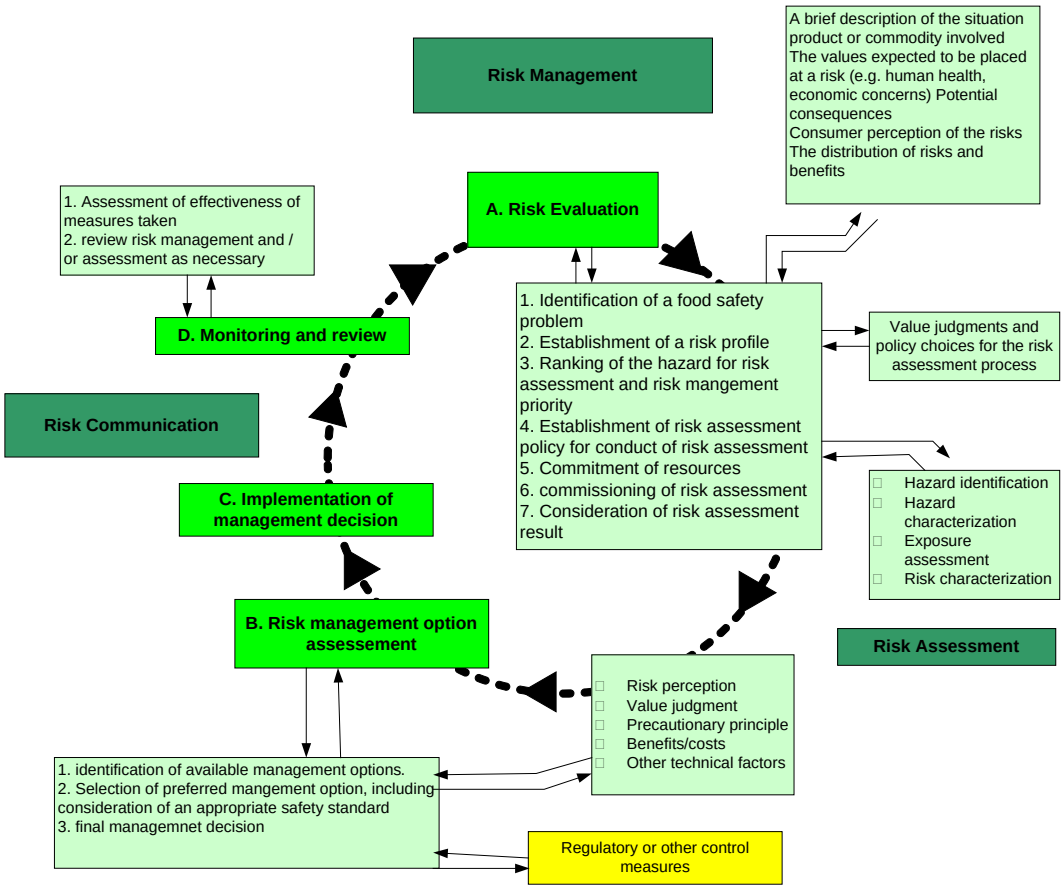


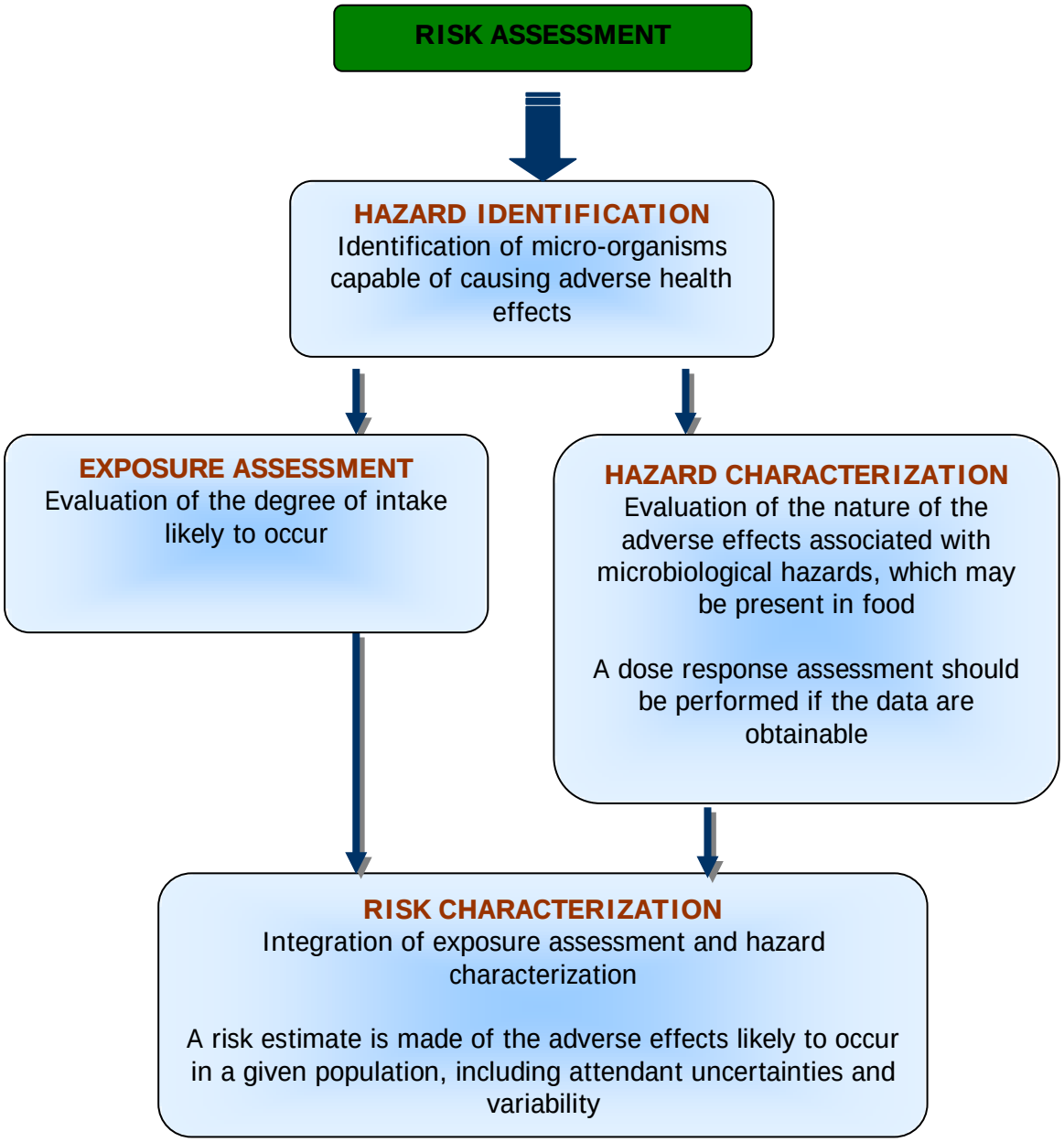
Fig 3: Illustrative chart of interactive pillars of risk analysis; assessment, management and communication (Adopted from FDA, 2004).

6.1 Risk assessment

As mentioned previously, risk assessment process was carried out in a descriptive or qualitative concept. Although, some data were available for few local dairy products in addition to CGMP violation, but still such data and information were not enough to develop quantitative risk assessment. Thus, such data were used as evidence when discussing risk assessment components and variables or categorization, ranking and filtering of risks. However, the risk assessment process is illustrated in Fig. 4 with a short explanation of its main components.

However, when discussing risks and evaluating their impact on health, socio-economical and environmental conditions, approved acceptable, least damaging level of contamination, and market conditions should be taken in consideration. Particular attention was given to the European Union (EU) and Codes Alimentarious recommendations and guidelines related to hygienic conditions and food safety in general. A summary of such requirements are listed in Box 1.

Fig. 4: FLOWCHART OF RISK ASSESSMENT PROCESS



Frankly speaking, it is almost impossible to meet these requirements in Lebanon due to shortage in necessary data, lack of expertise, inefficient and/or absent official strategy of control, fragmented, non-continuous and modest reporting systems, and lack of knowledge related to hygienic and manufacturing practices.

Box 1: EU principles of microbiological risk assessment (CAC 1999).

1. Microbiological risk assessment should be soundly based on science
2. There should be a functional separation between risk assessment and risk management.
3. Microbiological risk assessment should be conducted according to a structured approach that includes hazard identification, exposure assessment, hazard characterization and risk characterization.
4. A microbiological risk assessment of microbiological hazards should clearly state the purpose of the exercise, including the form of risk estimate that will be the output.
5. The conduct of a microbiological risk should be transparent.
6. Any constraints that impact on the risk assessment such as the cost, resources or time, should be identified and their possible consequences described.
7. The risk estimate should contain a description of uncertainty and where the uncertainty arose during the risk assessment process.
8. Data should be such that uncertainty in the risk estimate can be determined: data and data collection systems should, as far as possible, be of sufficient quality and precision that uncertainty in the risk estimate is minimized.
9. A microbiological risk assessment should explicitly consider the dynamics of microbiological growth, survival and death in foods, and the complexity of the interaction (including sequelae) between human and agent following consumption as well as the potential for further spread.
10. Wherever possible, risk estimates should be reassessed over time by comparison with independent human illness data.
11. A microbiological risk assessment may need re-evaluation, as new relevant information becomes available.

6.1.1 Hazard Identification

Risk ranking of complex systems typically requires an identification of multiple quantitative and qualitative factors for each risk and/or hazard. These factors in turn, often fall within a complex hierarchy of criteria under a stated risk question. For example, a simple risk question, such as "what factors might be related to the risk of poor food product quality?" is likely to generate different lists of factors depending on the background, perspective, and expertise of the respondent. For example, one group might focus on the microbiological parameters of the food product. Another group might focus on the processes used in manufacture, or on the factors related to the facilities regulatory history with the official inspecting entities.

Based on such concept, hazard identification was carried out according to three main components. These are food establishment (site of production), product and process used to transform the product. A list of questions

generated from the modern concept of food safety procedures to protect consumer health was used as a guide lines to draw those critical factors associated with the three components. Questions included the followings:

- What hazards (source of harm) related to manufacturing can adversely impact food quality attributes?
- What variables are associated with, or predictive of, those hazards?
- What processes or process parameters are critical for quality attributes?
- What factors may affect the identified hazards and critical parameters and processes?
- What factors are predictive of high or low quality manufacture?

This process resulted in identifying three levels of potential risk factors, the first is quantitative and related to product, the second and third are risk factors related to establishment and processes. Both, second and third are rather qualitative and descriptive, although process critical factors include quantitative measures of control.

6.1.1.1 Site Risk Potential

Site risk potential covers all risks associated with food handling from "farm to fork". Main components of the chain are product, process and facility regardless of how complicated the process is. Table 2 illustrates a briefing of definitions for each component.

Table 2: Top-level components for the site selection model

Factor Category	Description	Example(s)
Product	Factors pertaining to properties of food product such as quality deficiencies which could potentially and adversely impact public health	Microbial load, dosage, chemical properties
Facility	Factors relating to characteristics of a manufacturing site believed to be predictive of potential quality risks, such as the lack of effective quality management systems	Poor GMP compliance
Process	Factors pertaining to aspects of food manufacturing operations that may predict potential difficulties with process control	Measuring, filling, closing, compression, temperature control

The model requires huge work to be done on each product – process within specific food sector. This is to quantify potential risks, although descriptive estimation of risks can be done through direct site inspection. The model was applied on some products in dairy, meat and tahini sectors. An example of such conceptual module is illustrated in Fig 5.

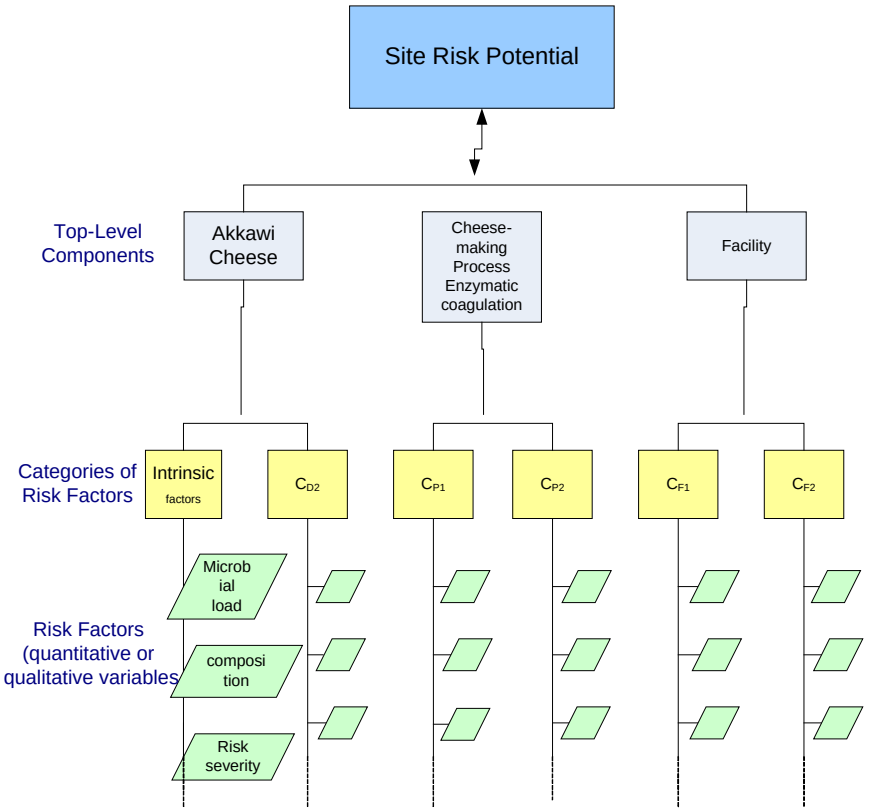


Fig. 5: Conceptual Organization of the Site Selection Model.
Food Establishment Critical Factors

As been mentioned earlier, facility critical factors include those relating to characteristics of a manufacturing site believed to be predictive of potential quality risks, such as lack of effective quality systems. The main concept that may cover such characteristics is recently introduced as Good Hygienic Practices (GMP) and other related topics. The most advanced standard that cover food safety control systems is currently known as ISO 22000: 2005.

