

Challenges and Opportunities in Food Safety-A Review

Iram Asim

Department of Microbiology and Molecular Genetics, The Women University Multan, Pakistan,
iramasim.mmg@gmail.com

Humaira Yasmeen

Department of Microbiology and Molecular Genetics, The Women University Multan, Pakistan,
humaira.6127@wum.edu.pk

Follow this and additional works at: <https://corescholar.libraries.wright.edu/jbm>



Part of the [Animal Diseases Commons](#), [Bacterial Infections and Mycoses Commons](#), [Food Microbiology Commons](#), and the [Food Processing Commons](#)

Recommended Citation

Asim, I., & Yasmeen, H. (2021). Challenges and Opportunities in Food Safety-A Review, *Journal of Bioresource Management*, 8 (2).

DOI: <https://doi.org/10.35691/JBM.1202.0177>

ISSN: 2309-3854 online

(Received: Jan 11, 2021; Accepted: Feb 22, 2021; Published: Apr 23, 2021)

This Article is brought to you for free and open access by CORE Scholar. It has been accepted for inclusion in *Journal of Bioresource Management* by an authorized editor of CORE Scholar. For more information, please contact library-corescholar@wright.edu.

Challenges and Opportunities in Food Safety-A Review

© Copyrights of all the papers published in Journal of Bioresource Management are with its publisher, Center for Bioresource Research (CBR) Islamabad, Pakistan. This permits anyone to copy, redistribute, remix, transmit and adapt the work for non-commercial purposes provided the original work and source is appropriately cited. Journal of Bioresource Management does not grant you any other rights in relation to this website or the material on this website. In other words, all other rights are reserved. For the avoidance of doubt, you must not adapt, edit, change, transform, publish, republish, distribute, redistribute, broadcast, rebroadcast or show or play in public this website or the material on this website (in any form or media) without appropriately and conspicuously citing the original work and source or Journal of Bioresource Management's prior written permission.

CHALLENGES AND OPPORTUNITIES IN FOOD SAFETY-A REVIEW

IRAM ASIM¹ AND HUMAIRA YASMEEN¹

¹*Department of Microbiology and Molecular Genetics, The Women University Multan, Pakistan*

Corresponding author's email: humaira.6127@wum.edu.pk

ABSTRACT

Food-borne diseases are the group of disorders that are caused by consuming food having microbial existence in it. So safe food handling is to make sure the lessening of detrimental effects in growth to the packaging of food to minimize health issues on consumers which otherwise can lead to large scale disease outburst. This review concludes the findings of the studies on how food is being handled from farm to fork, how airlines are contributing towards the spreading of diseases, how any negligence in any one of the steps can cause havoc to mankind in the light of the recent coronavirus pandemic. This review suggests the methods for the detection of food-borne viruses and the challenges for the regulation of zoonotic outbursts. This review recommends strict regulation, updating of the food handling policies, and ways to control emerging infectious diseases in relation to food.

Keywords: Farm to fork, food handling, zoonosis, hazard, pandemic, COVID-19.

Abbreviations: FBD: foodborne diseases, WHO: World Health Organization, GIT: gastrointestinal tract, Nov: noroviruses, HAV: hepatitis A virus, FS: food safety, EIDs: emerging infectious diseases, MERS-CoV: Middle East Respiratory Syndrome Coronavirus, (2019-nCoV: 2019 Novel Coronavirus, NiVE: Nipah Virus Encephalitis, RTE: ready to eat, FBZV: food-borne zoonotic viral, SARS: Severe Acute Respiratory Syndrome

