

## Risk analysis of campylobacter species in broiler meat

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### Abstract

It has been repeatedly reported that *Campylobacter* is the main cause of bacterial enteritis in the Europe and many developed countries in the world. The risk analysis on *Campylobacter* includes risk assessment, risk management and risk communication which has explored the risk of *Campylobacter* to humans as a result of handling and consumption of undercooked broiler meat. Various risk management options were provided to mitigate the risk particularly to humans who might come in contact with broiler meat at different stages of the food chain. The need to communicate the risk and the control measures to adopt for consumers who are the last CCP in the food chain has also been emphasised. Special emphasis has been given to consumer training that involves things like cooking demonstration and provision of sufficient information through various channels. Thus could be used to reduce the rising cases of Campylobacteriosis in the EU and other countries in the world.

**Keywords:** Consumers, Risk, Campylobacter.

### Introduction

For the last two decades, *Campylobacter* was repeatedly reported as being the leading cause of human bacterial enteritis in the European Union (EU), and many other developed countries [World Health Organisation (WHO) 2009<sup>[19]</sup>; European Food Safety Authority (EFSA), 2011]<sup>[5]</sup> Poultry has been recognised to play a significant role in human *Campylobacter species* infection. It can infect humans via cross-contamination of ready-to-eat foods and directly through hand- to-mouth transfer during food preparation, and from undercooked poultry meat consumption (WHO, 2009)<sup>[19]</sup>. *Campylobacter spp.* are ubiquitous and repeatedly identified in the alimentary tracts of animals, particularly birds and can contaminate the environment, including water. Human incidences of *Campylobacteriosis* are mostly caused by the thermo-tolerant *Campylobacter spp.* called *Campylobacter jejuni* that has recently overtaken *Salmonella species* as the primary reported cause of food-borne bacterial infections (Gunther and Chen, 2009)<sup>[10]</sup>.

Poultry meat, a major source of infection are reported to be the second most important meat species that were produced in the EU, and EU is regarded as the third largest poultry meat producer in the world. About 11.6 million tons of poultry were produced in 2008 and comprised broiler (75%), turkey (16) and ducks (4%) (EFSA, 2011)<sup>[5]</sup>. This indicated that poultry is a significant source of *Campylobacter* infection in human due to the largest quantity that has been produced in the EU. In view of the consumer health and economic problems presented by *Campylobacter spp.*, it became imperative to take appropriate measures to reduce its occurrence all through the poultry production chain. This is likely to reduce the incidence of the human illness (Djenane and Rancoles, 2011)<sup>[4]</sup>.

The risk analysis on *Campylobacter* will explore a range of options to be used to control the spread of the organism in the food chain and communicate this to the consumers, who are the last critical control point (CCP) in the food supply chain. In this

review, the risk analysis on *Campylobacter* in broiler chicken will address the three components that include risk assessment, risk management and risk communication. The risk analysis will address the prevalence of *Campylobacteriosis* with emphasis on the EU countries.

### Risk assessment

The risk assessment will comprise the hazard identification, source of illness and various risk factors and the characteristics of the hazard.

### Hazard identification

The human incident of *Campylobacter* infections has increased markedly in many developed countries within the period of last 20 years (WHO, 2009)<sup>[19]</sup>. *Campylobacteriosis* remained as the most repeatedly reported zoonotic disease in humans with an approximate incidence rate of 50 confirmed cases per 100,000 of the population in over 17 EU countries. Approximately, 9 million cases of human *Campylobacteriosis* were estimated annually in the 27 EU countries, resulting in 0.35 million disability-adjusted life years (DALYS) which engulfs about 2.5 billion euros per year (EFSA, 2011)<sup>[5]</sup>.

*Campylobacteriosis* was observed to be food-borne, with poultry meat as an important source although animal contact and environmental sources were identified. Broiler meat has been reported to account for 20% to 30% cases of *Campylobacteriosis* in human as a result of its handling, preparation and consumption while 50% to 80% may be associated with the chicken reservoir as a whole including broiler meat itself (EFSA, 2010)<sup>[6]</sup>.