However, Lebanese food establishments are mainly of medium and small size businesses, where only few enterprises apply modern concepts of food safety management systems. Although, there are many updating and training activities are taking place in the country with the support of EU through various projects such as QUALEB and ELCIM, together with UN organizations particularly UNIDO through projects such as the Food Safety Project (FSP), MACLE and LAISER. Most of these activities are executed under the supervision of the Ministry of Economy and Trade. In addition to the quality certification of several Lebanese enterprises, probably, the most significant achievement was the new, modern science risk-based, food safety law which will be endorsed by the Lebanese parliament in the near future.

Within the frame work of several studies carried out by UNIDO 2004 and 2005 on risk identification of the fields dairy, meat and tahini derivatives, about 100 establishments have been site inspected to assess GMP compliance. The general frame work is illustrated in Fig. 6. The outcome of site-inspection with this regard can be summarized as follows:

6.1.1.1.1 Dairy Site Location and environmental impact

Physical contamination surrounding a food industry in North Lebanon. Note the glass and wreckages beside the main entrance

It was observed that the majority of inspected sites in several region of Lebanon did not respect the environmental impact on both ways in and out. Only few were enforced sometimes by local regulations to take steps to minimize certain contamination aspects that seems obvious e.g. spices industry, roasteries and some poultry facilities. Facilities are mostly subject to external environmental contamination particularly those located in crowded traffic areas. Such environment adds to the chemical contamination such as heavy metals. Also the poor hygienic conditions in the sites surroundings, specifically the rural areas and subsequently increased organic dumping and accelerated fermentation contribute to microbial contamination. Also, physical contamination was observed in various sites of production. These include glass, wood, soils, dirt and others. Probably, the most significant element that may increase cross-contamination was the misuse of industrial water.

Uncontrolled water supply at the roof of a food industry in Mount Lebanon

It was noticed that industrialists are either not aware of the environmental aspects or they have no knowledge of their control. Difficult to solve issues are generally related to infrastructural nature, where government should take actions to resolve them. These include sewage water drains, power and water supply. Most industrialists were convinced that water supply was a major issue, especially when proved by microbiological tests, and therefore they took the initiative to mount water treatment units at their sites.

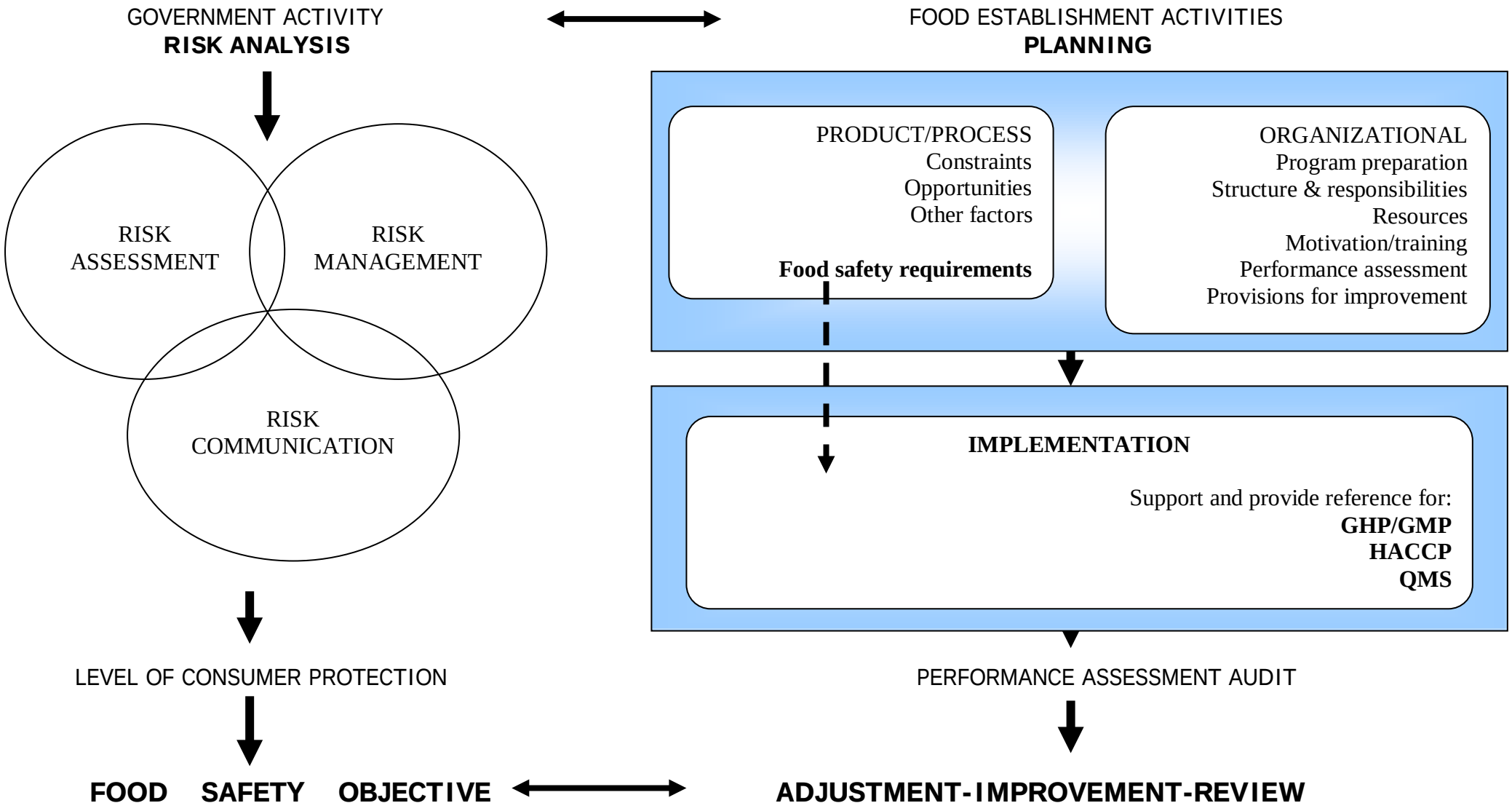


FIG.6: INTERACTION BETWEEN GOVERNMENTS' AND ESTABLISHMENTS' ACTIVITIES

6.1.1.1.2 Building Design

Due to the high cost of land in Lebanon, most industrial buildings are composed of multistory state, except for the few newly built large size enterprises. Also the majority were established small then get larger by the time. The extensions were gradual with unfit industrial planning. The area of various operations become crowded and does not allow enough space to protect food products and provide safe maneuver of operation control. These conditions together with the lack of knowledge about principles of food hygiene and good manufacturing practices have led to difficulties in the prevention of cross contamination. The exterior status of the majority of food facilities is not designed in such a way to protect interior operations and subsequently food products. Fences, platforms, docks, exterior walls, windows, parking lots, entrances suffer major defects or unsuitability for food production site. It was observed that industrialists are not aware of the specifications required for food premises. Also, many of them are financially short to meet such specifications.

Unnecessary suspended damaged sealing and fittings just besides filling operation of food product

Moreover, invasion of pests, birds, insects and animals is inevitable due to the absence of pest control management, traps and insulation. In some establishments water ponds surround the building and encourage breeding of insects and attract birds and animals to the perimeter of the building.

The interior part of most premises lack proper industrial design and subsequently does not prevent cross contamination, particularly, raw materials and end product crossing. This also applies to cleaning operations handling and other practices that take place inside a tight and crowded premise. This situations increase the possibility of physical risks, accidents and loss of materials in fall and breakages, which may add to cross-contamination.

Nice finishing and bad practices

Internal walls, windows, doors, floors, drains and most of other infrastructures are in most of cases out of specifications. Fittings and mounted pipes, wires and tools are misplaced and may cause cross-contamination through harboring of insects and rodents. Doors are mainly made of iron, which may get rusted due to high humidity and excessive use of water. Such conditions are not suitable in the food manufacturing premises. Drains are not sanitary and in most of the inspected sites, they are used for both sewage and industrial waste, a situation that is objectionable in food industry. Windows, particularly in hardware and raw material storage are filthy, and not equipped with proper screens to prevent birds and insects from getting into premises. Floors are mostly made of concrete where some of them applied a modest layer of epoxy paint, which is in most cases suffer great damages. Some tiles are not suitable for food industry, especially wet area, due to their non-homogenous structure.

On the other hand, utilities e.g. generators, gases, water tanks, oils and others are either left outside the premise or they are misplaced in an abundant room with distinguished dust and dirt. Also, in most of the establishments, there were no distinguished colors for each service and it was very difficult for workers, especially if they are new, to distinguish between propane gas and edible materials or water pipes.

Equipment, however, are classified into two main types; those sophisticated and imported from outside countries mainly Europe, and those locally made or adapted. It was observed that, unlike locally made or adapted, imported and sophisticated equipment are well placed and maintained. The reason is probably related to the knowhow of exporting company which normally send a specialized engineer to mount and maintain their equipments.

Although, various and concentrated activities regarding training and upgrading food safety systems and conditions are taken place for several years, yet more effort should be given to broaden such activities on a long term basis. Technical and scientific concepts should also be introduced and contained in these activities. It was clearly observed that there was a significant lack of knowledge and shortage in the availability of specific information and expertise to support training and upgrading activities. Recognizable weaknesses were observed in the field of post-milking stage of handling. Thus, more work should be given to this segment of food chain, especially because it is not quite visible.

Water ponds containing dirt and insects just besides the entrance of food producing industry

This preceding brief descriptive risk assessment applies to establishments that are hosted by an industry having all required food operations i.e. from raw materials to

end product. Other food handling establishments micro-business and similar activities suffer significant drawbacks and they are worse than those of industrial nature.

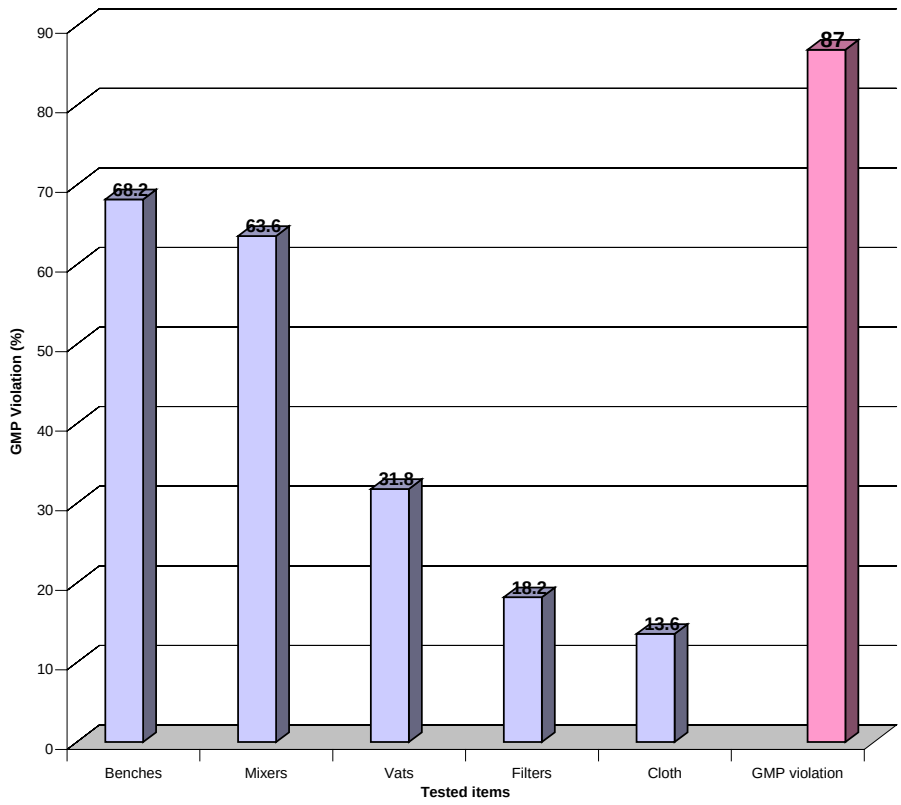


Fig.7: Percentage CGMP violation of inspected dairy sites in Lebanon. *The overall CGMP violation include items that are not plotted in the figure*.