INTRODUCTION

Foodstuffs and nutrition are vital for the persistence of life. The worldwide requirement for nutrition and foodstuffs has also amplified with the populace's progression and advancement. The manufacturing of foodstuff encompasses a variety of different arenas but principally husbandry along with agronomics. While they persist as the elementary source of nutrition source beforehand being cooked or processed by the producers and transported to the purchaser in a sense to what is acknowledged as the from farm to fork term. Though, risks from the physical, microbiological, and biochemical compounds, which add the allergens, carry a challenge and hurdle in making certain that the food is harmless for ingestion. While additional obstacle is the possibility for contamination or infectivity which can happen at somewhat all the phases in the food supply string (Ruby et al., 2019). It is imperious to understand the international problem of the outbreaks involving foodborne diseases (FBD), nevertheless of whether the republics are advanced nations or under developing. WHO (World Health Organization) has approximated that 600 million individuals have a medical condition from foodborne diseases such as stomach flu, diarrhea, vomiting, and some other nastiest consequences that even could cause cancer because of the ingestion of unhygienic foodstuffs with verification of about 420,000 fatalities each year (WHO, 2017). However, the outburst of food-borne diseases typically orbits around the hygiene of foodstuffs, preparation, and the numerous phases involved in the management of food making. The buyers are eventually the culmination consumers in the sequence of food processing, and at this point, they can effortlessly get spoiled (Ruby et al., 2019). The foodborne toxicities are classically

communicable or fatal and are typically triggered by organic constituents' viruses, parasites, or microbes through contaminated foodstuff and liquids, also invading the individuals (Walsh et al., 2019).

The Interface of Food Safety and Security

Overall, the worldwide humanoid inhabitants are likely to extend to 9.7 billion individuals by the year 2050. While the humanoid inhabitants keep on increasing, the world experiences cumulative encounters to certify that the individuals will have an approach to healthy safe, nutritious, and hygienic foodstuff. However, by the year reaches 2050, the production and processing of food and foodstuffs will necessitate amplifying by more than 50% to 60% as compared to the production levels in 2012 to upsurge the requirement. Whilst the amplified requirement for foodstuffs has previously stressed over the environmental possessions consequential in the contamination of the environment and atmosphere, damage to the biodiverse topographies and erosion of soil all around the globe thus posing novel tasks in maintainable food production, safety, and security. Furthermore, transboundary illnesses and calamities present a massive risk to food security and food safety. Environmental catastrophes such as seismic activity floods, fires, and volcanic activity generate ways in which heavy metals disease-causing microorganisms, pollutants, and chemicals easily pollute the water, air, and soil as well as the environment in which we survive and grow foodstuffs for consumption (Garcia et al., 2020).

Causes

i. Low Socioeconomic Populations

The incidence intensities of food-related illnesses have not predictably been tracked with the help of traditions, ethnicity, or wages. Nevertheless, there is a limited quantity of research that has observed that the slight working populace of persons is one of the furthestmost possibly to undergo massive expenses. Moreover, there is as well escalating validation that the objects of peripheral ethnical and traditional groups struggle from improved indictments of illnesses having origins linked with food products and kinds of stuff. Minimum pays, as well as peripheral populations, undergoes higher percentages of infection consuming contaminated food products, although at this point the question arises as per were in the series of farm to fork such inhabitants might be suffering bigger jeopardy of revelation with the foodborne pathogenic microorganisms. However, in certain circumstances, the epidemiological confirmation has already made it well defined that a specific pattern of intake of foodstuffs amongst inhabitants leads to an augmented contact with a certain type of pathogenic microorganism. This was the situation for *Listeria* and Hispanic residents (consumption of fresh Mexican style cheese and cheese products) along with the *Yersinia* and African Americans (eating of chitterling). Also, there is an additional likelihood to how and where inhabitants in minority might encounter larger risks for foodborne diseases is at the food provision facility stage or the foodstuffs merchandizing. So, this idea has been defined as well as documented by the US Department of Agriculture as the Food Deserts where there is an absence of huge hypermarkets and ultimately inclines to be the source of a huge variety of minor ready to eat foods or fast-food retailers as well as grocers (Quinlan, 2013).

