2. LITERATURE REVIEW

2.1 Natural History of *Campylobacter*

2.1.1 Bacteriology and Ecology

Awareness of public health implications of *Campylobacter* infections has evolved over more than a century. *Campylobacter* was first described in 1880 by Theodore Escherich (Friedman *et al.*, 2000). The name *Campylobacter* is derived from the Greek word "kampylos", which means curved. Campylobacters are Gram-negative, slender, spiral, curved rods having dimensions of 0.2 to 0.8 µm width and 0.5 to 5 µm length. Extremely rapid, darting, reciprocating motility can be seen with a phase contrast microscope, with comma shaped, S, or gull wing-shaped cells. In 1957, King described the isolation of related Vibrio from blood samples of children with diarrhea, and in 1972, clinical microbiologists in Belgium first isolated Campylobacters from stool samples of patients with diarrhea.

The development of selective growth media in 1970s enabled more laboratories to test stool specimens for *Campylobacter*. Soon *Campylobacter* spp. was established as common human pathogens. *Campylobacter jejuni* infections are now the leading cause of bacterial gastroenteritis reported in the United States. *Campylobacter* is a fastidious organism that is capable of surviving in a wide range of environments. It has been isolated from rivers, estuarine and coastal waters, at cell counts ranging from 10 to 230 cfu/100ml (Bolton *et al.*, 1982, 1987).

Campylobacter jejuni and *C. coli* account for the majority of human infections (Friedman *et al.*, 2000) and are commonly referred to as "thermophilic" campylobacters, being able to grow at 37ºC to 42ºC, with an optimum growing temperature of 42ºC, but being incapable to grow below 30ºC. However, a recent study (De Cesare *et al.*, 2002) found that *C. jejuni* will nevertheless survive in excess of 4 hours at 27ºC and 60-62% relative humidity on some common clean or soiled food contact surfaces. Freeze thawing also reduces the population of *Campylobacter* (Stern and Kazmi, 1989). *Campylobacter* is inactivated by frozen storage at –15ºC in as few as 3 days (Stern and Kotula, 1982); however, freezing does not eliminate the pathogen from contaminated foods (Lee *et al.*, 1998). Hazeleger *et al.* (1995) discovered that aging *C. jejuni* cells survived the longest at 4ºC. *Campylobacter* will not survive below a pH of 4.9, it is capable of growing in pH range of 4.9 to 9.0, and grows optimally at pH 6.5 to 7.5. *C. jejuni* is unusually sensitive to oxygen and dehydration. *Campylobacter* requires a special gas atmosphere for growth in or on laboratory media, which usually consists of 5% oxygen, 10% carbon dioxide, and 85% nitrogen (Stern and Kazmi, 1989).

The results of Doyle and Roman (1982) suggest that *C. jejuni* is quite sensitive to drying and storage at room temperature, but at refrigeration temperatures and appropriate humidity, large numbers may survive drying and remain viable for several weeks. However, isolates are extremely diverse, compared to some other enteropathogens. There are more than 60 different heat-stable serotypes, more than 100 heat-labile serotypes, differences in adherence properties, invasive properties, toxin production, serum resistance, colonization potential, aerotolerance and temperature tolerance (Vandeplas *et al.*, 2008). *Campylobacter* is oxidase and catalase positive and contains a single polar unsheathed flagellum at one or both ends. *C. jejuni* hydrolyzes hippurate, indoxyl, and acetate, reduces nitrate, but is unable to oxidize or ferment carbohydrates. Some species of *Campylobacter* are sensitive to nalidixic acid and resistant to cephalothin (Table 2).

Table 2: Differentiation of *Campylobacter* species (Quinn et al.,1998)

Species	Growth at 42°C	Catalase	Oxidase	H_2S Production		Hippurate Hydrolysis	Susceptibility to (30mg/disc)	
				Lead Acetate	TSI		Nalidixic Acid	Cephalothin
C. jejuni	+	+	+	+	-	+	S	R
C. coli	+	+	+	+	+	-	S	R
C. laridis	+	+	+	+		-	R	R
C. upsaliensis	+	V	+	+	-	-	S	S
C. mucosalis	-	-	+	+	+		V	S
C. cryaaerophila	-		+	+	-		S	R
C.fetus subsp venealis	-	-	+	-	-		R	S
C. sputorum boivar faecalis	-	-	+	+	+		R	S

S = Susceptible
R= Resistance

2.1.2 Infection and disease

Disease control studies have demonstrated that 50 to 70% of human *Campylobacter* illness is attributed to consuming poultry and poultry products, thus the value of reducing levels associated with raw poultry has drawn considerable attention (Tauxe, 1992; Allos, 2001). The lowest dose reported leading to symptoms of illness was 500 cells only (Robinson, 1981). Children less than 1 year and young adults aged 15-25 are more susceptible to develop this disease, and individuals with immune suppression can develop prolonged or unusually severe cases of illness (Friedman *et al.,* 2000). Deaths attributed to *Campylobacter* infection in the United States are estimated at 680-730 cases per year (Saleha *et al.,* 1998).

The most common clinical symptoms of campylobacteriosis are fever, abdominal pain, and diarrhea that occurs within 2 to 5 days of ingestion of food or water contaminated with *C. jejuni* (Robinson, 1981; Black *et al.,* 1988). Pathogens invade epithelial cells in the ileum and large intestine thanks to chemotaxis and high motility, which causes inflammatory diarrhea with usually moderate uncharacteristic symptoms (van Vliet *et al.,* 2001). Symptoms are usually self-limiting and are resolved within a period of 3-10 days, and most cases do not require the use of antibiotics. When antibiotics are necessary, erythromycin and fluoroquinolones (macrolides) are usually administered.