### Source of illness and risk factors

Handling of raw poultry and the consumption of poultry products has been identified by most studies as significant risk factors that account for a variable percentage of reported cases (Wingstrand *et al.*, 2006; Ghareeb *et al.*, 2012)<sup>[9]</sup>. Additionally,

cross-contamination of *Campylobacter spp.* from raw chicken to other foods during food preparation is also identified as another significant risk factor (Kapperud *et al.*, 2003) [12]. *C. jejuni* has been isolated as the microorganism accountable for more than 90% of cases of *Campylobacteriosis* in many countries. This is followed by *C. coli* that are often the second most isolated species. For the purpose of this report, when discussing *Campylobacter spp.*, particularly with respect to human infection, this is referring to *C. jejuni* (WHO, 2009) [19].

**Hazard characterization**

Information for hazard characterization was sourced from published literature obtained from EFSA, Food and Agriculture Organisation (FAO) and the WHO. The characterisation of risk focuses on the evaluation of the adverse health effects related with foodborne infection by *Campylobacter spp.* and the method used for quantitative assessment of the connection between the extent of the foodborne exposure and the probability of the occurrence of adverse health effects [Food and Agriculture Organisation (FAO), 2000].

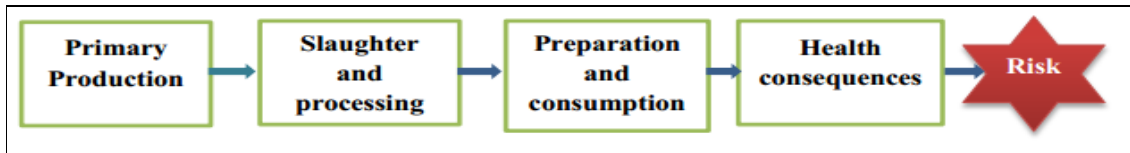
*Campylobacter spp.* are non-spore forming gram-negative bacteria that grow at 37°C with an optimum growth temperature of 42°C. However, it can survive at 4°C. It is therefore, assumed that it does not grow during slaughter, transport and refrigerated storage although it survived the prolonged period of chilled and frozen storage of chicken products. *C. Jejuni* and *C. coli* are

said to heat sensitive, and *C. jejuni* is mainly associated with poultry products (WHO, 2009; EFSA, 2011) [19, 5].

The most common symptoms of *Campylobacteriosis* include diarrhoea, fever, malaise and abdominal pain. The symptoms are self-limiting in some cases and usually last for only a few days (Lindqvist and Lindblad, 2008) [13]. In some cases, adverse health effects that follow infection with *C. jejuni* include acute gastroenteritis and reactive arthritis (non-gastrointestinal sequelae), Guillain-Barré syndrome (GBS) and a variant of GBS; Miller- Fisher syndrome. GBS is an acute paralytic disorder and has been reported to happen once in every 1000 cases while reactive arthritis approximately occurs in 1% of patients with *Campylobacteriosis*. There is no estimation of the frequency of the occurrence of Miller- Fisher syndrome (FAO, 2001; WHO, 2009) [19].

**Exposure assessment**

An exposure assessment model was developed as illustrated in Figure 1. This is used to evaluate the risk to human health posed by the prevalence of *Campylobacter spp.* in broiler chickens. The main objective of the exposure assessment was to estimate the probability and extent of exposures to *Campylobacter* due to the consumption of a meal containing broiler chicken meat. The model will determine the prevalence and numbers of *Campylobacter spp.* in the food chain using the farm to table approach.



**Fig 1:** Model framework for the risk assessment of *Campylobacter spp.* in broiler chickens (FAO, 2000)

**Primary production**

Djenane and Rancoles (2011) [4] reported that the benefits of controlling *Campylobacter spp.* to human health at primary production are expected to be to a large extent better than control at a later stage in the food chain. This is due to the fact, it highly likely that the bacteria spread from farms to human by other pathways than the broiler meat. These pathways can be by farm workers that constitute risk factors for flock colonization, human traffic where *Campylobacter* is introduced from the external environment into the poultry house and sometimes contaminated water drinkers (Workman *et al.*, 2008) [18]. Peyrat *et al.*, (2008) indicated that any bird colonized with *Campylobacter* will excrete vast numbers of the organisms, and this can spread to other birds on the farm causing the prevalence of the organism within the farm. Furthermore, it has been indicated that the strains of the *campylobacter* can be able to survive on the surfaces in the slaughterhouses even after cleaning and disinfection, and this highlights a newly presumed source of carcass contamination during processing.