On the other hand, current legislative status are very old and do not respond to the modern hygiene requirements, and therefore, even when abiding to such regulatory conditions safety measures will still be jeopardized. The new food law will probably be the first correct step in consolidation of food safety conditions in Lebanon. Yet, huge amount of work need to be done regarding detailed information, manuals, guidelines, technical regulations for each sector of food production.

6.1.1.1.3 Product Critical Factors

Product critical factors are those pertaining to the intrinsic properties of food products such that quality deficiencies could potentially and adversely impact public health such as chemical or microbiological properties. Factors are considered critical if they cause health impacts when their functional limits are outside specified safety margins at a certain food handling operation. This will vary according to each factor e.g. pH of food is divided into three main groups; high, medium and low acid foods. Thus, process condition will be determined according to each acidity division. Based on such complex matrix, risk assessment and evaluation is normally carried out.

Currently, there are two types of factors in the product component of the model:

1. Intrinsic factors: all those factors that when altered may impact consumer health such as chemical composition and microbial load,
2. Past recall for quality defects: monitoring history of product on the market including number of recalls, scorings, risk ranking, severity etc. Such information are scares in Lebanon due to weak or unavailable reporting systems and poor inspection strategy. Normally, product types with a high frequency of recall occurrence and high hazard severity are given higher weight.

However, the module applied in this study is summarized in Fig. 8.

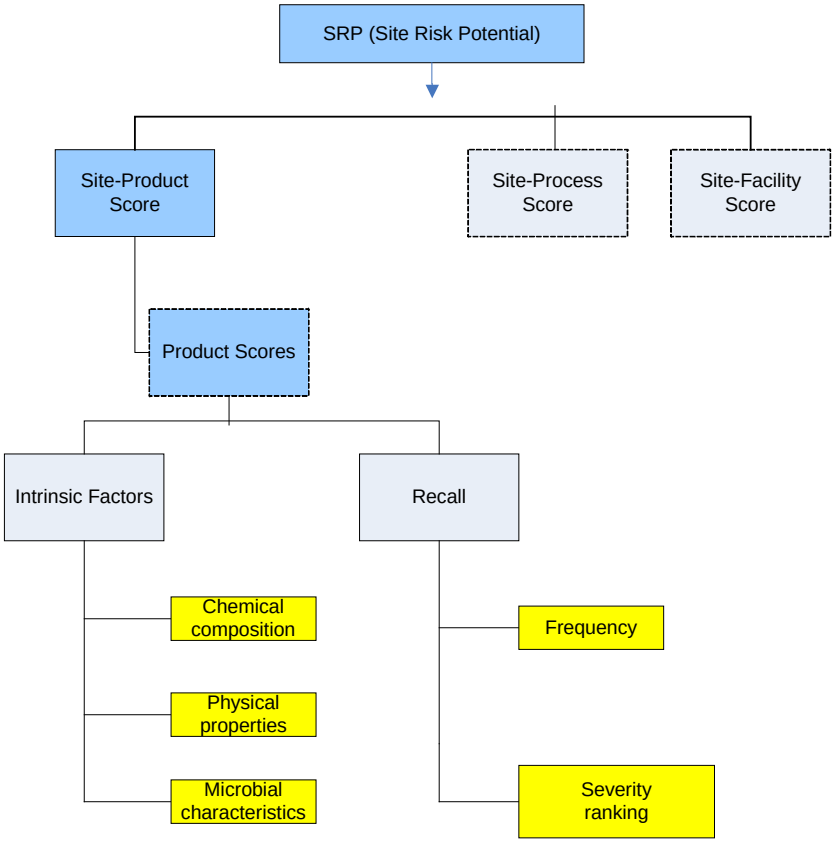
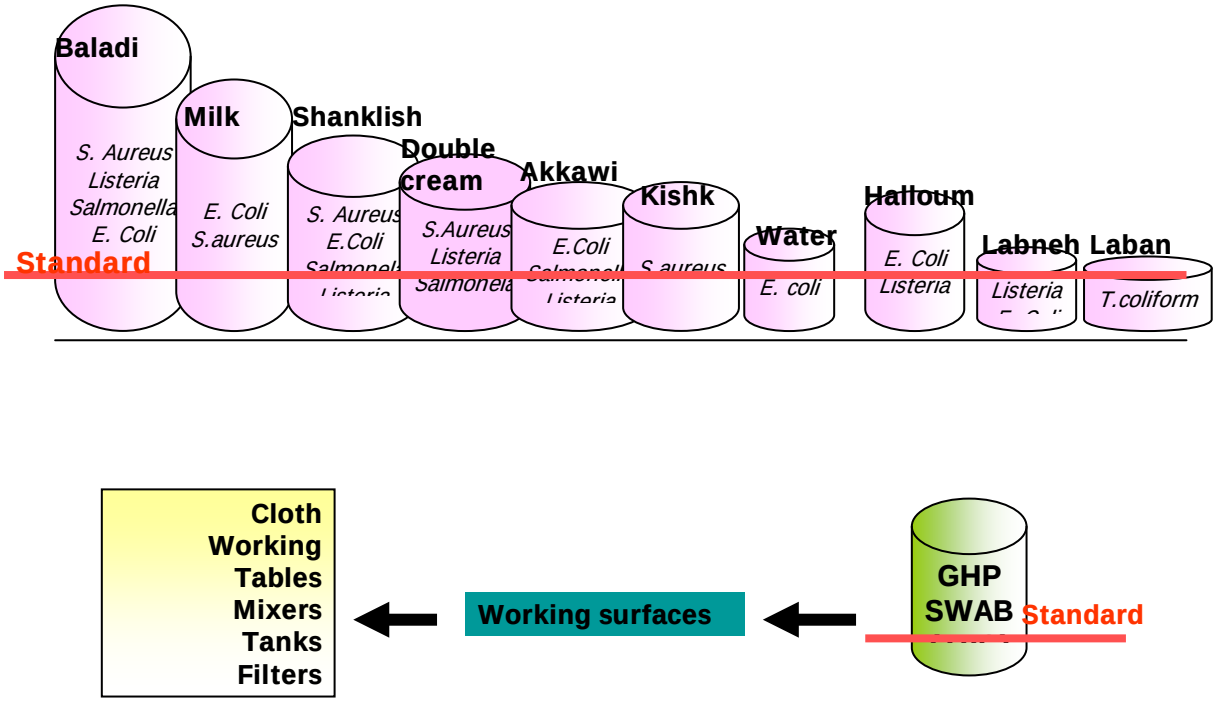


Fig. 8: Schematic module illustrating product component in relation to process and facility

Previous field studies on risk identification in Lebanese food sectors (Tahini and Halawi, Dairy and Meat) were carried out by UNIDO in 2004 and 2005. The studies included inspection of products taken from their site of production from over 100 location all over Lebanon. Detailed results are right reserved to and may be obtained from the organization (UNIDO) in Vienna.

The biological potential risks in the dairy sector in Lebanon have also been assessed by UNIDO scientific committee in 2005 and 2008. Identified risks were also alarming. A brief and descriptive illustration is shown in Fig. 9. Major causes of contamination



were industrial water, poor hygiene, transport and milk collection conditions, and inferior quality raw milk.

Fig. 9: Descriptive and relative contamination of Lebanese dairy products and violation of related standards. GMP/GHP violation of standard and examined items are also illustrated.

The results obtained projected a broad contamination spectrum of various dairy products. This may imply that the application of general guidelines of hygiene and manufacturing practices can significantly improve the situation, especially that swabbing tests have shown contamination of various surfaces. This means poor hygienic conditions and practices.

However, the microbiological results of locally produced soft and semi-hard cheeses were analyzed and classified according to Lebanese regions. These are illustrated in figures 10, 11, and 12. Cheeses produced in the South of Lebanon showed less contamination when compared to those of Bekaá and North Lebanon. Greatest contamination was observed in cheeses produced in North region. Listeria monocytogen was notably observed in cheeses of the Bekaá Valley, whereas Salmonella was recorded in cheeses produced in the North. The oldest dairy industry was actually established in the Bekaá Valley with accumulation of inferior traditional practices. Such conditions encourage the growth of Listeria monocytogen. On the other hand, the Northern part, particularly Akkar area, is well known to encounter sewage water and dumping or waste disposal problems. These finding goes along with incidents of outbreaks taken place in the area. Most of these outbreaks were

related to Salmonella species. The latest being in October 2008 when a child has been dead because of Salmonella in some sort of locally made sweet stuffed with dairy cream. It has reported by the Ministry of Public Health that the vender (street food) has stored sweets in the trunk of his car for two days, the Minister said, though the shelf life of such products is only 24 hours.

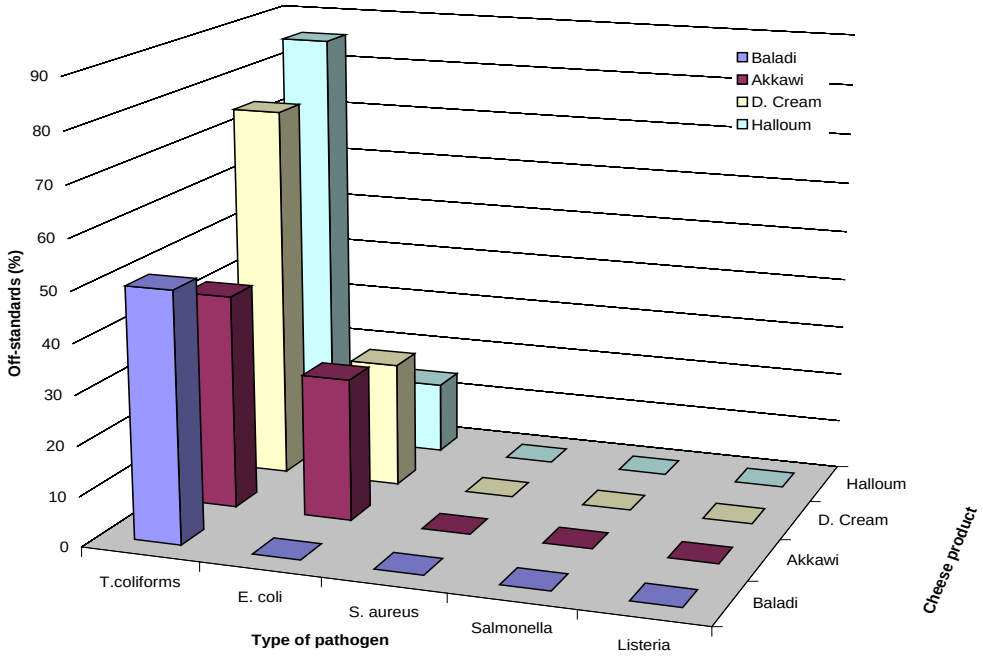


Fig. 10: Percentage off-standards of cheese varieties produced in South Lebanon region in accordance to type of pathogens.

Regarding Bekaá Valley, dairy industry goes back many years ago, probably hundreds of years, but no recognizable alteration, development or improvement has been taken place. Inspection and extension still to date very poor and did not guide or enforce dairy enterprises which are mostly of micro- and small businesses to improve their conditions of production. Simply, old ways do not fit any more. This fact has led to the dominance of Listeria and E.coli in the region, especially the Bekaá Valley is colder than other regions, probably the coldest in Lebanon.

Dairy industry is rather newly established in the South of Lebanon when compared to other regions. Also, the number of enterprises and mass of production is very modest. Yet, contamination of local cheeses by coliforms and E. coli was observed with absence of Listeria and Salmonella.