It is estimated that one on 1,000 *Campylobacter* infections lead to the Guillain-Barré syndrome, an acute demyelinating disease characterized by muscular paralysis and leading to 2-3% mortality (Allos, 1997). This syndrome is usually confined to very young or elderly patients or to immuno-compromised suffering people (Altekruse *et al.,* 1999). Up to 40% of patients with the syndrome have shown evidence of recent *Campylobacter* infection. Approximately 20% of patients with GBS are left with some disability, and approximately 5% die despite advances in respiratory care. This disease, first described by Guillain, Barré and Srohl in 1916, is characterized by ascending paralysis, conduction block with segmental demyelination of the nerves, macrophage and lymphocytic infiltration of the nerves, and elevated protein with no cells or very few cells in the cerebrospinal fluid (Constantinescu *et al.*, 1998; Nachamkin *et al.*, 2000). The first reports of an association between *Campylobacter jejuni* and GBS were published during 1982-1984 (Kaldor and Speed, 1984). Investigators from different parts of the world since then have isolated *C. jejuni* from the stools of patients with GBS at the onset of neurologic symptoms (Hariharan *et al.*, 1996; Allos, 1997). Other possible autoimmune diseases from *Campylobacter* infections include the Miller Fisher syndrome (MFS) and the Reiter's syndrome or reactive arthritis (Kuroki *et al.*, 1993; Nachamkin *et al.*, 1998).

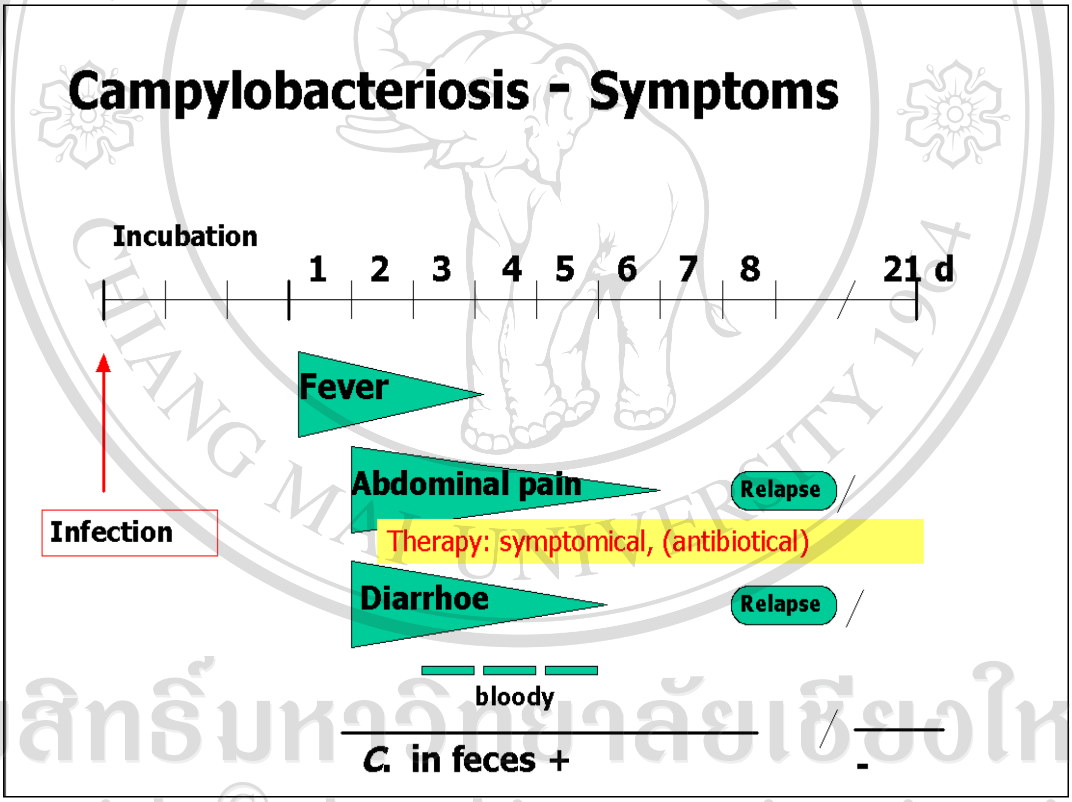

Figure 1 : Symptoms of campylobacteriosis

(Source : Nachamkin 2000 : Skirrow and Blaser. BfR, ba/05.04)

Table 3: *Campylobacter* species and their epidemiological supply

(Source : Vandamme, 2000; Lastovica and Skirrow, 2000).

Species or subspecies	**Recognised sources**
C. jejuni subsp.jejuni	Poultry, cattle, wild birds, pigs, water, cats, dogs
subsp. Doylei	Humans
C. coli	Pigs, poultry, cattle, wild birds, cats, dogs
C. lari	Cats, dogs, chickens, monkeys, seals, mussels, oysters, river water, seawater, gulls
C. fetus subsp. Fetus	Cattle, sheep
subsp venerealis	Cattle
C. hyointestinalis	
Subsp. hyointestinalis	Pigs, cattle, hamsters
Subsp. Lawsonii	Pigs, birds including poultry
C. upsaliensis	Cats, dogs, ducks, monkeys
C. helvaticus	Cats, dogs
C. mucosalis	Pigs
C. sputorum	
bv. Sputorum	Humans, cattle, pigs, sheep
bv. Faecalis	Cattle, sheep
bv. Paraureolyticus	Humans, cattle
C. rectus	Humans
C. gracilis	Humans
C. showae	Humans
C. conciscus	Humans
C. curvus	Humans