**Slaughter and processing**

The prevalence of positive flock is directly linked to slaughter age (EFSA, 2011) [5]. *Campylobacter spp.* can contaminate the chicken meat through faecal contamination during slaughter and processing. Some of the processing operation stages such as scalding, de- feathering, evisceration, washing and chilling have been indicated to cause changes in the contamination level

of *Campylobacter spp.* (Rosenquist *et al.*, 2006). In most cases scalding by immersion method, de-feathering and evisceration results in cross contamination of the carcasses with a significant increase in number and levels of carcasses contaminated with the organisms (Perko-Mäkelä *et al.*, 2009) [15]. It is important to prevent rupture of the intestines and the spread of faecal *Campylobacter*, which may be present in relatively high numbers in the intestines of positive birds. Washing of the carcass was indicated to yield a ten-fold reduction in the level of *Campylobacter spp.* (Djenane and Rancoles, 2011) [4].

**Human exposure during handling, preparation and consumption**

It has been indicated that oral route is the medium for most of the *Campylobacter* infections occurring after handling raw poultry or consumption of undercooked broiler meat (Djenane and Rancoles, 2011) [4]. In the summer and early autumn, chickens contaminated with *Campylobacter spp.* are most abundant. During meal preparation at home, consumers are highly likely to be exposed to *Campylobacter spp.* from contaminated fresh chicken by quite a number of ways. These ways include, direct contamination of food commodities which are not be undergoing any subsequent cooking process before ingestion, indirect contamination of surfaces in which cooked products or ready-to-eat food are placed and prepared direct contamination on hands and subsequently ingestion into the body through oral route, inadequate cooking process and a wide

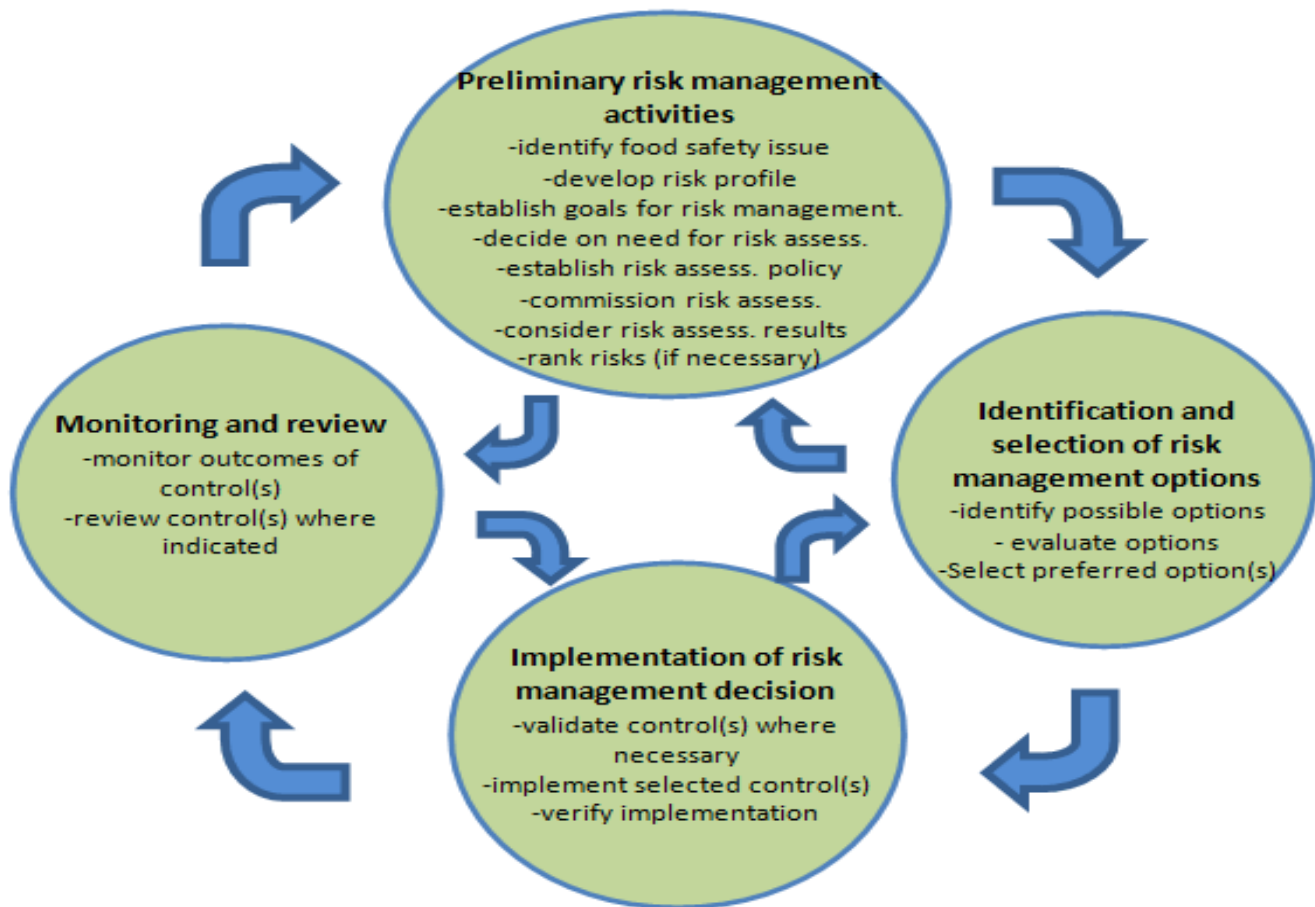
variety of other ways of potential contamination (Boysen *et al.*, 2011; Djenane and Rancoles, 2011) <sup>[1,4]</sup>. Exposure of individual to *Campylobacter spp.* from consumer handling can also be addressed as the potential for the survival of *Campylobacter spp.* in cooked meat which is subject to uncertainty. Due to the large degree of variability and uncertainty as a result of the complexity of consumer food handling behaviours, the estimation of the risk of infection through cross-contamination and undercooking is said to a very difficult exercise (WHO, 2009) <sup>[19]</sup>.