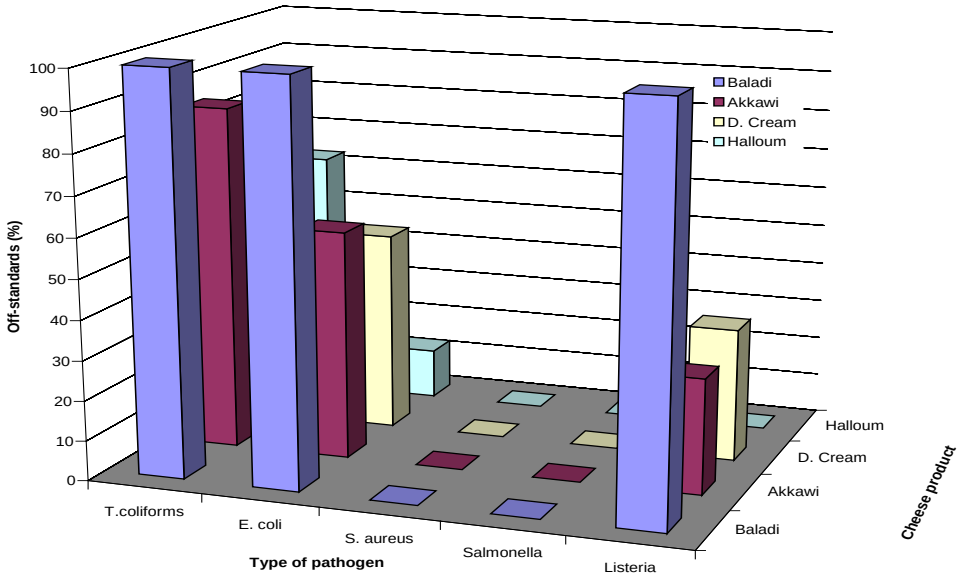


Fig. 11: Percentage off-standards of cheese varieties produced in the Bekaá Valley in accordance with the type of pathogen

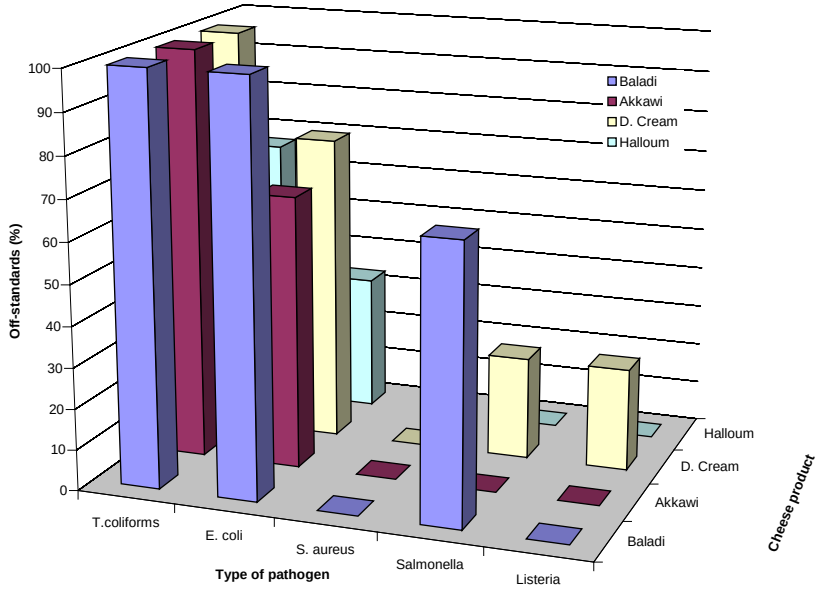


Fig. 12: Percentage off-standards of cheese varieties produced in the North of Lebanon in accordance with the type of pathogen

It's evident that water used in the various processing and cleaning operations had a significant effect on the level of product contamination. Only few sites were found using biologically clean water. Thus, it would be logic to consider water to be the most apparent factor of contamination especially that raw milk was found relatively acceptable.

Another major source of contamination may have been evolved from site conditions, particularly incubation rooms and chilled stores. The presence of yeasts and molds indicate non convenient conditions of brining and ageing rooms.

Pathogenic organisms namely *Staphylococcus aureus* and *Listeria* were detected in various products and sites. The first being quite common organism in the region was detected in most sites. Associated products are raw milk, Baladi, Double cream, Akkawi cheeses, although the level does not exceed international limits. On the contrary, *Listeria* which should be absent from 25ml or grams, was detected in over 20 sites. Associated products were Laban, Halloum, Baladi, Double cream, Akkawi and goat's Labneh. The different processes of these products may imply that such contamination may be attributes to handling and cross-contamination.
Salmonella was not detected in all sites and products tested.

The presence of *Streptococcus faecalis* and *E. coli* in most sites imply contamination by handling (personnel hygiene), cross- contamination, insects, rodents' excrements and animal wastes.

However, the study has addressed all segments of the dairy production chain applying modern approaches. A descriptive interpretation of the findings are presented in Table 3.

Table 3: Identified hazards along the dairy chain in Lebanon and possible risk factors

Steps	Hazards	Risk factors
Farm	• **Fecal contamination:** *E. coli, Salmonella, Clostridium*	Transmission by the hands of the milkman Contamination by the animal at milking, by the tail and the splashes when the bucket is near the animals
	• **Contamination by environmental germs**: psychrotrophes flora (*Listeria, Pseudomonas*), Enterobacteria, yeasts and fungus	Milk in open air at milking time
	• **Multiplication of bacteria on milking material**	Inefficient cleaning and disinfecting of material and/or drying
	• **Contamination by pathogen bacteria:** *Staphylococcus aureus, Streptococcus, Listeria, Mycobacterium tuberculosis, bovis, Brucella, E. coli*	Healthy carrier animals: *Mycobacterium, Brucella* Animals with mastitis: *Staphylococcus sp., Streptococcus sp.* Environment: *Listeria sp.*

	• **Contamination by chemical residues**	Non-respect of waiting time for veterinary medicine
	• **Lipolysis and raw milk turning rancid**	Frequent and brutal decanting
	• **Proteolysis: gelification of UHT milk, decreasing of cheese yield; appearance of sour components**	Collecting milk with mastitis
	• **Inhibition of lactic fermentation: problems for milk processing**	Collecting milk from animals treated with antibiotics
Transport	• **Growing of microbial flora**	Carrying time too long, at high temperature
	• **Contamination by material**	Cleaning and inefficient disinfecting of material and/or bad drying
Collecting center	• **Cross-contamination**	Cleaning and inefficient disinfecting of materials Absence or bad quality control of the milk before mixing (upon arrival)
	• **Contamination with hazardous extraneous material (wood, glass,...)**	Improper cleaning/physical filtration of raw milk upon arrival
	• **Human contamination**	Hand contacts with the milk at the time of sampling
	• **Contamination by environmental germs**	Use of contaminated water for cleaning the material
	• **Development of psychrotrophic flora: synthesis of proteolytic thermostable enzymes**	Temperature of cooling tanks not regulated and too lengthy storage
	• **Development of coliform flora**	Absence of cooling
	• **Lipolysis**	Manual filling of the tanks from the top

6.1.1.1.4 Process Critical Factors

In relation to risks, some processes are more complex and more susceptible to problems than others. It was further recognized that one primary goal of the GMP inspections is to ensure that processing operations are in state of control. Thus consensus among experts was that it would be important to include process-related risk factors in the risk-ranking model. The key issues in the implementation of the risk-ranking model involves questions concerning the relevant process control and risk mitigation factors, and how to weigh/rank them, as illustrated if Fig. 10.

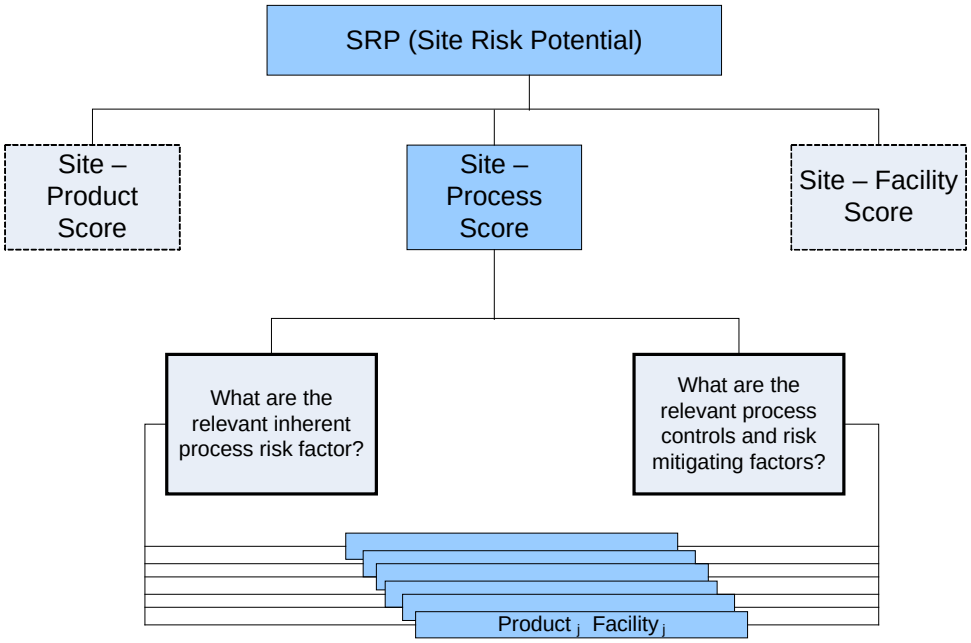


Fig. 13 : Process component factor in relation to product and facility components

Although, responsible and competent authorities lack specific databases to answer these questions, some modest trials have been carried out by various institutions through the implementation of food safety management systems. Yet there are no recorded scores, ranking or results concerning critical factors of processes. This fact would encourage scientists and food business operators to seek developed approaches in describing, weighing and ranking risks related to their process of interest.

In a process such as that of Tahini production, pasteurization is considered as a critical control point that should make a difference in the hygienic characteristic of the product. But, in fact, it is almost impossible to determine optimum process conditions regardless of the two components (product and facility). Therefore, a matrix model should be formulated for each product-process-facility. In Lebanon, risk-vulnerable processes are characterized by the followings:

- Those having no international reference for their critical factors optimum conditions such as Tahini and Halawi production,
- Processes that have no risk-elimination operations such as cheese production,
- Those require sophisticated technologies to be fit for consumptions such as High Pressure Processes,
- Those rely on Post-harvest and /or post-mortem changes such storage of meat,
- Processes that are handled in very primitive and traditional ways without any consideration of environmental changes such most micro-size businesses.

6.1.2 Exposure assessment

Exposure assessment is the qualitative and/or quantitative evaluation of the likely intake of biological, chemical and physical agents via food as well as exposure from other sources if relevant.

Exposure assessment determines the likelihood of consumption and the likely dose of the pathogen to which the consumers may be exposed in a food. The assessment should be in reference to a portion size of food at the time of consumption or a specified volume of water consumed per day. Overall, it describes the pathways through which a hazardous micro-organism enters the food chain and is subsequently distributed and challenged in the production, distribution and consumption of the food. This may include an assessment of an actual or anticipated human exposure. For food-borne micro-biological hazards, exposure assessment might be based on the possible extent of food contamination patterns and habits. Exposure to food borne pathogens is a function of the frequency and amount of food consumed, and the frequency and level of contamination. The steps in food production that affect human exposure to the target organism from primary production to consumption are described as the "farm-to-fork" sequence or the process-risk model and illustrated in Fig. 11.

The diagram emphasizes the two sets of data required in a quantitative risk assessment: prevalence and concentration of the specified pathogen. Depending upon the scope of risk assessment, exposure assessment can begin with either the pathogen prevalence in raw materials or with the description of the pathogen population at subsequent steps, such as during processing. Where surveillance data is lacking or insufficient, such as the case in Lebanon, the effect of processing on prevalence and concentration can be modeled using predictive microbiology. However, exposure assessment is one of the most complex and uncertain aspects of microbial risk assessment. Great emphasis must be placed on estimating the effects of a large number of factors on the microbial population. These factors include the followings:

- The microbial ecology of the food
- Microbial growth requirements
- The initial contamination of raw materials
- Prevalence of infection in food animals
- The effect of production, processing, cooking, handling, storing, distribution steps and preparation by the final consumer on the microbial agent
- The variability in processes involved and the level of process control
- The level of sanitation, slaughter practices, rates of animal-animal transition
- The potential for recontamination and cross-contamination
- The methods or conditions of packaging materials, distribution and storage of the food.