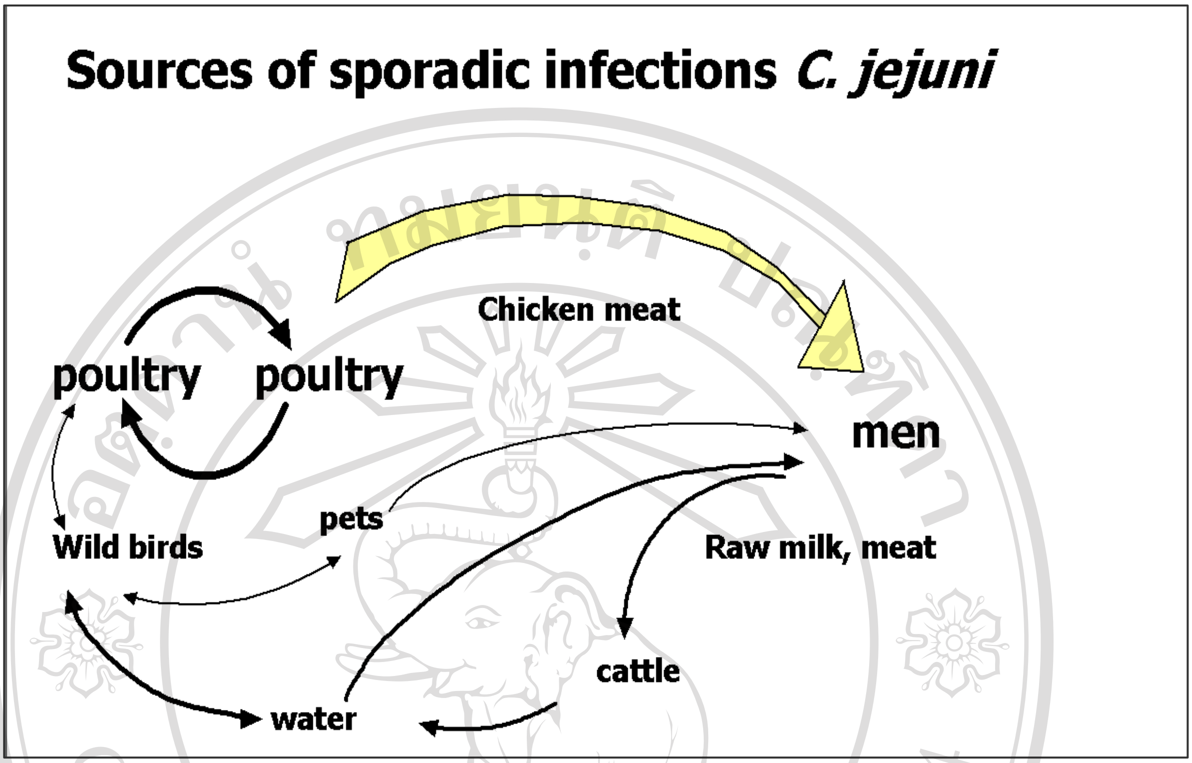

Figure 2 : Sources of sporadic infections for *Campylobacter jejuni*.

(Source : Nachamkin 2000: Friedman et al. BfR, ba/05.04)

2.2 Contamination in primary production

2.2.1 Sources of contamination on the farm

Pearson *et al.* (1996) found no difference between *Campylobacter* isolated in the hatcheries and *Campylobacter* isolated in the subsequent broiler chickens, suggesting that *Campylobacter* contamination may have occurred by way of vertical transmission. When a flock of broiler chickens becomes positive for *Campylobacter*, the prevalence of infection among birds is high, often reaching 100% of birds tested (Pokamunski *et al.*, 1986; Gregory *et al.*, 1997). As a commensal organism in poultry, *Campylobacter* colonizes the intestinal mucus layer in the crypts of the intestinal epithelium (Beery *et al.*, 1988). Birds, especially breeding poultry, appear to be the main reservoir for these pathogens, their internal temperature of 41-42°C being favourable for thermophilic *Campylobacter* proliferation (Hariharan et al., 2004).

Horizontal transmission is thought to be mainly through contaminated water, litter, insects, wild birds, rodents, fecal contact and transfer of the bacteria by farm personnel via their boots (Aarts *et al.*, 1995; Evans and Sayers, 2000). Feed has not been implicated in the spread of *Campylobacter* because it is too dry to favor survival of the organism.

In Malaysia, nineteen chicken flocks from ten broiler farms were studied (Saleha, 2004) for the colonization of *Campylobacter*. A variety of factors such as farm location and chicken house structure, water source, rearing practice and hygiene management were investigated. Each flock was sampled weekly, from day-old-chicks to slaughter age chickens, and environmental samples including water, feed, wood shavings, flies and chicken house environment were further collected for the presence of *Campylobacter*. On all farms, in one- and seven-day-old chicks, *Campylobacter* was not detected; it was first detected in 38.2% of 14 day-old chicks and in 45.3% of 21 day-old chickens. Samples of feed, wood shavings, flies and chicken house environment were all negative while 1.5% of the untreated water supplies were found positive for campylobacters. The prevalence of campylobacter's colonization of birds was possibly associated with untreated water, presence of other animals and unhygienic management practices; also, flying birds could be a source as they were found to also harbor campylobacters; on one farm where a 'fishing net' was placed over the chicken house to prevent birds from entering, *Campylobacter* was not isolated in the chickens up to slaughter age.