Zhao *et al.*, (1998) claimed that transfer of the organisms can be facilitated by liquid carried on hands, cutting boards and other utensils. Additionally, unhygienic food handling procedures in some private kitchens are claimed to be responsible for a large number of cases of *Campylobacteriosis*

in most countries. This suggests that various control options will need to be established and implemented to reduce the risk.

### Risk Management

A risk management framework (RMF) is required to provide a systematic procedure where knowledge on the risk and estimation of other factors relevant for the control of hazards will be used to select and implement regulatory standards or effective control measures. Figure 2 shows the components that are involved in the application of RMF. An effective risk management strategy will incorporate appropriate risk communication and the representation of stakeholders at all stages in the food chain [Ministry for Primary Industries (MPI), 2013] <sup>[14]</sup>.



**Fig 2:** Risk management framework (Foodrisk.org 2011)

The risk management option for the control *Campylobacter spp.* in broiler chicken especially its risk to human during preparation and consumption need to be established and implemented. There is the need to control the spread of the organism at the primary production and slaughter and processing stages (Codex, 2011) <sup>[3]</sup>. Effective implementation of biosecurity measures in primary production and the use of Prerequisite Programs such as Good Manufacturing Practices (GMP) and Good Hygienic Practices (GHP) and Hazards Analysis and Critical Control Point (HACCP) will be used to minimise the colonisation of broiler with the organism (Djenane and Rancoles, 2011) <sup>[4]</sup>.

### Control measures approach from primary production to consumption

Generic guidelines are used for the control of *Campylobacter* from primary production to consumption by identifying all stages in the food chain to determine steps where control measures can be applied. This will enable a logical approach to the identification and assessment of all potential control measures and by considering all stages in the food chain it will enable the development of a different combination of control measures particularly where differences exist in primary production and processing operations [Codex Alimentarius Commission (Codex), 2011] <sup>[3]</sup>.