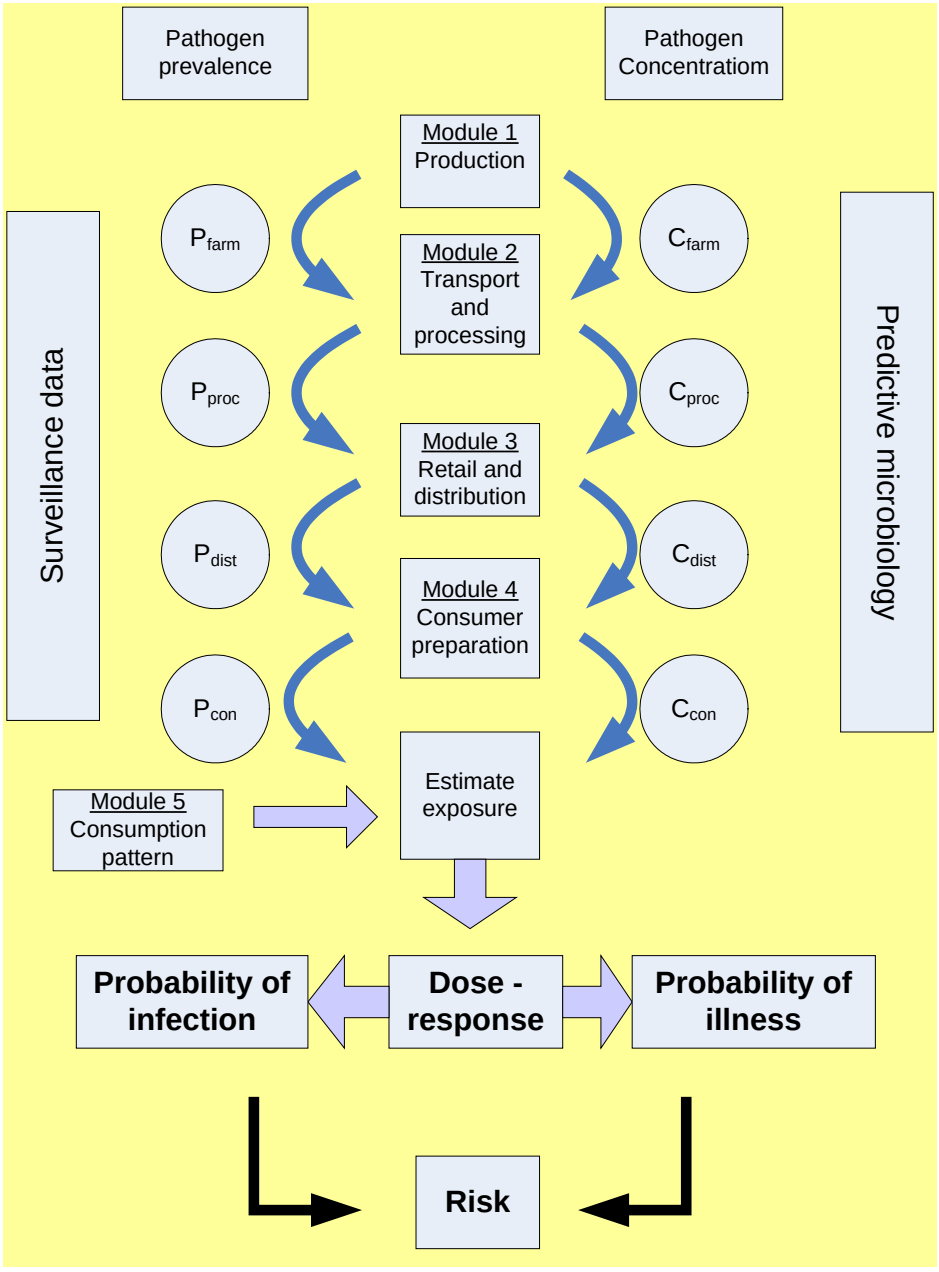


Fig. 14: Framework of "farm-to-fork" module for exposure assessment

Factors related to the food matrix are principally those that may influence the growth of the pathogen through the hostile environment of the stomach may include:

- Composition and structure of the food matrix
- Entrapment of bacteria in lipid droplets
- Processing conditions (e.g. increased acid tolerance of bacteria following pre-exposure to moderately acid conditions)
- Conditions of ingestion (e.g. initial rapid transit of liquids through and empty stomach)

Information on consumption patterns and habits may include the followings:

- Socio-economic and cultural background, ethnicity
- Consumer preferences and behavior, because they influence the choice of the amount of food intake (e.g. frequent consumption of high-risk food)
- Average serving size and distribution of sizes
- Amount of food consumed per a year, considering seasonality and regional differences
- Food preparation practices (e.g. Lebanese eat raw meat)
- Demographic and size of exposed populations (e.g. age distribution, susceptible group).

As stated previously, the module requires a definite type of data to quantify and determine very near approximate of exposure percentage. Such data are not actually available in Lebanon in a module effective and continuous enough to cover all segments of the food production chain. The amount of work required is very huge and require great budget. Still it is very important to invest in such an area because on the long run it will be much cheaper than the cost of food poisoning in the country. Qualitative exposure assessment can not be very helpful in drawing effective strategy for ranking and filtering risks, though pathogens and their association to food products differ from one environment to another. Even if international researches, trials, and experience are intended to be used, the amount and quality of information and data required are very short.

However, available data include statistical surveys on the consumption of local dairy product in Lebanon. These are illustrated in Figures 12, 13 and 14. The amount of each item of local dairy products ranges from 10 to 250 grams/day, the highest being yoghurt followed by strained yoghurt then milk. Amongst cheeses, highest consumption rate was Akkawi cheese followed by Halloum, Baladi and then Double-cream. Shalal and Majdouli cheeses had the lowest rates, even when compared with Shankalish.

Now, the level and percentage of contamination in the end product of an individual product e.g. Baladi cheese, is determined from the results of risk identification, then the results are compared to the average of consumption per day to have a crude idea of the exposure assessment rate from one food item/day. This will be added to other items of food that are consumed per day, week or month to calculate the number of pathogens ingested by the individual or group of people e.g. family. The number obtained will be compared to the required number of intoxicating pathogen. Such data are obtained from research studies such as those presented in Table 5.

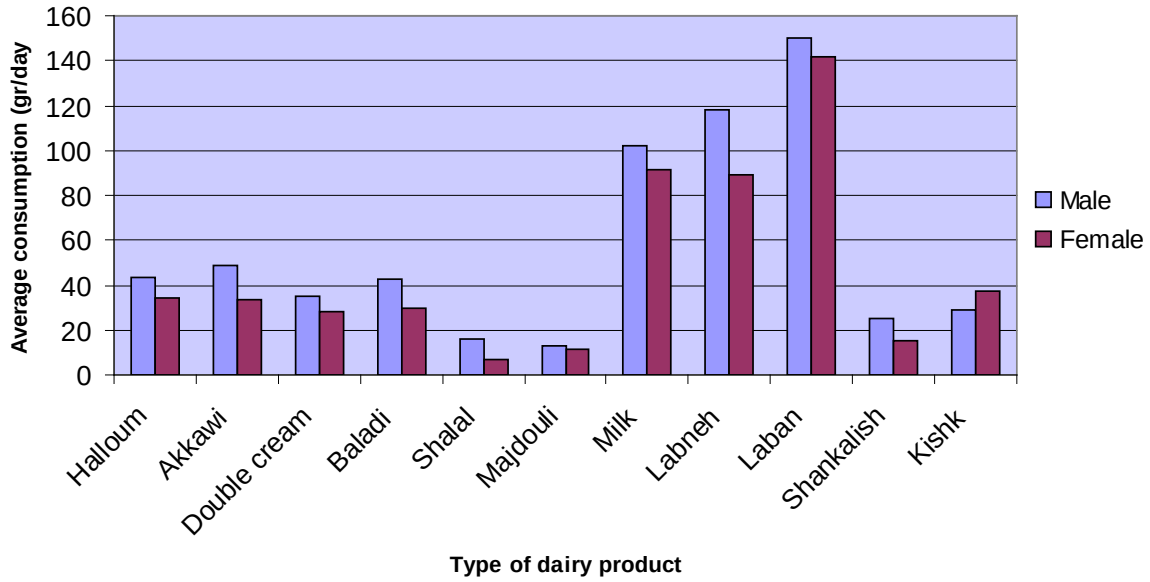


Fig. 15: Average consumption of local dairy products according to gender

Furthermore, based on the dose ingested, the response, probability of illness and infection, can be calculated. According to a field survey carried out by Dib and El Hajj in 2008 (unpublished data), male in the Lebanese society are more exposed to contaminated dairy product than female. The only exception was in the case of Kishk product (a lactic-fermented mixture of pourgouri, crushed wheat, and yoghurt). Probably, this is due to the fact that, unlike others, the product need initial cooking prior to consumption. It is thought that, female are more patient than male and would bear up time required for preparation. Probably, and for the same reason male consume more dairy product because they are handy and normally consumed fresh.

When considering exposure assessment, it is important to include both prevalence and concentration at the same time without neglecting other factors that have been mentioned previously. This module may be applied on the some of dairy product consumed or on each individual product. In both cases complicated and integrated data are necessary to clarify the real picture of dose response.

As can be seen in Fig. 13, the rate of consumption according to age was less determinant than the effect of gender factor. It is recognizable that the lowest rate of dairy products consumption was recorded for adolescent and youths (age ranges from 10 to 29). This is quite understandable, where this segment of population tend to be fast and junky food oriented. On the other side, the highest rate of yoghurt consumption was recorded for the olds. Probably, this is due to the fact that the product is easily swallowed and digested. General observations showed that middle age group of population tend to consume more dairy products than others, particularly Akkawi cheese, Labneh (strained Yoghurt) and milk. This is probably due to their higher consumption rate

of Manakish (pizza-like made with Akkawi cheese) and labneh snack, especially that they are either students or employees who spend most of their days outside home.

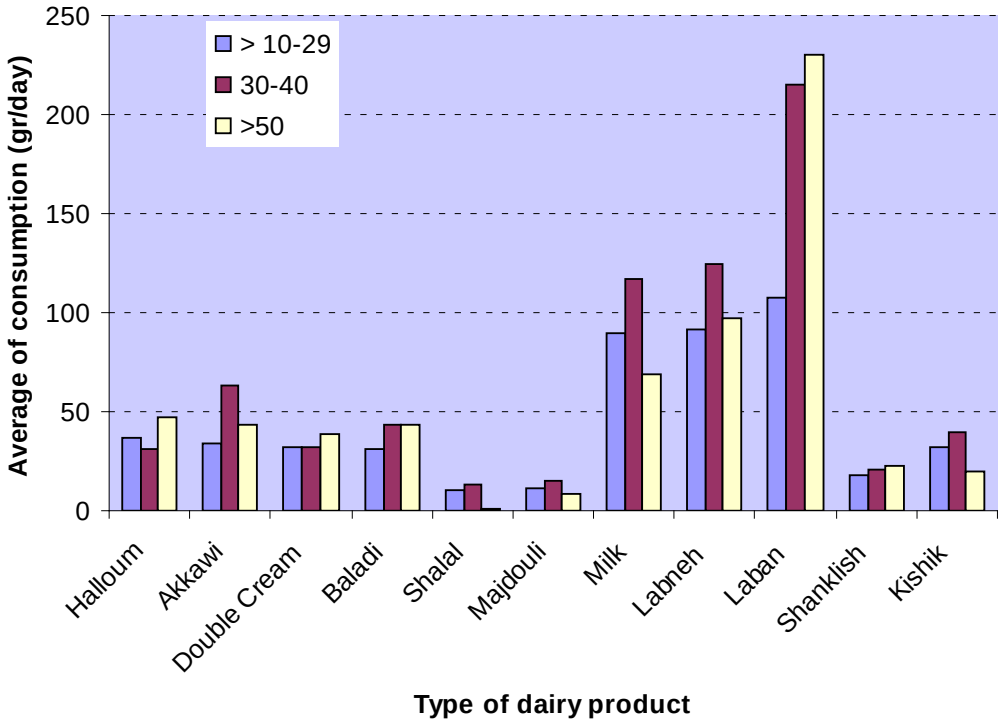


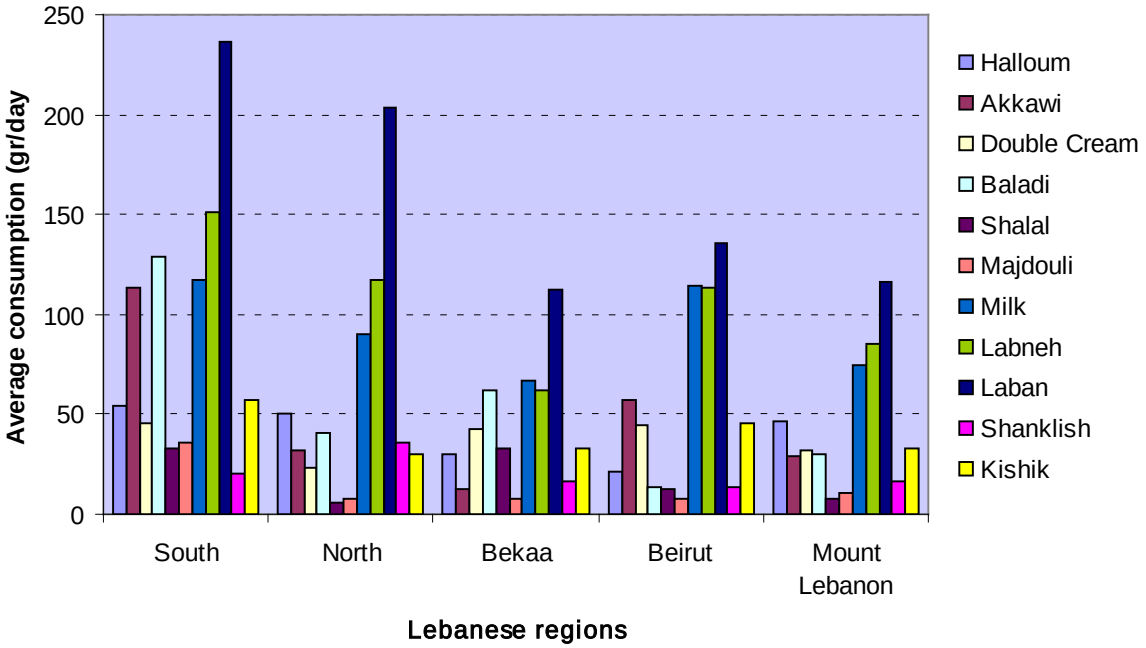
Fig. 16: Average consumption of local dairy products according to age

Regarding this particular factor, age, probably it is important to consider each dairy product as a separate case i.e. one product-one pathogen module. Then percentages will be summed for each age group and added to the module.