In two separate studies on flying birds caught around poultry farms and in crows caught around residential areas, it was found that 18% of the flying birds (Saleha *et al.,* 2001) and 25.3% of the crows (Chong, 2001) did harbour Campylobacters. The management and hygiene practices on the farm do play important roles in the colonization of *C. jejuni* in chickens (Humphrey *et al.,* 1993; Kazwala *et al.,* 1993). Generally, farms which practice good management and hygiene have lower rates of *Campylobacter* infection (Kazwala *et al.,* 1993) and may limit or prevent the horizontal spread of *C. jejuni* (Humphrey *et al.,* 1993) within the flock and between flocks.

Table 4: Prevalence of *Campylobacter* in broiler flocks from selected countries (Newell et al., 2003)

Country	Sample type	Prevalence (%)
United States	Cecal/Faeces	87.5
United Kingdom		76
	Cloaca	>90
	Cloaca	45
Denmark	Cloaca	42.5
		39.6 (*C. jejuni*)
		5 (*C. coli*)
Norway		18
Sweden		27
Germany		41.1
Italy	Cloaca	80
France	Faeces	42.7
Canada	Cloaca/Caeca	44.4
Chile	Faeces	19.7 (*C. jejuni*)
		6 (*C. coli*)
Taiwan	Cloaca	24.1
Malaysia		53.7 (*C. jejuni*)
		28.3 (*C. coli*)
Japan		45

2.2.2 Feed Withdrawal

Byrd *et al.* (1998b) studied the effect of feed withdrawal on *Campylobacter* in the crops of market-age broiler chickens. The purpose of feed withdrawal is to allow the clearance of the gastrointestinal tract and thus reduction of potential fecal contamination of poultry carcasses during slaughter. Feed withdrawal caused a significant increase in *Campylobacter* positive crop samples taken from seven of nine houses sampled. They found 90 of 360 birds tested before feed withdrawal to be positive for *Campylobacter*, whereas 254 of 359 birds tested after feed withdrawal were positive. As per Codex guidelines, when feed withdrawal is practiced, water additives such as lactic acid that may lower post-harvest crop contamination may be considered (FAO/WHO, 2009).

2.2.3 Transportation

Commercially raised poultry flocks are collected on the farm, placed into crates, transported to the processing plant and processed on the same day. An increase in *Campylobacter* load in faeces from containers was observed in several flocks, comparing with the load at farms (Pacholewicz *et al.* 2007). *Campylobacter* populations have been shown to increase during transport and holding prior to slaughter (Stern *et al.,* 1995). It is known that stress can cause a disturbance of intestinal functions, may lower the resistance of the live animal and consequently increase spreading of intestinal bacteria. Potential sources of *Campylobacter* contamination on poultry carcasses include fecal contamination of feathers and skin during transport to the slaughter facility, leakage of fecal content from the cloaca, intestinal breakage and contact with contaminated equipment, water, or other carcasses (Jacobs-Reitsma, 2000). Feathers may carry 8 log total bacteria/g (Barnes, 1975) and skin 6 log bacteria/cm^2 (Wilkerson *et al.,* 1961). Poultry carcasses further can become contaminated with *Campylobacter* from their intestinal contents during the slaughter process (Wempe *et al.,* 1983; Genigeorgis *et al.,* 1986).

2.3 Contamination in the processing plant

At the processing plant, birds are unloaded, shackled, slaughtered, scalded, de-feathered, eviscerated, washed, cooled and packaged (Figure 5). Contrary to the common belief that it would be easy to remove the organism from a processing plant because of the strict environmental growth requirements, the incidence of contamination remains at high levels (log 5 to log 8 cfu/ml of carcass rinse), because the organism is constantly re-introduced with the high number of birds being processed daily (Bashor et al., 2004).

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2.3.1 Scalding

The scalding procedure is used to open the feather follicles in order to facilitate the removal of feathers. The potential for bacterial cross-contamination during scalding and picking is well recognized. It is hypothesized that the follicles might remain open throughout processing until the carcass is chilled. When the follicles close during chilling, the microorganisms may be retained. Data typically show no reduction in populations of aerobic bacteria, *E. coli*, or *Campylobacter* on carcasses during scalding and de-feathering (Mercuri *et al.,* 1974; Bailey *et al.,* 1987). During scalding the feet of the birds do not dip into the scalding water thus the birds, if carrying the organism from the farm, may contaminate further (Fries *et al.,* 2005).

2.3.2 De-feathering

Wempe *et al.* (1983) isolated *C. jejuni* from 94.4% of feather picker drip water samples, and found a high fauna of organisms to be present. The authors believed that de-feathering is an area where cross-contamination may occur, since the rubber finger-like projections that beat the feathers from the bird become contaminated and may pass organisms from bird to bird. Berrang and Dickens (2000) found that after de-feathering, bacterial counts increased significantly (3.70 log). An increase in *Campylobacter* counts following de-feathering has been reported (Acuff *et al.,* 1986; Izat *et al.,* 1988).

2.3.3 Evisceration

Removal of the viscera happens through a small opening of the cavity. The problem in this step is that the carcasses are not entirely uniform in size and some may be damaged by the evisceration machinery. So ruptures might occur with the consequence of contamination of the carcasses. The high incidence of contaminated neck flaps and breast tissues suggest that crop contents may be an important source of *Campylobacter* contamination during processing. The crop has been found to be a significant source of *Campylobacter*, thus potentially contributing to carcass contamination (Byrd *et al.,* 1998a).