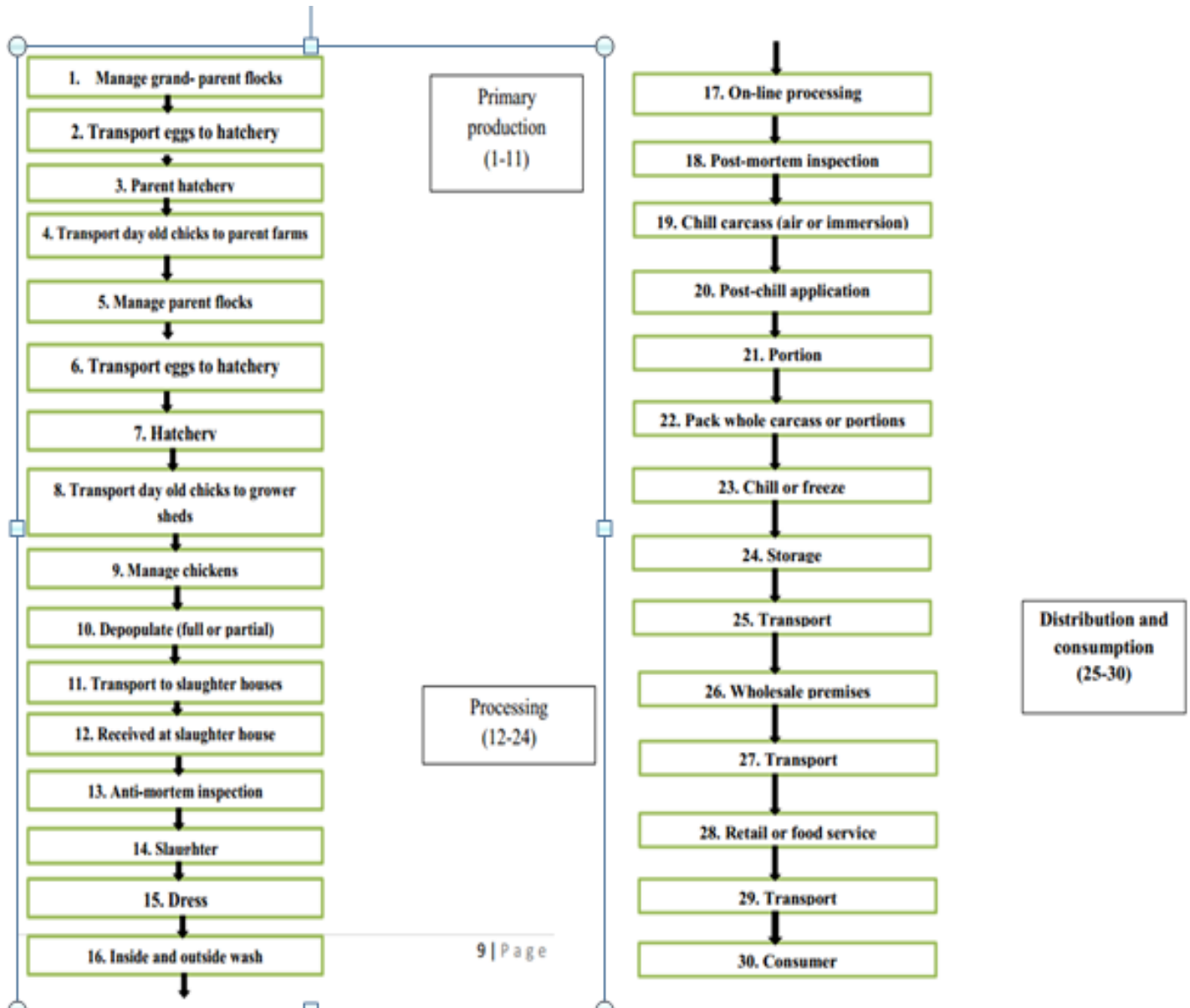


Fig 3: Risk management approach from primary production to the consumer (Codex, 2011) [3].

### Control measure in primary production

Risk management in primary production (1-11) entails the prevention of on-farm horizontal transmission using biosecurity measures. The biosecurity measures are generally used to protect birds from outside sources of *Campylobacter* infection. It is an essential control measure due to the fact that *Campylobacter* can spread rapidly once it enters into a broiler flock and will be difficult to control at a later stage. Biosecurity measures are therefore useful in the prevention of colonised broiler flock from entering the processing line and the food chain (Hermans *et al.*, 2011) [11].