Regarding regions of Lebanon, the field survey showed greatest consumption in the South of Lebanon. This was followed by North of Lebanon, Beirut, and then Bekaá and Mount Lebanon. It is worth mentioning that dairy sector in the South of Lebanon is fairly new when compared to those of North of Lebanon and Bekaá. It seems that even consumption pattern is subject to the economical rule of supply and demand. The supply of dairy products in Bekaá is much higher than demand and it is an old tradition which may explain the reduced demand and subsequently reduced consumption rate. On the contrary, habitants of Beirut (the capital) and Mount Lebanon tend to consume more dairy products, especially local, that they are "Baladi", home made, nature production, country-side products etc.

Note that most interpretation are related to social elements such as consumer habits, behavioral changes of consumption, and societal developments.

Fig. 17: Average consumption of local dairy products according to region



Based on the data obtained from the previous results, it will be possible to decide that the percentage of population exposed to contaminated dairy products will be (**X%**), a figure obtained from the results of risk identification, of which there will be (**Y%** male), a figure taken from data of Fig. 12. Southern habitants will be more exposed to contaminated dairy products by a percentage of (**Xs%**). Highest contamination by Salmonella and Literia pathogens was recorded for Baladi cheese which is recorded for 30 and over group of age. Then, the percentage of this group to the population will be calculated (**Z%**) and interpreted in term of amount of cheese per day (**m**). The amount (m) will be multiplied by the level of contamination cfu/g, and compared to the infection dose in Table 5. The resultant number will decide on the probability of illness and infection as a result of dairy consumption in relation to a particular pathogen such Salmonella.

To give a descriptive conclusion of available data, there are 15.6 % of locally produced cheeses are contaminated with *Listeria monocytogens*, of which 28.57 % are known as Baladi Cheese with an average count of 30 cfu/g. The average consumption of Baladi cheese is 37.1 g/day per capita i.e the average ingestion of bacterial cells will be 1113 per portion per day. The highest portion of Baladi cheese consumed per day was recorded to be 200 g which is equivalent to $7.42x10^3$ cfu/day/capita. The infectious dose of Listeria ranges from 100 – 1000 cfu/g i.e the whole portion of population that consume Baladi cheese may be infected by the pathogen. Southern male of age 30 and over are more vulnerable than others.
This is a simplified example of a quantitative risk assessment of dairy products in Lebanon with a particular margin of one-product; one-pathogen i.e. Baladi cheese; Listeria monocytogens.

Table 4: Minimum infectious dose of various intoxicating cells (Forsythe 2000)

Organism	Estimated infectious dose
Non spore forming bacteria	
C.jejuni	1000
Salmonella spp.	$10^4 – 10^{10}$
Sb.flexneri	$10^2 – 10^9$
Sb.dysenteria	$10 – 10^4$
E.coli	$10^6 – 10^7$
E.coli 0157:h7	10 – 100
St.aureus	10^5 - $<10^6/g^a$, 0.5-5 ug toxin
V.cholera	1000
V.parabaemolyticus	$10^6 – 10^9$
Y.enterocolitica	10^7
L. monocytogens	100 – 1000
Spore forming bacteria	
B.cereus	$10^4 – 10^8$
Cl.perfringens	$10^3 – 10^{5a}$
Cl.botulinum	$10^6 – 10^7$, 0.5-5 ng toxin
Viruses	
Hepatitis A	<10 particles
Norwalk-like virus	<10 particles
Protozoa	
Cryp.paruum	10 oocysts
Entamoeba coli	1 cyst

6.1.3 Hazard Characterization and Dose-response

Hazard characterization is the qualitative and/or quantitative evaluation of the nature of the adverse effects associated with biological, chemical and physical agents that may be present in food. If data are available then a dose-response should be performed.

Hazard characterization provides an estimate of the nature, severity and duration of the adverse effects following ingestion of the hazard i.e. for a given number of micro-organisms consumed at a sitting, what is the probability of illness? If sufficient data are available, then a dose response relationship is performed.
Ingestion of a pathogen does not necessarily mean the person will become infected, nor that illness or death will occur. As shown if Fig. 15 , there are a number of barriers to infection and illness. These barriers can be compromised as the result of host and food matrix factors. The response (infection, illness, death) to pathogen ingestion will vary according to pathogen, food and host factors; this is commonly known as the "infectious disease triangle".

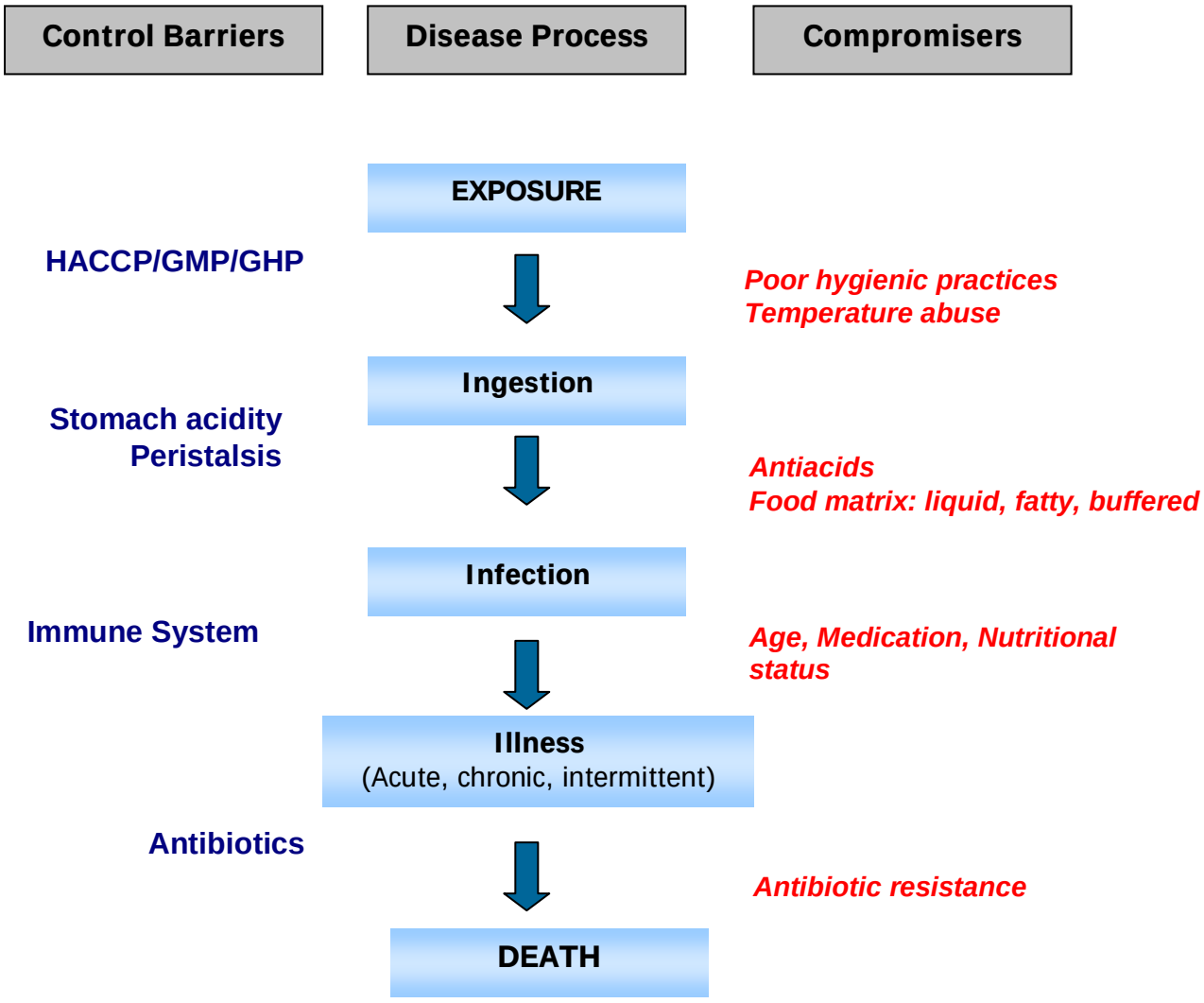


Fig. 18: Barriers to infectious diseases

In Lebanon, the control barriers related to hygienic requirements and GMP are still insufficient to control the prevalence and concentration of pathogens in food

products throughout the food chain. This has been explained in some detail earlier in this report together with reasons of insufficiency. Regarding other barriers, stomach acidity, immune system, antibiotics, etc.), there is no data to quantify. Qualitative and substantial outcome of food poisoning outbreaks give the impression of weak efficiency of these barriers.

For the time being, a qualitative risk estimation matrix can be used to describe human health risks in relation to available data concerning particular pathogen-product approach. This is illustrated in table 5.

Table 5: Example of risk matrix for human health risks (risk characterization) (FDA, 2004)

	Probability of occurrence				
Severity scale	**Very low**	**Low**	**Medium**	**High**	**Very High**
Death	Medium	Medium	High	High	High
Hospitalization	Low	Medium	Medium	High	High
Acute Illness	Low	Medium	Medium	High	High
Worry	Low	Low	Low	Medium	Medium

The probability of occurrence and severity scale will be calculated based on the dose-response assessment for each pathogen-product taking in consideration all affecting factors that have been explained earlier. For example, the risk in question might be botulism poisoning from canned food. Contemporary food packaging standards reduce the probability of occurrence to Low – Very low; however, the consequence of a poisoning event is sometimes death. Thus the overall risk might be scored at medium.

Results obtained from the risk identification of meat sector in Lebanon (UNIDO, 2005), revealed that over 50 % of meat purchased from butcheries was overloaded with *Salmonella* and *Staphylococcus aureus* . Therefore the probability of occurrence for Salmonella in red meat is high and, in best cases, the consequence of infection is hospitalization; then human health risk is "high". Consumption of raw meat, a Lebanese habit, will certainly increase the probability of occurrence to "very High". That is why, it is vitally important to magnify hygienic requirements, operations control and developed inspection system.

As the goal of dose response is to determine the relationship between the magnitude of exposure (dose) to the pathogen and the severity and/or frequency of adverse health effects (response), comprehensive information should be collected about food matrix, microbial load and types, and variation in host susceptibility. It was reported that high doses of Salmonella resulted in greater frequency of severe illness. Then, if

a Lebanese consume, on one day, a 100 gram of raw Kebbeh, a 50 gram of local Baladi cheese and another 50 gram of Hummus Tahineh, then the results will be a high probability of ingesting 2660 cells of *Salmonella*. Knowing that the infectious dose of *Salmonella*, depending on spp, ranges from 10 for *S. dysenteries* to 10^9 for *S. flexneri*, there is no doubt that this number (2660) will drag him to hospital. At that time if that person is lucky, and his stomach pH is lower than 2.5, then only about 2% of cell numbers will pass i.e. about 54. Whereas, when pH of the stomach is over 4, then over 50 % of the pathogen will pass i.e 1330 cfu.

Certainly, there are other factors, barriers to food poisoning infections, taken in consideration when assessing the end point of intoxication chain. It is believed that available data are sufficient to draw qualitative conclusions about food safety in Lebanon in addition to semi-quantitative assessment in some products and few particular pathogens such as *Salmonella* and *Listeria*.

6.1.4 Ranking and filtering of risks

At this stage, accurate scientific ranking and filtering of risks require information and data related to Site Risk Potential (SRP) i.e. product-process-establishment. In addition, information such as inspection outcome, history of violation, frequency of inspection, productivity are also required.

Based on available data and previous on-site inspection of food establishment, together with food poisoning infections and outbreaks, risk-ranking of products and pathogens are shown in Table 7. The distinguished appearance of Staphylococcus aureus in food products implies that handling, hygienic and manufacturing practices are inferior. In such case human factor is a major cause, especially that this micro-organism is associated with bruises and cuts of human skin. Escherichia coli is an indicator of contamination and therefore it represent the first front of pathogen invasion. Emphasis should be placed on targeting this micro-organism as a first priority in all food sectors.

However, no data was found regarding the prevalence of Campylobacter jujeni in poultry meat products. The micro-organism is alarmingly focused on in international research data. Also, various risk assessments were carried out for poultry-C. jujeni with recognizable concerns. Thus, it is highly important to assess its prevalence in the Lebanese-produced products.

It is always desirable and beneficial to carry out quantitative risk assessment for all food sectors in Lebanon in order to develop appropriate strategies and programs of inspection (risk management). Such activities are related to the national legislative requirements, particularly food and feed laws and regulations. Unless such legislative requirements are brought to light, the safety of food and consumers health will always be under threats.