ii. Food Viruses

From the past few years, the viruses go on progressively more acknowledged as one of the significant triggers of food-related infection outbreaks. Whereas noroviruses are at present documented as the absolute dangerous viruses causing foodborne disease outbreaks associated with the unhygienic condition of the food and related products. Contamination of food materials employing viruses be highly influenced by the prime-making settings. At that moment, such viruses disseminate to individuals in numerous modes. However, the most important way is to infect the gastrointestinal tract (GIT) and then be expelled in waste materials, on the other hand, in a few situations, in the vomiting. Overall, noroviruses (Nov) are one of the greatest conventional bases of the food-related viral gastroenteritis globally, along with hepatitis A virus (HAV) which can as well be spread by food-related means, which remains to impersonate as a global health and well-being hazard (EFS, 2020).

iii. Food Handlers

It is more likely thinkable that the diseased food workers and staffs could initiate a virus particle in the food materials which they are working on and with, or maybe on the outsides within the food production and trade, mainly by sneezing, coughing, or by direct physical interaction, except they precisely adhere to the appropriate individual sanitization procedures. Conversely, the world health organization (WHO) recommends that the management of food products should be supervised for appropriate cold, cough, and sterility procedures, secure food systems, including the averting of adjacent communication, as soon as feasible with anybody displaying the signs of any respirational disease (Sattar et al., 2002, Mead et al., 1999).

iv. Food Hygiene

Germ-free regulator for food products is a critical point in the battle on the road to decrease or extenuation of the disease outburst of rampant food origin illnesses and infections. Individuals around the globe eat and enjoy foodstuffs in countless community spaces such as hotels, hospitals, restaurants, and even around monotonous street retailing settings. Fascinatingly, the community intake of foodstuffs is also a vital element of individuals day-to-day life along with the responsibility to confirm or make sure that the food material being serve up to the community fulfills the compulsory monitoring control procedures puts upon the food handlers and food makers who are directly engaged with the cooking, vending and handling of the food products to the general public. Safety information and awareness of the food vendors and handlers encompasses their perception of all the practices and surroundings and situations that compact with the appropriate and suitable preparation, storage of food along with the handling. Additionally, food handlers and makers should also hold satisfactory food safety and security information and facts that will enable the order to diminish or lessen the foodborne disease's outbreak or infections (Kwol et al., 2020).

v. Food Safety Culture

Founded on the postulations and as well as on the scientific facts of humanoid structural values, performance, and activities, food safety values (FS culture) develop the innovative and logical idea to fully comprehend the safety of food and food products. The FS culture is demarcated as the collective approaches, ideas as well as principles regarding the safety of food product's activities that are characteristically established in the field of food

handling and making. Griffith et al. (2010) identified a total of six aspects regarding the evaluation of the food safety (FS) culture which are the procedure, leadership, management structures, style, risk perceptions, environment, communication, and lastly the obligation. However altogether the aspects of food safety culture which when established and amended, that is the food safety and security as an essential portion of the commercial administrations that accomplish good in most phases and zones have enhanced FS culture. It can also serve as a marker for a corporation's structural principles besides amenability with endorsements. Besides, it can arise as a component for food safety and security principles in certain reports and investigations. For instance, an investigation involving food vendors observed that societal hassle (e.g., health inspection representatives, nobles, and stress from the administrators) served to encourage improved hand sanitization. However, the principles and ideas of food safety values and culture have been practiced in the food business sector to diminish the hazard of tragedies, accidents, and foodborne diseases spread and outbreaks as well (de Andrade et al., 2020).

vi. *Emergence and Re-Emergence of Infectious Diseases*

The technical and financial progression in the industry and agronomy, along with the increasing population of individuals (provokes the uncontrolled development of the earlier unoccupied natural zones), are one of the very limited determining aspects that are connected to the deprivation of such kind of settings. Congruently, such situations can lead to support the improved wildlife and human communications which in turn can enable the propagation of parasitic and transferrable mediums or microorganisms to the different environments and hosts, consequently, creates novel and possibly destructive associations, refurbishing the current environmental slots in the spread of illness phases and progressions (Garcia et al., 2020).