These measures include:

- Preventing *Campylobacter* from entering broiler houses at primary production by the use of hygienic measures such as thinning and reduction of slaughter age.
- Increasing the resistance of broiler chickens to *Campylobacter* colonisation using additives, phytocompounds, organic acids to their drinking water and feed, selective breeding and vaccination and

- Reducing *Campylobacter* concentration in broiler chicken intestines before slaughtering through treatment with bacteriocins or bacteriophages (EFSA, 2011) [5]. Additionally Good Hygienic Practice (GHP) could be used in addition to the biosecurity measures to strengthen the effectiveness of the control measures (Codex, 2011) [3].

### Control measure at the processing stage

Risk management at the processing (12-24) entails the use of GHP from slaughter to storage prior to distribution and consumption. These measures include:

- Improving the hygienic measures during slaughter by improving the design of slaughter equipment, slaughter practices, avoidance of faecal leak and personnel training in hygiene implementation,
- Use of physical and chemical treatments to decontaminate of carcasses
- Freezing of the carcasses during storage and



- d) Training of food handlers in hygienic practices to prevent cross-contamination during handling of broiler meat (EFSA, 2011) <sup>[5]</sup>.

#### **Control measure at distribution, retail and consumption**

Risk management at the distribution and retail as well as consumption includes the use of basic GHP, and these are explained below:

- (a) **Distribution:** GHP should be used during transportation of the broiler chicken to the markets, and this includes maintaining appropriate storage temperature during transport and proper packaging of the products.
- (b) **Retail:** Control at retail stage includes:
- i) GHP should be put in place to avoid cross contamination of the raw chicken with other foods.
  - ii) Raw foods should be separated from cooked foods and handling raw chicken meat should be followed by hand washing and disinfection.
  - iii) The provision of extra package for consumers to allow separation of raw chicken from other food purchased should be maintained and
- (c) **Consumers:** Through cooking of broiler meat chicken meat will destroy *Campylobacter* and research has indicated that cooking of chicken meat at 74 °C will result in at least a 7 log<sub>10</sub> reduction in the level of *Campylobacter* in cooked broiler meat (Codex, 2011) <sup>[3]</sup>.

#### **Risk communication**

Risk communication involves a constant and collaborative exchange of information among all parties that are involved in food safety (MPI, 2013) <sup>[14]</sup>. The risk of *Campylobacter spp.* will need to be communicated to the consumers which can be accomplished through training and enlightenment campaign in the media. Consumer education should put more emphasis on handling, defrosting, cooking, storage and the prevention of cross-contamination and temperature abuse (Codex, 2011) <sup>[3]</sup>. Particular attention needs to be given to the provision of education to all persons involved in food preparation especially to persons making foods for the young, elderly, pregnant and immunocompromised (Codex, 2011) <sup>[3]</sup>.

Sufficient information should be provided through multiple channels which include media, health care professionals, food hygiene trainers, product labels, pamphlets, food labels and cooking demonstrations. Washing of raw chicken in the kitchen used for other foods should be discouraged to reduce possible contamination of other foods and surfaces that may be in contact with food and humans. Where it deemed necessary, washing of raw chicken carcasses or chicken meat should be carried out in a way and manner that can reduce the likelihood of contamination of other foods and surfaces that may be in contact with other foods and humans. Consumers should be encouraged to wash and disinfect any food contact surfaces used after the preparation of raw chicken. This will help significantly in reducing the potential for cross-contamination in the kitchen (Codex, 2011) <sup>[3]</sup>.

#### **Conclusions**

*Campylobacteriosis* has remained as the most repeatedly reported zoonotic disease in humans with an approximate incident rate of 50 confirmed cases per 100,000 of the

population in over 17 EU countries. Approximately, 9 million cases of human *Campylobacteriosis* were estimated annually in the 27 EU countries, resulting in 0.35 million disability-adjusted life years (DALYS) which engulfs about 2.5 billion euros per year (EFSA, 2011) <sup>[5]</sup>.

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