Table 6: Risk ranking and filtering of some food sectors in Lebanon

Rank	Food/water Sector	Pathogens				Pathogen Priority rank	Eradication Priority
		Sa	List	Cl	St		
1	Water (industrial, service and potable)	+				E. coli Salmonella	Control of sources and drainage system
2	Meat Products and eggs a. Poultry Minced Whole chicken Tawook Boneless breast Turkey mortadella b. Red meat Beef lean meat Steak Roast beef, smoked Salami Mortadella olive Mortadella plain	 + + + + + + + +	 + + 	 + + + + + 	 + + + + + + + + + +	E. coli St. aureus Salmonella Cl perfringens Listeria	GHP/GMP (personal hygiene) Technical assistance
3	Dairy Products Baladi cheese Akkawi cheese Double cream cheese Majdouli Shalal Labneh Kishta (whipped cream)	 + + +	 + + + + +	 	 + + + +	E. coli Listeria St aureus Salmonella	Raw material control GHP/GMP (personal hygiene)
4	Tahini and Halawi products Tahini	 +	 	 	 	E. coli Salmonella	Raw material control GHP/GMP

NB:

- *Escherichia coli is always a first priority risk in all food sector*,
- *Risk priority ranking and filtering is based on available data*,
- *Levels of contamination qualitatively presented in the table are all above accepted standards,*
- ***Sa**: Salmonella; **Cl:** Clostridium perfringens; **St**: Staphylococcus; **List:** Listeria*

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Dr. Ahmad Idlabi (Anestesie + GP), Tripoli,
Dr. A. Khoury (Chirurgie plastique), Tripoli)
Dr. Ahmad Karaali (General surgery), Tripoli
Dr. Majed Jawde (GP), Tripoli,

Dr. Fawal Abd L Hamid (General surgery), Tripoli,
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8 Appendices

Appendix 1: Food poisoning cases registered in Tripoli hospitals for three consecutive years

Appendix 2: Food poisoning cases registered in Ain-w-Zein Hospital in Mount-Lebanon, Chouf Area

Appendix 3: Health indicators as published by the Ministry of Public Health

Appendix 4: Number of food poisoning cases according to years and hospitals

Appendix 5: Contamination levels of local dairy products

8.1 Appendix 1:

Food poisoning cases registered in Tripoli hospitals for three consecutive years.

Haykaliye Hospital

Years 2005/2008	Type of outbreak	Number of cases	Food causing outbreak
14/07/05	diarrhea	3	Raw meat
24/10/05	diarrhea	2 out of 6	Dairy product (kishta)
2005	diarrhea	2	Mayonnaise (KFC)
05/09/06	diarrhea	1	unknown
18/09/06	Diarrhea/vomiting	1	unknown
12/07/06	Diarrhea/vomiting	1	unknown
27/11/06	Epigastralgea (stomach pain)	1	unknown
27/12/06	Abdominal pain & vomiting	2	unknown
03/01/07	vomiting	2	unknown
12/02/07	intoxication	1	unknown
21/04/07	epigastralgea (stomach pain)	1	unknown
06/04/07	Vomiting, diarrhea, fever.	2	unknown
07/06/07	Abdominal pain, vomiting	1	unknown
13/06/07	Abdominal pain, nausea.	1	unknown
14/07/07	Diarrhea, vomiting, abdominal pain	1	unknown
04/08/07	Nausea, diarrhea, vomiting.	1	unknown
31/08/07	Abdominal pain, vomiting.	1	unknown
03/09/07	Abdominal pain, diarrhea	1	unknown

29-jan	diarrhea	1	unknown
31-jan	Diarrhea, vomiting	1	unknown
19-feb	Dizziness, stomach pain.	1	unknown
5-mar	Hepatitis A	1	unknown
9-mar	Abdominal pain, vomiting.	1	unknown
11-mar	Diarrhea, vomiting.	1	unknown
2-apr	Abdominal pain	1	unknown
18-apr	Muscular cramp	1	unknown
21-apr	Vomiting, abd. pain	1	unknown
3-jun	vomiting	2	unknown
11-jun	Gastric problems	1	unknown
13-jun	diarrhea	1	unknown
29/01/08	Hepatitis A	1	water
31/01/08	Hepatitis A	1	water
01/02/08	Hepatitis A	2	water
09/02/08	Hepatitis A	1	water
12/02/08	Hepatitis A	2	water
13/02/08	Hepatitis A	1	water
18/02/08	Hepatitis A	1	water
19/02/08	Hepatitis A	1	water
21/02/08	Hepatitis A	1	water
27/02/08	Hepatitis A	1	water

Nini Hospital

Years 2005/2008	Type of outbreak	Number of cases	Food causing the outbreak
25/10/05	ecoli	5 (whole family)	Dairy product (kishta)
26/10/05	diarrhea	1	unknown
19/01/06	fungus	1	unknown
15/03/06	diarrhea	1	unknown
15/03/06	salmonella	1	unknown
23/06/06	diarrhea	1	unknown
06/08/06	Entamoeba histolytica	1	Raw meat (sawda)
13/03/07	diarrhea	2	Canned meat
27/06/07	Entamoeba histolytica	3 (family)	unknown
09/07/07	Entamoeba histolytica	4	unknown
26/08/07	diarrhea	1	unknown

Monla Hospital

Years 2005/2008	Type of outbreak	Number of cases	Food causing outbreaks
January-05	Typhoid fever	1	water
February-05	Typhoid fever	1	water
February-05	Viral hepatitis A	9	water
March-05	Viral hepatitis A	1	water
April-05	Typhoid fever	1	water

June-05	Typhoid fever	1	water
June-05	Viral hepatitis A	1	water
July-05	Viral hepatitis A	2	water
July-05	Typhoid fever	3	water
July-05	brucellosis	1	Dairy product
September-05	Typhoid fever	2	water
September-05	brucellosis	1	Dairy product
October-05	Viral hepatitis A	1	water
October-05	dysentery	2	unknown
November-05	brucellosis	1	Dairy product
December-05	Typhoid fever	1	water
Jan-06	Typhoid fever	1	water
Mar-06	Viral hepatitis A	1	water
Apr-06	Viral hepatitis A	1	water
Apr-06	Typhoid fever	2	water
Jun-06	Typhoid fever	1	water
Aug-06	Typhoid fever	1	water
Nov-06	Typhoid fever	1	water
Jan-07	Viral hepatitis A	1	water
Jan-07	Typhoid fever	1	water
Feb-07	Viral hepatitis A	2	water
Mar-07	Typhoid fever	1	water
Mar-07	Paratyphoid fever	1	water
Apr-07	Viral hepatitis A	1	water
May-07	brucellosis	1	Dairy product

Jun-07	Viral hepatitis A	1	water
Jun-07	Typhoid fever	1	water
Jul-07	Typhoid fever	1	water
Aug-07	Typhoid fever	1	water
Aug-07	Viral hepatitis A	2	water
Sep-07	Typhoid fever	1	water
Nov-07	brucellosis	1	Dairy product
Jan-08	Viral hepatitis A	3	water
Mar-08	brucellosis	1	Dairy product
Mar-08	dysentery	1	unknown
May-08	Viral hepatitis A	4	water
May-08	brucellosis	1	Dairy product
Jun-08	Viral hepatitis A	3	water
Jul-08	Viral hepatitis A	2	water

Hanan Hospital

years 05/08	**Type of outbreak**	**Number of cases**	**Food causing outbreak**
07/01/05	typhoid	1	water
05/02/05	typhoid	1	water
10/02/05	typhoid	1	water
25/05/05	typhoid	1	water
04/07/05	typhoid	1	water
02/01/06	typhoid	1	water
05/02/06	Hepatitis A	1	water
06/05/06	typhoid	1	water

04/05/06	typhoid	1	water
19/05/06	typhoid	1	water
22/08/06	paratyphoid	1	water
28/08/06	Hepatitis A	1	water
29/08/06	typhoid	1	water
04/09/06	brucellosis	1	Dairy products (cheese & milk)
05/09/06	Hepatitis A	1	water
16/10/06	salmonella	1	meat
21/10/06	typhoid	1	water
21/11/06	Hepatitis A	1	water
22/11/06	S.typhoid	1	water
13/12/06	Sal. typhoid	1	water
27/01/07	Sal. typhoid	1	water
26/02/07	Salmonella typhoid	1	Meat, dairy products & water
28/02/07	Hepatitis A	1	water
14/03/07	typhoid	1	water
29/03/07	Hepatitis A	1	water
10/07/07	brucellosis	1	Water and dirty food
19/07/07	Salmonella typhoid	1	Meat, dairy products & water
24/07/07	brucellosis	1	Water and dirty food
20/10/07	Hepatitis A	1	water
15/10/07	paratyphoid	1	water
09/12/07	typhoid	1	water
25/12/07	typhoid	1	water

21/03/08	Hepatitis A	1	water
09/04/08	Hepatitis A	1	water
24/05/08	Hepatitis A	1	water
25/05/08	Hepatitis A	1	water
28/05/08	Hepatitis A	1	water
20/06/08	Hepatitis A	1	water
17/07/08	Hepatitis A	1	water

Mazloum Hospital

Years 05/08	**Type of outbreak**	**Number of cases**	**Food causing outbreak**
16/09/06	salmonella	1	meat
12/10/06	Hepatitis A	1	water
23/11/06	typhoid	1	water
14/02/07	cocci	1	Any type of unclean food
03/05/07	typhoid	1	water
01/06/07	Salmonella & paratyphoid	1	Water & meat
15/07/07	Fever, vomit & diarrhea	1	unknown
06/08/07	Hepatitis A	1	water
10/11/07	typhoid	1	water

18/11/07	typhoid	2	water
22/12/07	typhoid	1	water
17/01/08	brucellosis	1	Dairy products
07/04/08	Hepatitis A	1	water
27/06/08	Hepatitis A	1	water

Islami Hospital

Years 2005/2008	**Type of outbreak**	**Number of cases**	**Food causing outbreaks**
04/05/05	**diarrhea**	**3**	Arbouze
26/10/05	diarrhea	14	Dairy product (kishta)
27/10/05	diarrhea	2	Dairy product (kishta)
16/08/06	diarrhea	4	Yogurt/meat
29/08/06	diarrhea	3	Meat(sfiha)
26/09/06	diarrhea	2	meat
16/05/07	diarrhea	4	Canned meat(mortadelle)

8.2 Appendix 2:

Cases of food borne illnesses collected from medical records of Ain Wzein Hospital (Chouf Area):

***Year*:** **1/1/2007 to 31/12/2007**

***Total number of cases admitted in that Year*:** **8268**

Case Number	**Gender**	**Diagnosis**	Type of poisoning
1	M	Gastroenteritis	Viral and other specified intestinal infections.
2	M	Acute Gastroenteritis	Salmonella
3	M	Diarrhea	Diarrhea & Gastro enteritis of presumed infection.
4	F	Fever/ Diarrhea	Salmonella spp
5	F	Gastroenteritis/ Dehydration	Diarrhea & Gastro enteritis of presumed infection.
6	M	Gastroenteritis/ Dehydration	Diarrhea & Gastro enteritis of presumed infection.
7	M	Gastroenteritis/ Dehydration	Diarrhea & Gastro enteritis of presumed infection.
8	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
9	M	Acute Gastroenteritis	Entamoeba coli cyst
10	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
11	F	Vomiting	Diarrhea & Gastro enteritis of presumed infection.
12	M	Vomiting & Dehydration	Diarrhea & Gastro enteritis of presumed infection.
13	M	Vomiting & Dehydration	Diarrhea & Gastro enteritis of presumed infection.
14	M	Acute Gastroenteritis	Rotavirus
15	F	Diarrhea	Diarrhea & Gastro enteritis of presumed infection.
16	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection./ Yeast like fungi in stool.
17	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
18	F	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
19	F	Acute Gastroenteritis	Entaemoeba Coli cyst & trophozoites
20	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
21	M	Nausea/ vomiting	Bacterial Food intoxication
22	M	Vomiting/ Diarrhea	Diarrhea & Gastroenteritis of

			resumed infection
23	M	Abdominal pain	Diarrhea & Gastro enteritis of presumed infection.
24	F	Diarrhea	Diarrhea & Gastro enteritis of presumed infection.
25	F	Acute Gastroenteritis	Rota virus
26	F	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
27	F	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
28	F	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
29	M	Fever	Rota virus
30	F	Acute Gastroenteritis	Rota virus
31	F	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
32	F	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
33	M	Acute Gastroenteritis	Rota virus
34	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
35	M	Fever/ Vomiting	Diarrhea & Gastro enteritis of presumed infection.
36	F	Vomiting/ Diarrhea	Diarrhea & Gastro enteritis of presumed infection.
37	F	Acute Gastroenteritis	Diarrhea with occult blood
38	F	Acute Gastroenteritis	Rotavirus
39	F	Acute Gastroenteritis	Food intoxication. Salmonella
40	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
41	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
42	F	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
43	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
44	F	Acute Gastroenteritis	Rotavirus
45	F	Severe Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
46	M	Acute Gastroenteritis	Typhoid Fever
47	F	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
48	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
49	M	Acute Gastroenteritis	Typhoid Fever/ shigella
50	M	Acute Gastroenteritis	Rotavirus
51	F	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
52	F	Acute Gastroenteritis	Rotavirus
53	F	Acute Gastroenteritis	Rotavirus
54	M	Acute Gastroenteritis	Dysentery