2.3.4 Carcass washing systems

Carcasses are commonly washed with systems of washers, sometimes using chlorinated water to remove contamination, such as blood, tissue fragments, and fecal contamination as part of the regular processing procedures. Chlorination is banned in certain countries. The development of new washer systems makes it very difficult for a processing plant to know which type or system would be best for them, as only limited studies have been conducted on evaluating the performance and effectiveness of poultry washers and sanitizing treatments within the processing plants (Anand *et al.,* 1989; Dickens and Cox, 1992; Bautista *et al.,* 1997). There are numerous parameters that affect the overall efficiency of a carcass washing system, including the number and types of washers.

2.3.5 Chilling and freezing

During chilling, metabolism of most bacteria can be slowed down using temperature of 4^{o}C and below. Kinde *et al.* (1983) indicated that the presence of *Campylobacter* in market broilers diminishes over time during refrigerated storage. The prevalence of *Campylobacter* spp. in poultry and poultry meat products in Germany was studied by Atanassova and Ring (1999). Of 509 samples taken from poultry flocks, 41.1% were *Campylobacter* positive, whereas 45.9% of broiler carcasses were positive.

Table 5: Prevalence of *Campylobacter* on poultry carcasses in Malaysia (Saleha, 2003).

Authors	Type of samples and prevalences			*Campylobacter* species
	Types of samples	No. of samples	positives (%)	
Nazarina (1998)	Chicken carcasses from 3 type of markets	90	87%	*C. jejuni* > 50%
Saleha et al. (1997)	Chicken carcasses and parts in 3 poultry processing plants at 5 different processing sites	87	(11.1 – 62.5%)	
Joseph et al. (1989)	Poultry carcass rinses from 4 different sources	44	31.8%	*C. jejuni* 15.9% *C. coli* 0%

2.4 Poultry economy in Malaysia

2.4.1 Broiler farming system

The poultry industry in Malaysia continues its transformation into a modern and efficient industry to serve the needs of the consumers. The national annual broiler requirement is about 600,000 mt and is supplied by local producers (USDA 2004). The Malaysian poultry industry operates on a purely commercial basis with no subsidies from the government, except for tax incentives for modern technology investments. The industry is highly commercially oriented, from small independent farmers to large multinational integrators with farm- food processing- retailing integration. The concentration and vertical integration in the broiler industry has developed very rapidly and hence there are only a few major players in the industry. There are still quite a number of small farmers in operation through contract farming with major integrators like KFC. However, the small farmer's role is slowly diminishing.

The large broiler farms are closed house systems with evaporative cooling pads, well ventilated and located at least 1 km away from housing and industrial areas. The largest broiler operation can house about 300,000 broilers at one farm site while small ones house about 5,000 broilers on one farm. These farms mostly are accredited by DVS under the Good Animal Husbandry Practices and Livestock Farming Scheme (SALT). Raw ingredients for animal feeds are not produced in Malaysia. As such, the intensive livestock industries, especially poultry, are dependant on imported feed. Maize and soybean meal are the major imported raw materials.

2.4.2 Slaughter house system

All poultry slaughtering plants in Malaysia are privately run. The poultry slaughter plants in Malaysia can be divided into three categories, which are modern processing plants implementing HACCP and GMP, slaughter plants without GMP and HACCP, and backyard or traditional wet market slaughter. Slaughtering of chickens is still allowed in wet markets in Malaysia.

2.4.2.1 Modern slaughter process

A cold chain system usually starts with poultry farms that separates chickens at least by generation and keep chickens separate from other bird species, people and other animals as much as possible. Birds are then taken to a slaughter plant. After slaughter the meat is refrigerated or frozen. Then there are an interconnected series of refrigerated storage facilities and vehicles that bring chilled chicken to markets where consumers continue the chain by taking meat home to refrigerators.

The modern slaughter plants follow linear flow processing with compartmentalization of activities and overhead conveyer line systems. Facilities are designed and constructed with material that is smooth, easily cleaned and sterilized, rust-resistant, odourless and impact resistant. The rooms are air-conditioned from processing to packaging and dispatch. The cold chain is maintained throughout processing. The external environment is also clean and plants have their own waste water treatment facility. The utilization of quality assurance program (HACCP and GMP) principles within meat and poultry slaughter plants does help prevent contamination and does lead to safer products. Quality assurance programs involve procedures to ensure that products are manufactured to meet a certain quality and safety requirement. The establishment of performance standards coupled with routine microbial testing are also components that will lead to safer meat production. Primary processing involves the halal slaughtering and production of chicken parts to the required specifications. In these processing plants, electrical stunning is done to stun the live chicken as soon as they are hung on the shackle, with the head dragged through electrically charged water bath at 20 to 40 volts, depending on the bird size, for 15 seconds.

Following stunning, the neck is opened (Halal slaughter carried out by a Muslim) by hand cutting all the major vessels with a sharp knife for the purpose of bleeding. The birds are left to bleed for about three to four minutes and the blood is passed through a tunnel into a holding tank. The birds are scalded by immersing them in hot water at a temperature ranging between 56^{o}C and 62 ^{o}C for 2 to 2.5 minutes. After scalding, the feathers are mechanically removed by a series of online plucking machines, whereby the rubber finger-like projections beat the feathers off the birds. Following a re-hanging, feet and head are removed. Then all carcasses are directed into another room where the vent is mechanically opened and an eviscerator removes the viscera. The viscera are placed on a small tray and directed to another room for further cleaning and processing. Liver, heart and gizzard can be salvaged, but the intestines are not allowed for sale. The carcass then is passed through an automatic inside outside bird washer.