vii. *Emerging infectious diseases (EIDs)*

The emerging infectious diseases (EIDs) can be defined as infections having an amplified frequency in the last twenty years which can be intensified sooner while, such diseases can be triggered by the newly identified strains or recognized etiological mediators accounting for about 12% of all the existing humanoid pathogenic microorganisms. A few highlighted cases are influenza, West Nile fever, Middle East Respiratory Syndrome Coronavirus (MERS-CoV), Severe Acute Respiratory Syndrome (SARS) along with the existing outburst of viral pneumonia which is connected with the recent coronavirus known to be 2019 Novel Coronavirus (2019-nCoV). Consequently, EIDs of wild animals can be cataloged into three sets, which are established on the mentioned ultimate epizootiology decisive factor, EIDs connected with excess of domesticated animals to wildlife populations living in the close vicinity. EIDs are precisely associated with human involvement, EIDs without apparent participation of domestic animals along with humans and throughout translocation of either parasite or host. Such circumstances have two imperative and biological inferences. First, numerous wild animal species are the rich source of numerous pathogenic microorganisms which threaten the community health or domestic animals. Secondly, EIDs of wildlife characterize a substantial threat to the preservation of the global biodiversity of animals. SARS, Ebola, 2019-nCoV and Nipah Virus Encephalitis (NiVE) are some of the cases of added noticeable EIDs, which originate from wildlife. This presents global pandemic jeopardy and causing currently massive societal burdens and economic hurdles to humanity. Novel evolving zoonosis is also accountable for gradually burdening wellbeing structures and global economies, predominantly in the areas where inhabitants are compactly agglomerated (Cupertino et al., 2020).

However, the hazard of the novel humanoid pandemic is undoubtedly most probable in an extreme hazard interface resulting in the promotion of the reemergence of former diseases and pathogenic microorganisms far deadlier than before. As far as viral diseases are concerned, consistent data on the environments at the point of their propagation doesn't exist for numerous viral particles. Meticulously, data on animal illnesses are mostly inadequate and unavailable due to imprecise surveillance of wild animals universally (Johnson et al., 2015).

Challenges

i. Air travel

In the case of food management practices, onboard commercial airplanes are frequently standardized so there are actual obstacles that delay devotion to hygiene procedures and regulations. With the sharp upsurge in international air transportation, there is a huge number of individuals who can encounter the danger of insignificant food measures and hygiene practices in air travel situations. The world health organization gives an approximation that every year as many as 600 million individuals universally suffer illness from unhealthy food products, in which 420,000 die yearly. Most of the republics have launched multifaceted, enforceable regulations on food cleanliness for the on-field food sites, to ensure that food handlers will have a stress-free approach to handwashing sinks and lavatories. Nevertheless, such protocols normally do not harness food management in flights, and acclimating ethics to airplane cabins poses a question. Airplanes are documented as the significant mediums for the rapid spread of foodborne diseases and even in the outbreaks of certain diseases. Global or international air transportation embraces a wide variety of food security risks that arises from the type of aircraft cabin settings and atmospheres. Characteristics of the airplane cabin that influences to spread of pathogen are the huge sums of people sharing enclosed area, and common hygienic accommodations. For instance, lacking to wash hands later touching dirty workstation tops is probable to be perilous than unable to wash hands after contacting one's uniform. Unable to wash hands after using the lavatory is expected to be perilous if the subsequent action is to organize a fruit or bread container rather than revamping toiletries. Even though food handlers are stereotypically dejected from management and handling drinks or foodstuffs if they have any indications of disease or infection that could be transmittable, cabin staff was noticed to habitually fly when feeling sick or ailing. Diseased crew staff could therefore also represent a source for the spread of disease or infection in-flight or during the flight (Grout and Speakman, 2020).