55	F	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
56	F	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
57	M	Acute Gastroenteritis	Salmonella Spp
58	M	High Fever	Rotavirus
59	M	Diarrhea/ fever	Diarrhea & Gastro enteritis of presumed infection./ stool in blood
60	M	Acute Gastroenteritis	Rotavirus
61	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
62	F	Abdominal pain/ vomiting	Bacterial food borne intoxication
63	M	Abdominal pain/ vomiting	Rotavirus
64	M	Abdominal pain/ vomiting	Diarrhea & Gastro enteritis of presumed infection.
65	M	Acute Gastroenteritis	Rotavirus
66	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
67	M	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection.
68	F	Acute Gastroenteritis	Diarrhea & Gastro enteritis of presumed infection./ stool occult blood
69	M	Acute Gastroenteritis	Rotavirus
70	M	Gastroenteritis	Salmonella SPP

Results:

Food borne Disease	**Total number of registered cases (attributed to food intoxication)**	**Percentage of Total cases (attributed to food intoxication)**
Diarrhea & Gastroenteritis of presumed infection	38	58%
Rota virus	15	23%
Salmonella intoxication	9	14%
Amoebiasis	3	5%

Cases of food borne illnesses collected from medical records of Ain Wzein Hospital:

***Year*:** **1/1/2008 to 30/9/2008**

***Total number of cases admitted in that year*:** **7419**

Case Number	**Gender**	**Diagnosis**	Type of poisoning
1	M	Gastroenteritis	Diarrhea and Gastro enteritis of presumed origin(Enterocolitis)
2	M	Viral and other specified intestinal infections	Rotavirus
3	F	Abdominal Pain	Enterocolitis
4	F	Abdominal pain	Diarrhea and Gastro enteritis of presumed origin(enteritis/colitis)
5	M	Abdominal Pain	Amoebiasis
6	M	Acute Gastroenteritis	Rotavirus
7	F	Abdominal pain	Enterocolitis
8	F	Vomiting & Fever	Diarrhea and Gastro enteritis of presumed origin(Enterocolitis)
9	M	Acute Gastroenteritis	Rotavirus
10	M	Diarrhea/ fever	Rotavirus
11	M	Diarrhea/ fever	Rota virus
12	M	Acute Gastroenteritis/ fever	Rotavirus
13	M	Acute Gastroenteritis	Rotavirus
14	M	Acute Gastroenteritis	Rotavirus
15	M	Acute Gastroenteritis	Rotavirus
16	M	Acute Gastroenteritis	Rotavirus
17	M	Acute Gastroenteritis	Rotavirus
18	M	Acute Gastroenteritis	Rotavirus
19	M	Acute Gastroenteritis	Rotavirus
20	M	Acute Gastroenteritis	Diarrhea and Gastro enteritis of presumed origin(Enterocolitis)
21	F	Acute Gastroenteritis	Rotavirus
22	M	Vomiting/ Diarrhea	Rotavirus
23	M	Vomiting/ Diarrhea	Rotavirus
24	F	Acute Gastroenteritis	Rotavirus

25	M	Acute Gastroenteritis	Rotavirus
26	F	Acute Gastroenteritis	Rotavirus
27	M	Acute Gastroenteritis	Rotavirus
28	F	Acute Gastroenteritis	Rotavirus
29	M	Acute Gastroenteritis	Diarrhea and Gastro enteritis of presumed origin(Enterocolitis)
30	M	Acute Gastroenteritis	Rotavirus
31	M	Vomiting/ Diarrhea	Rotavirus
32	F	Acute Gastroenteritis	Rotavirus
33	M	Vomiting/ Diarrhea	Rotavirus
34	M	Vomiting/ Diarrhea	Rotavirus
35	M	Acute Gastroenteritis	Rotavirus
36	F	Vomiting/DDiarrhea	Rotavirus
37	F	Fever/ diarrhea	Rotavirus
38	M	Fever/ diarrhea	Enterocolitis
39	M	Diarrhea/ vomiting	Rotavirus
40	M	Acute Gastroenteritis	Rotavirus
41	M	Acute Gastroenteritis	Rotavirus
42	M	Acute Gastroenteritis	Rotavirus
43	F	Acute Gastroenteritis	Rotavirus
44	F	Acute Gastroenteritis	Rotavirus
45	F	Acute Gastroenteritis	Rotavirus
46	F	Acute Gastroenteritis	enterocolitis
47	F	Vomiting/ diarrhea	Rotavirus
48	F	Acute Gastroenteritis	Rotavirus
49	F	Diarrhea/ fever	Rotavirus
50	F	Diarrhea/ fever	Rotavirus
51	M	Typhoid Fever	Salmonella Typhi
52	F	Acute Gastroenteritis	Rotavirus
53	M	Acute abdominal pain	No identification
54	F	Fever/ Diarrhea	Amoeba coli cyst & trophozoites
55	F	Acute Gastroenteritis	Parasites: yeast like fungi n stool
56	M	Acute	No identification

		Gastroenteritis	
57	M	Acute Gastroenteritis	Dysentery/unspecified
58	M	Acute Gastroenteritis	Dysentery/unspecified
59	F	Acute Gastroenteritis	Dysentery/ unspecified
60	F	Acute Gastroenteritis	Rota virus
61	F	Acute Gastroenteritis	Salmonella Typhi
62	F	Diarrhea/ Dehydration	Diarrhea and Gastroenteritis of presumed infection.
63	F	Acute Gastroenteritis	Diarrhea and Gastroenteritis of presumed infection.
64	F	Vomiting/ Diarrhea	Diarrhea and Gastroenteritis of presumed infection.
65	M	Vomiting/ Diarrhea	Diarrhea and Gastroenteritis of presumed infection.
66	M	Vomiting/ Diarrhea	Diarrhea and Gastroenteritis of presumed infection.
67	M	Vomiting/ Diarrhea	Diarrhea and Gastroenteritis of presumed infection.
68	M	Vomiting/ Diarrhea	Diarrhea and Gastroenteritis of presumed infection.
69	M	Vomiting/ Diarrhea	Diarrhea and Gastroenteritis of presumed infection.
70	F	Vomiting/ Diarrhea	Diarrhea and Gastroenteritis of presumed infection.
71	M	Vomiting/ Diarrhea	Diarrhea and Gastroenteritis of presumed infection.
72	M	Vomiting/ Diarrhea	Diarrhea and Gastroenteritis of presumed infection.
73	F	Diarrhea	Diarrhea and Gastroenteritis of presumed infection.
74	F	Diarrhea/ Fatigue	Diarrhea and Gastroenteritis of presumed infection.
75	F	Diarrhea/ Fever	Diarrhea and Gastroenteritis of presumed infection.
76	F	Diarrhea/ Fever	Diarrhea and Gastroenteritis of presumed infection.
77	F	Diarrhea/ Fever	Diarrhea and Gastroenteritis of presumed infection.
78	M	Diarrhea/ Fever	Bacterial Food borne Intoxication
79	F	Diarrhea/ Fever	Diarrhea and Gastroenteritis of presumed infection.
80	M	Gastroenteritis	Entamoebal Parasite
81	F	Acute Gastroenteritis	Diarrhea and Gastroenteritis of presumed infection.
82	F	Severe Diarrhea	Entamoebal Coli cyst
83	F	Severe Diarrhea	Enteritis / Parasite , bloody stool

84	F	Severe Diarrhea	Entercolitis

Emergency Records:

5 cases admitted due to a food borne intoxication, but no further analysis was conducted to identify the strain of cause.

1 case of Salmonellosis

Results:

Food borne Disease	Total number of registered cases (attributed to food intoxication)	Percentage of Total number of cases(attributed to food intoxication)
Diarrhea and Gastroenteritis of presumed infection	29	38%
Rota virus	37	48%
Salmonella intoxication	4	5%
Amoebiasis	7	9%

8.3 Appendix 3:

Health indicators as published by the Ministry of Public Health

Health Indicators

Demographic Indicators

Indicator	Figure	Remarks
Population estimate	4,435,000	Estimate for a closed population **2005**
Population Growth Rate	1.58	Baseline Growth rate taken from CAS study of 1997 with a decrease of 0.06 every 5 years
Population by age <15 65+ Dependency ratio	 27.3% 7.5% 53.4	PAPFAM 2005 (preliminary report)
Unemployment ratio	9.9%	Multiple Indicator Cluster Survey (MICS II)(**2000**)
Total Fertility Rate	1.7	PAPFAM 2005 (preliminary report)

Coverage With Primary Health Care Indicators

Indicator	Figure%	Remarks
Infants fully immunized OPV3	85.2%	PAPFAM 2005 (preliminary Report)
Infants fully immunized Measles	43%	PAPFAM 2005 (preliminary Report)
Population with access to safe drinking water	100	PAPFAM 2005 (preliminary Report)
Married women using contraceptives	58	PAPFAM 2005 (preliminary Report)

Budgetary Resources Indicators

Indicator	Figure	Remarks
Allocated to MOH from government total budget	3.6%	الموازنة العامة**2005**
Annual budget of MOH (Lebanese pounds)	360.3 Billion L.P.	الموازنة العامة **2005**
Annual budget of MOH per capita in US$ (2005)	53.9	الموازنة العامة **2005**
GDP per capita, $US exchange rate	4,400	(GDP=29,416 bill LBP) وزارة المالية **2004**
National Expenditure on Health, per capita in US$	476.0	دراسة الحسابات الوطنية **1999**
National Health Expenditure as % GDP	11.30	دراسة الحسابات الوطنية **1999**

Department of Statistics Apr 2006

Manpower and Physical Resource Indicators (rate per 10,000 population)

Indicator	Figure	Remarks
Physicians	23.6	10454 registered and active doctors till end **2005**
Dentists	8.81	3849 registered and active dentists till end **2004**
Pharmacists	8.14	Syndicate figure (Pharmacists Repertoire) **2003-2004**
Nursing and Midwifery Personnel	13.2	**2005**
Hospital Beds	36	**2005**

Health Status Indicators

Indicator	Figure	Remarks
Infant Mortality Rate (per thousand livebirths)	18.6	PAPFAM 2005 (preliminary Report)
Less than Five Mortality Rate	19.2	PAPFAM 2005 (preliminary Report)
Children with Acceptable Weight for Age (%)	96.1	PAPFAM 2005 (preliminary Report)
Maternal Mortality Rate (per 10000 live births)	10.4	النتائج المجمعة للمسح العربي لصحة الأم والطفل في الوطن العربي- جامعة الدول العربية 1996 (Sisterhood Method)

Selected Morbidity Indicators (in number of notified cases)

Indicator	Figure	Remarks
Cholera	0	Epidemiologic Surveillance Unit-MOH
Polio	0	ESU
Measles	644	ESU
Pulmonary TB(+ve smear)	131	TB-program
Diphteria	0	ESU
Tetanus	3	ESU
Neonatal Tetanus	0	ESU
AIDS	24	NAP
Malaria	57	Malaria Control program.All are imported cases (46 falciparum, 11 not confirmed)

6.4 Appendix 4:

Number of food poisoning cases according to years and hospitals

	Year			
	2005	2006	2007	2008
Number of cases in Hanan Hospital	5	15	12	7
Number of cases in Haykaliye Hospital	7	6	25	12
Number of cases in Islami Hospital	19	9	4	5
Number of cases in Mazloum Hospital	11	3	9	3
Number of cases in Monla Hospital	29	8	17	10
Number of cases in Nini Hospital	6	5	10	5
Total	77	46	77	37 + 130 cases of 2 outbreaks

6.5 Appendix 5:

Contamination levels of local dairy products

kind of cheese	Site of Infection by *Salmonella*	*List.Mono*
Double Cream	2.7 % in North	5.4 %Bekaa & 2.7% North
Baladi	5.4% in North	2.7% in Bekaa & 2.7% Mount lebanon
Akaoui	0%	5.4 % Bekaa

Kinds of cheese	*Salmonella %*	*List. Mono %*
Halloum	0%	0%
Double Cream	5.50%	16.60%
Baladi	28.50%	28.50%
Akaoui	0%	9%

Salmonella

	North%	**South%**	**Bekaa%**	**Mount Lebanon%**
Halloum	0	0	0	0
Double Cream	2.7	0	0	0
Baladi	5.40	0	0	0
Akaoui	0	0	0	0

List.Mono

	North%	**South%**	**Bekaa%**	**Mount Lebanon%**
Halloum	0	0	0	0
Double Cream	2.7	0	5.4	0
Baladi	0	0	2.7	2.7
Akaoui	0	0	5.4	0

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Telephone: (+43-1) 26026-0, Fax: (+43-1) 26026-69
E-mail: unido@unido.org; Internet: http://www.unido.org