All the carcasses must next be immersed into a spin chiller for at least 20 minutes to bring down the temperature of the carcasses. The temperature of the water in the spin chilling tank has to be maintained at $1^{o}C$- $4^{o}C$ by adding ice. This aims to slow the growth of harmful bacteria, which can multiply rapidly. The meat would turn bad sooner if the surrounding/ambient temperature is high. Chlorine is added continuously by a pulsator to maintain 20 to 40 ppm chlorination in the water. Carcasses discharged from the spin-chilling tank are hung on the weighing line. As the lines move, they are dropped automatically into the weighing bins according to their weight. The carcasses are packed into plastic bags and then placed in a chiller or freezer for delivery. Cleaning of the processing equipment is carried out every day with high-pressure water at the end of processing. DVS inspectors are stationed in these VHM plants to perform a regular inspection on ante-mortem, post mortem and to collect carcass samples for pathogen and drug residues monthly following the national sampling program stipulated by the DVS.

Figure 3: **CCP at spin chiller in modern processing plant (immersion chilling with chlorine and chilled water).**

Figure 4: Chicken being discharged out of spin chiller in a modern processing plant.

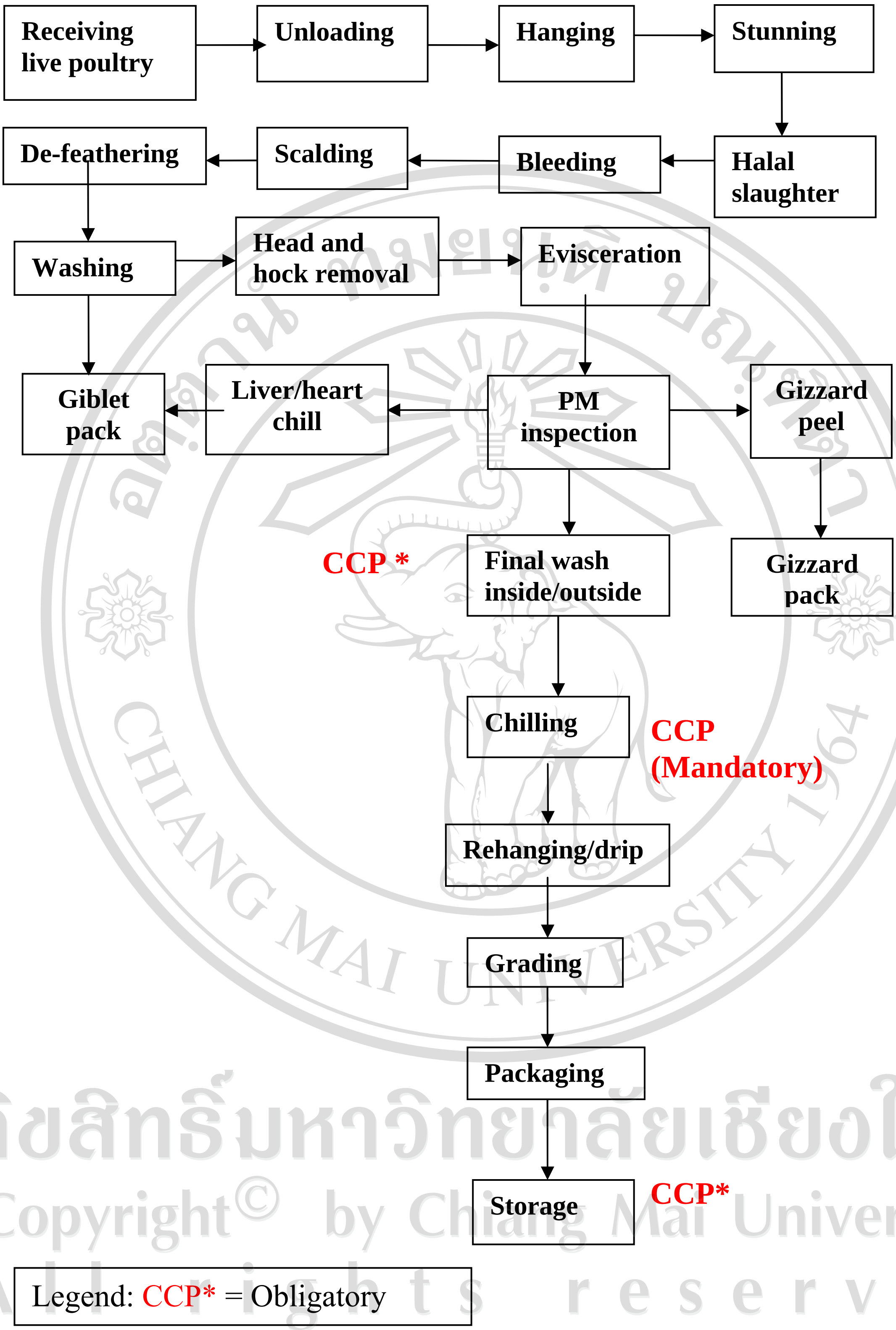

Figure 5: Standard Poultry Slaughter Process Flow Chart in Malaysia

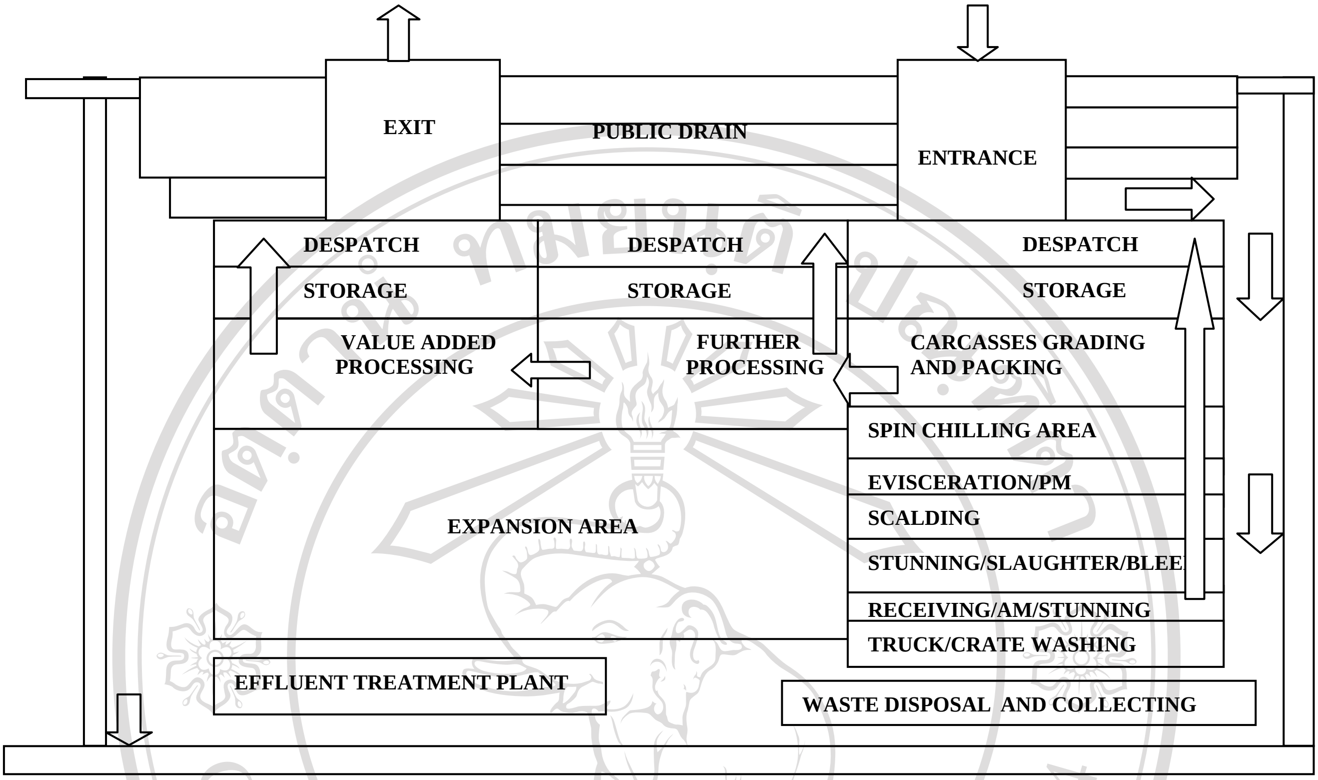

Figure 6: Poultry Processing Plant Design Concepts in Malaysia

2.4.2.2 Traditional wet markets slaughter process

A wet market is generally an open food market. In Malaysia modern large scale processing plants exist together with several small scale poultry slaughter units in wet markets with minimum technological interventions (Bhusal 2004). The main characteristics of the market have traditionally been associated with a place that sells live animals out in the open. The floors and surroundings are often routinely sprayed and washed with water to the extent of flooding it at frequent intervals. Wet markets generally combine butcher shops and fish markets in the vicinity. There are also many small shops units with display