ii. COVID-19

Coronaviridae illnesses are acknowledged in the livestock animals and winter dysentery in dairy livestock and beef, respirational coronaviridae in avian, and swine contagious bronchitis in roosters. However, the transmission of animal-linked coronavirus to individuals was apparent during the outbreaks of Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). Likewise, the zoonotic contribution which includes pangolins and bats has been alleged in the light of the present COVID-19 pandemic disease. On the other hand, meaty food products like poultry beef, seafood, pork contain greater amounts of heparan sulfate (glycosaminoglycans), which are extremely charged fixers for SARS CoV-2 to intermingle with the host tissue epithelia. Deliberating the fact that SARS CoV-2 can persist for several days on insensate surfaces and places like stainless steel plastic and cardboard, it is noticeable that the animal tissue (meat) exteriors would be a dangerous vault of the foodborne spread of the COVID-19 virus. However, the coronavirus could probably get a chance to spread from hands by touching the infected surfaces during

the handling of food and food products. Whilst there are so many biohazards that are linked with the supply and handling of food products. Recently the sudden outbreak of the COVID-19 virus epitomizes another question in pledging that the food supply should remain secured. So, as a hands-on tactic, the following are the four crucial steps for the protection of food products which are Cook, Separate, Chill, and Clean to avert any type of food-related infections (Pressman et al., 2020).

Nevertheless, founded by the data from the literature, it is highly rational to ponder that the readily available or on-the-spot food managers, street vendors, and further staff were accidentally exposed to the COVID-19 in a process of selling, slaughtering, and managing the diseased animals. However, such infected workers along with the food managers were not the first hand or primary victims or customers of the food merchandise being wholesaled in the marketplace. Nevertheless, close breathing and talking in the epidemiologic element holding atmosphere and surroundings may have instigated those individuals to be exposed unintentionally by the virus particles. Even though 2019-nCoV spread employing person to person at food products facility and merchandising division becomes an added complication. Nonetheless not anything has been stated on such a decisive facet. However, this matter should not be correspondingly overlooked in the light of the up-to-date situation which is becoming highly life intimidating. On the other hand, such an aspect does emanate from food handling and food safety concerns (Shahbaz et al., 2020).

iii. Food Protection

At present, there is not any peer-reviewed work on the investigation of the COVID-19's capability to reside and remain virulent on food products. Consequently, appropriate management is specifically significant in the case of droplets having airborne origin resounding the virus particles to stay on the ready-to-eat (RTE) food products. By employing appropriate reliable food-management procedures, customers can achieve self-assurance. Food customers have stated their apprehensions and fears regarding the contagion's food protection suggestions. Above all, food protection is very important, nevertheless of whether there is an epidemic or pandemic or nothing. Clear-cut and average procedures that guard contrary to the diseases, having an origin of food is equally significant to secure against the COVID-19 virus (Feng, 2020).

The key is to prevent consuming uncooked food materials. While it can be defying and difficult to request individuals not to consume uncooked food they enjoy. On the other hand, food preference is guided by numerous cultural, environmental, and communal aspects. Fresh and nonboiled milk along with soft cheese produced from the nonboiled milk was linked to quite a lot of outbreaks with food backgrounds (Centers for Disease Control and Prevention, 2019, U.S. Food and Drug Administration, 2018). Uncooked mushrooms, vegetables, sprouts, and fruits were also observed to be one of the causes for the food originated pathogenic microorganisms which caused individuals to become ill (Centers for Disease Control and Prevention, 2020b, 2020c; US Food and Drug Administration, 2020a, 2020b).

iv. Detection Methodologies

Of late, the sum of detection approaches accessible for the food origin viruses in additional food environments has been on the rise, which imitates the implication of the acknowledgment of food-borne zoonotic viral (FBZV) illness. Subsequently, the COVID-19 virus genome, which was initially issued in January 2020, allows us to compare the strains already isolated in animals with the human form of the coronavirus. With that, one could state that epidemiological observations are extremely important in all the republics nowadays.