table for selling poultry, meat, fish, fresh fruits and vegetables as well as other dry food materials. Depending on the region, animals are usually caged and killed for live preparation. The slaughter and butchering is performed in front of customers upon request. Many times the carcasses are thrown on the floor to be butchered more easily. The image of butcher shops and markets filled with live animals has been heavily criticized in many countries. If the sanitation standards are not maintained, wet markets can easily spread diseases. The processing in wet markets often cause environmental pollution such as drainage problem, smell and flies. Insects such as flies have relatively easy access to the food products.

Live chicken for slaughter in wet markets usually obtained from small farms and also commercial farms. In all traditional wet markets, the stunning procedure is skipped. The chicken is killed by bleeding with a sharp knife. Chickens are scalded in a semiautomatic scalding tank of about 58°C to 60°C within 2 to 3 minutes. De-feathering is carried out with a semi-automatic de-feathering machine with rubber fingers. The evisceration process is performed by hand with a knife to open the carcass. No chlorination is done in water for cleaning the carcasses and no chilling process is practiced. Floors are wet and dirty. There is also no SOP for cleaning and disinfection. Sometimes clean water is not available and water from wells is used to wash poultry. Processed carcasses and organs are sold there and displayed on a small concrete table.

Out of the total world population of 6.5 billion people, the poorest 3.25 Billion purchase their chicken from a live or "wet" market while the richest 3.25 billion purchase their chicken from a cold chain market (Paul, 2005). The "traditional" live chicken system of chicken rearing and marketing is currently under suspicion because of encouraging the spread of disease and having the potential to generate a human pandemic. In addition, the traditional system provides a reservoir of disease that can put the cold chain system in danger as well. The higher hygiene standards of supermarkets have forced many wet markets to operate indoors.

2.4.3 Broiler marketing system

In Malaysia, meat are sold under different marketing conditions – as fresh meat in the morning wet markets, "warm" meat (from the animals slaughtered in wet markets in morning) in night markets and as chilled and/or frozen meat in supermarkets. In Malaysia, about 30 percent of broilers are channeled through modern processing plants and sold in supermarkets and mini markets as well as numerous retail outlets operated by some of the integrated poultry companies. Modern processing plants have implemented Good Manufacturing Practices (GMP) and Hazard Analysis Critical Control Points (HACCP) under the supervision of the Department of Veterinary Services and accredited with Veterinary Health Mark (VHM) certification. Broilers processed in modern slaughter plants normally are sold to fast food restaurants, airlines & shipping ports, caterers, hotels, hypermarkets and supermarkets. Broilers processed in the other slaughter plants without GMP and HACCP are sold to school hostels, universities, mini markets, the retail sector and convenient shops and the some to wet markets even. The different types of processing procedures and retailing conditions of these meats contribute to the contamination with and proliferation of coliforms and pathogens (Saleha 2004[b]).

2.5 Preventive measures

The Department of Veterinary Services is the leading agency responsible for livestock sector development and ensuring the quality and safety of livestock products. Various programmes and schemes, such as Livestock Farm Accreditation Scheme (SALT), Veterinary Health Mark (VHM) for Livestock Product Processing Plant and Quality Assurance Programme (QAP) are implemented. Food safety in Malaysia is governed by the Food Act 1983 and the Food Regulations 1985.

2.5.1 GAHP and SALT *(Livestock Farm Accreditation Scheme)*

Livestock and farm products accreditation scheme is necessary to develop the country's agriculture industry. Such accreditation would become a trend in the future and consumers demanding for safe, hygenic and quality food indirectly sought a holistic implementation of such schemes. DVS Malaysia has launched the Livestock Farm Accreditation Scheme (SALT) programme as an effort towards establishing a high sanitation standard for livestock farms and increasing safety of food produced from the farms. The criteria for getting SALT accreditation include good animal husbandry practice (GAHP), livestock health management, biosecurity, good infrastructure and controlled usage of veterinary medication.

2.5.2 Processing procedures- Good Manufacturing Process (GMP) and Hazard Analysis Critical Control Points (HACCP).

In recent years the control over the food production has become tighter and tighter. Food safety management systems such as HACCP and the pre-requisite systems GMP and Good Hygienic Practice (GHP) have provided the professional players with excellent tools to assure product safety (Gorris, 2004). GMP regulations are designed to control the risk of contaminating foods with filth, chemicals, microbes, and other means during their manufacture. In general terms, this statute mandates that food companies follow good manufacturing practices (GMP) to assure the processing, storage and transporting environments are clean and that no unacceptable substances enter the food product.

Food products are sensitive to microorganism contamination by bacteria, viruses and parasites. After becoming contaminated, they provide an excellent environment for growth of bacteria. Bacterial contamination and growth is a problem because it may result in foodborne illness. To improve product safety, the food industries are adopting a process control system known as "Hazard Analysis Critical Control Point" (HACCP). HACCP is a food safety management system, which concentrates on prevention strategies on known hazards and risks of them occurring at specific points in the food chain. The system improves product safety by anticipating and preventing health hazards before they occur. The HACCP system, which is science based and systematic, identifies specific hazards and measures for their control to ensure the safety of food. HACCP is a tool to assess hazards and establish control systems that focus on prevention rather than relying mainly on end-product testing. Any HACCP system is capable of accommodating change, such as advances in equipment design, processing procedures or technological developments (Anonymus 2009).

HACCP can be applied throughout the food chain from primary production to final consumption and its implementation should be guided by scientific evidence of risks to human health. As well as enhancing food safety, implementation of HACCP can provide other significant benefits. In addition, the application of HACCP systems can aid inspection by regulatory authorities and promote international trade by increasing confidence in food safety. The successful application of HACCP requires the full commitment and involvement of management and the work force. It also requires a multidisciplinary approach; this multidisciplinary approach should include, when appropriate, expertise in agronomy, veterinary health, production, microbiology, medicine, public health, food technology, environmental health, chemistry and engineering, according to the particular study. The application of HACCP is compatible with the implementation of quality management systems, such as the ISO 9000 series, and is the system of choice in the management of food safety within such systems (FAO, 1992).

2.5.3 Veterinary Health Mark (VHM)

This Veterinary Inspection and Accreditation Program in Malaysia was developed during the 1980's to facilitate veterinary certification of animal and poultry products meant for export. Under this program, accredited plants were awarded the VHM logo. The implementation of the program reduced significantly the processing period for applications of veterinary export permits from weeks to just a few days and achieved widespread local acceptance from both the livestock processing industry and consumers. Being pro-active in nature and a time-saving mechanism, the program was nominated and won the Innovation Achievement Award from the Government of Malaysia in 1995. The VHM Logo has been classified as a certification trade mark (Class 16, 29 and 44) under the Trade Marks Regulations 1997 / Trade Marks Act.

The Veterinary Health Mark Logo is a mark of quality and safety given to plants processing livestock products, awarded under the Veterinary Inspection and Accreditation Program of the Department of Veterinary Services (DVS), Ministry of Agriculture, Malaysia. It also signifies the complete compliance by the plants to the minimum standards of hygiene and sanitation, quality assurance and food safety set by DVS, verified through the process of plant inspection, examination and auditing of the food safety quality system and good manufacturing practice programs.

The program is voluntary and is open for participation from all livestock food processing plants. However, the program becomes compulsory for all export livestock food processing plants because importing countries impose mandatory Veterinary Certification of their products by a competent veterinary authority as one of the conditions to be fulfilled prior to their export.

Accredited plants awarded with the VHM logo are allowed to imprint it on the label of approved products / packaging material, not only to gain public confidence on the safety of the product but also as marketing tool. The benefit to the consumers are, greater assurance of food safety , significant contribution towards improved public health and expansion in the range of products safe for human consumption.