So, this accessibility of the epidemiological observations will make sure that the facts and figures would be enough for a further consistent assessment of the zoonotic viruses and related diseases. This would also make certain the willingness of each investor for the consequential distribution of viruses which would result in additional difficulties (Shahbaz et al., 2020).

v. *Regulation of Zoonotic Outbursts*

The handling of the dangers of the viral particles frequently necessitates procedures that are diverse from those which are stereotypically utilized to fight against bacteriological threats as well. While most of the strategies along with procedures practicing across the globe of community wellbeing assessment mainly emphasize the food products cleanliness regulations which possibly will aid in the anticipation of microbial contagions, but it might not be applicable in the case of zoonotic virus particles and diseases (Johnson et al., 2015). Up till now, substantially consistent investigations and research highlight the damaging socio-economic impression of every single zoonotic outbreak which also resulted in epidemics. Devising such investigations will stress digging up the cause or origin of the zoonotic viral particles resulting in disease outbreaks. This ultimately results in adding adequate struggles and attempts to eradicate on the precise moment employing great accessibility of the examiners experienced in community health. Furthermost current outbreaks converted into a pandemic, like severe acute respiratory syndrome (SARS), and in recent times 2019-nCoV being present in the hospitals as compared to exist in the main source or environment which is the Wuhan's market in China. Consequently, we realize that humanity should have to deal with a problematic zoonosis outbreak which is linked to healthcare contagions as compared to food-related illnesses resulting from a probable cause that may well have been alleviated beforehand (Kwol et al., 2020).

Recommendations

i. *Introduction of Zoonotic Virus-Free Framework*

Extensive outbursts of diseases frequently instigate from an amalgamation of numerous communicable means like specifically if the zoonotic virus particles are introduced in a very sensitive or weakly immune inhabitants by drinking water, asymptomatic shedder, or foodstuff which is further pursued by the effectual multiplication of the viral particles employing the vulnerable inhabitants by the nonstop individual to individual interaction or through the polluted and infectious atmosphere. Moreover, this matter is even highly crucial if we understand that the present outbreak converted into a pandemic may emanate next time or maybe next year from an under-advancing republic that does not have the possessions of China who dealt with the COVID-19 outbreak very professionally. Henceforth, founded on such important actuality which was extracted from the literature study and analysis, there is an immediate requirement to create a community health structure that is zoonotic virus-free or at least exposure (Shahbaz et al., 2020).

ii. *State-of-the-art Community Health Practices*

Across the globe, the human factor is the important constituent of viral contact or safety. In nearly all the republics, there are guiding principles for the secure preparation, manufacture, processing, and packaging of foods and food products. Nevertheless, the fulfillment and approach to these procedures diverge nation to nation, and to the precise amount by the facility which includes organization, farms, fields, merchandising individual

wager, and processor. However, it is of immense importance that further research spotlights the socio-economic worth of the beneficial community health procedures to make sure that both community and administrations team up on informing at the precise hour. For instance, gloving (barehand interaction) advice is simply as better as following such above mentioned suggestions. Farm laborers can simply put into practice appropriate personal health if they are offered an approach to satisfactory resources. Such mentioned aspects necessitate being believed in contact valuation (Buheji, 2020).

CONCLUSION

For the foundation of a better and secure world, an inadequate amount of research and analysis exist in this content. Fundamentally nothing is acknowledged about fulfillment tariffs nor approach to satisfactory health services in the underdeveloped world which makes it difficult to control the future outburst of deadly diseases.

CONFLICT OF INTEREST

Nil

REFERENCES

- Authority, EFS (2020). The European Union Summary Report on Antimicrobial Resistance in zoonotic and indicator bacteria from humans, animals, and food in 2017/2018. *EFSA J.*, 18(3).
- Buheji M (2020). Stopping future COVID-19 like pandemics from the Source-A Socio-Economic Perspective. *Am J Econ.*, 10(3): 115-125.
- Centers for Disease Control and Prevention. (2020a). About Quarantine and Isolation. Retrieved from <https://www.cdc.gov/quarantine/quarantineisolation.html>.
- Centers for Disease Control and Prevention. (2020b). Outbreak of E. coli infections linked to romaine lettuce. Retrieved from <https://www.cdc.gov/ecoli/2019/o157h7-11-19/index.html>.
- Centers for Disease Control and Prevention. (2020c). People at Risk for Serious Illness from COVID-19. Retrieved from <https://www.cdc.gov/coronavirus/2019-ncov/specific-groups/high-risk-complications.html>.
- Cupertino MC, Resende MB, Mayer NA, Carvalho LM, Siqueira Batista R (2020). Emerging and re-emerging human infectious diseases: A systematic review of the role of wild animals with a focus on public health impact. *Asian Pac J Trop Med.*, 13(3): 99.
- De Andrade M L, Stedefeldt E, Zanin LM, Da Cunha DT (2020). Food safety culture in food services with different degrees of risk for foodborne diseases in Brazil. *Food Control.*, 112: 107152.
- Feng Y (2020). Keep calm, handle food safely. Purdue Extension.
- Garcia SN, Osburn BI, Jay Russell MT (2020). One Health for Food Safety, Food Security, and Sustainable Food Production. *Front Sustain Food Syst.*, 4: 1.
- Grout A, Speakman EM (2020). In-flight transmission of foodborne disease: How can airlines improve? *Travel Med Infect Dis.*, 33: 101558.
- Johnson CK, Hitchens PL, Evans TS, Goldstein T, Thomas K, Clements, A, Mazet JK (2015). Spillover and pandemic properties of zoonotic viruses with high host plasticity. *Sci Rep.*, 5: 14830.
- Kwol VS, Eluwole KK, Avci T, Lasisi TT (2020). Another look into the Knowledge Attitude Practice (KAP) model for food control: An investigation of the mediating role of food handlers' attitudes. *Food Control.*, 110: 107025.

- Mead PS, Slutsker L, Dietz V, Mc Caig LF, Bresee JS, Shapiro C, Tauxe RV (1999). Food-related illness and death in the United States. *Emerg Infect Dis.*, 5(5): 607.
- Pressman P, Naidu AS, Clemens R (2020). COVID-19 and food safety: risk management and future considerations. *Nutr Today.*, 55(3): 125-128.
- Quinlan JJ (2013). Foodborne illness incidence rates and food safety risks for populations of low socioeconomic status and minority race/ethnicity: a review of the literature. *Int J Environ Res Public Health.*, 10(8): 3634-3652.
- Ruby GE, Abidin UFUZ, Lihan S, Jambari NN, Radu S (2019a). A cross sectional study on food safety knowledge among adult consumers. *Food Control.*, 99: 98-105.
- Ruby GE, Abidin UFUZ, Lihan S, Jambari NN, Radu S (2019b). Predicting intention on safe food handling among adult consumers: A cross sectional study in Sibu district, Malaysia. *Food Control.*, 106: 106696.
- Sattar SA, Springthorpe VS, Tetro J, Vashon R, Keswick B (2002). Hygienic hand antiseptics: should they not have activity and label claims against viruses. *Am J Infect Control.*, 30(6): 355-372.
- Shahbaz M, Bilal M, Moiz A, Zubair S, Iqbal HM (2020). Food safety and COVID-19: precautionary measures to limit the spread of coronavirus at food service and retail sector. *J Pure Appl Microbiol.*, 14(1): 749-756.
- Walsh C, Leva MC (2019). A review of human factors and food safety in Ireland. *Saf Sci.*, 119: 399-411.