International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Association between Food Handling Practices, Food Handlers Personal Hygiene Checklist , and Microbial Contamination of Food Prepared at Cloud Kitchen

Ms. Shreya Valvekar

Student, Nutrition and Dietetics, College

ABSTRACT

The study entitled *"***Association Between Food Handling Practices, Food Handlers Personal Hygiene Checklist, and Microbial Contamination of Food Prepared at Cloud Kitchens***"* was undertaken to assess the association between food handling practices, food hygiene practices, and the level of contamination in cloud kitchens. With the increasing demand for online food delivery services, ensuring proper hygiene and safe food handling practices has become essential for maintaining food safety and protecting consumer health. The study was conducted among 20 food handlers from 5 selected cloud kitchens, with participants ranging from 22 to 82 years of age. Data were collected using a structured questionnaire covering Socio-demographic characteristics, personal hygiene, health-related issues, utensil and equipment hygiene, hand-washing practices, food handling practices, storage, and ventilation. Microbial analysis using TPC was done on 10 samples (sambar and dal).The findings revealed that most food handlers followed personal hygiene practices such as maintaining clean uniforms 9 (45%), trimming nails 14 (70%), using gloves 9 (35%), and avoiding jewellery while handling food 9 (45%); however, variations were observed in certain food handling practices. The microbial analysis showed differences in microbial load among the selected cloud kitchens, with the highest counts observed in **IVASA Cloud Kitchen (106 CFU)** for dal samples and **Cloud Kitchen For U (263 CFU)** for sambar samples. Statistical analysis using the chi-square test showed a significant association (137.8) and (52.8) between personal hygiene practices and microbial contamination levels ($p < 0.05$), supporting the alternate hypothesis, while ANOVA indicated no significant difference (0.24) between and within the selected cloud kitchens. The study concluded that better personal hygiene and food handling practices were associated with lower microbial contamination levels. Therefore, maintaining proper hygiene standards and safe food handling practices is important for improving food safety and reducing the risk of microbial contamination at cloud kitchens.

CHAPTER - I
INTRODUCTION

Food is one of the most essential components of human existence, providing the necessary nutrients required for growth, development, and maintenance of life. However, despite its fundamental importance, food also represents a significant pathway for the transmission of diseases when contaminated by harmful agents. Food safety, therefore, has become a major global public health

concern, encompassing all measures and practices that ensure food is handled, prepared, processed, stored, and consumed in a manner that minimizes the risk of contamination and prevents food-borne illnesses. Contamination of food may occur at any stage of the food supply chain, from primary production to final consumption, and can arise due to biological, chemical, or physical hazards. Among these, biological hazards, particularly microbial contamination, are the most significant contributors to food-borne diseases. Microorganisms such as bacteria, viruses, parasites, and fungi can grow and multiply rapidly under favorable conditions, making food an ideal medium for their proliferation. The increasing complexity of food systems, driven by globalization, urbanization, industrialization, and changing dietary patterns, has further increased the risk of contamination and made food safety an increasingly challenging issue to address.Food-borne diseases are one of the most significant public health concerns globally, affecting millions of individuals every year. These diseases arise due to the consumption of food or water contaminated with pathogenic microorganisms such as bacteria, viruses, parasites, or toxic substances (Rossie E.M. *et al* ,2017). The impact of food-borne illnesses extends beyond individual health, as they also impose a heavy burden on healthcare systems, food industries, and national economies. The World Health Organization has identified food-borne diseases as a major cause of morbidity and mortality worldwide, particularly in developing countries where food safety systems are often inadequate (World Health Organization, 2015).

The study encompasses the following :

1.1 - Cloud kitchen
1.2 - Pathogens
1.3 - Contributing factors for food borne Illness
1.4 - Aspects of food borne Illness
1.4.1- Role of Handlers
1.5 - Food Safety - Hygiene and Packaging
1.6 - Cross - Contamination
1.7 - Techniques
1.8 - Statistical Analysis
1.9 - Need of study

1.1 - CLOUD KITCHEN

India is a food-loving nation, and Indian cuisine combines elements from many different cultures and customs. The increase of middle-class consumers with large discretionary income, changing lifestyles, and the accessibility of restaurants in the area all contributed to the success of Indian eateries. Experts in the field predict that the Indian market for food delivery services will grow by double to $13 billion by 2025 and that cloud kitchens would grow to be a $2 billion industry in India by 2024 from $400 million in 2019.The food sector has made a number of technical breakthroughs as a result of rising competition and advancing technology. Cloud Kitchen is one such concept that has made its way into the culinary sector and took the global restaurant scene by storm. According to reports, the cloud kitchen concept is one of the restaurants industry's fastest-growing sub-sectors and is thought to be a more intelligent way to run restaurants.A limited selection of food is provided in the cloud kitchen. Only orders placed through online channels are used to create the meal, which is then delivered by a variety of food delivery services, including Food Panda, Swiggy, Zomato, and others.Cloud Kitchen is commercial space is ready to prepare food, exclusively for customer orders or deliveries.(Cherekar,M.N., *et al*,2025)

Sometimes referred to as virtual kitchen, shared kitchen, ghost kitchen, or satellite kitchen.There are no dine-in customers in a cloud kitchen; instead, food is exclusively produced in a commercial kitchen for delivery or takeout.With the help of Cloud kitchens restaurants can easily grow an already existing business or launch a digital brand.The method of placing an order for food via a website or another application, either for delivery or pickup, is known as online food ordering. While food delivery platforms have taken centre-stage,“Cloud Kitchen" is one of the growing business models that benefits from the expansion of food delivery.Cloud kitchens, in particular, have emerged as a popular food service model in recent years. These kitchens operate without dine-in facilities and primarily focus on food delivery. While they offer convenience and efficiency, concerns have been raised regarding their hygiene practices and regulatory compliance. Limited monitoring and lack of standardized guidelines may contribute to variations in food safety practices across different establishment.(Machi Eunica *et al* 2025)

1.2 - PATHOGENS

Food-borne illnesses are reported annually, with pathogens such as **Campylobacter spp.**, **Salmonella,** and **norovirus** accounting for approximately 73% of all cases (Anonymous, 2018). Food-borne pathogens are diverse and widely distributed in nature. Among the most common bacterial pathogens are **Salmonella enterica, Escherichia coli, Campylobacter spp., and Listeria monocytogenes.** These microorganisms are found in various environmental sources, including soil, water, animals, and food products .Viral pathogens such as norovirus and hepatitis A virus also contribute significantly to food-borne illnesses. The ability of these pathogens to survive under different environmental conditions makes them particularly difficult to control.The transmission of food-borne pathogens occurs mainly through contaminated food and water. Contamination can happen at any stage of the food chain, including production, processing, distribution, and preparation.(Magambo,J.M.J., *et al.*, 2025).

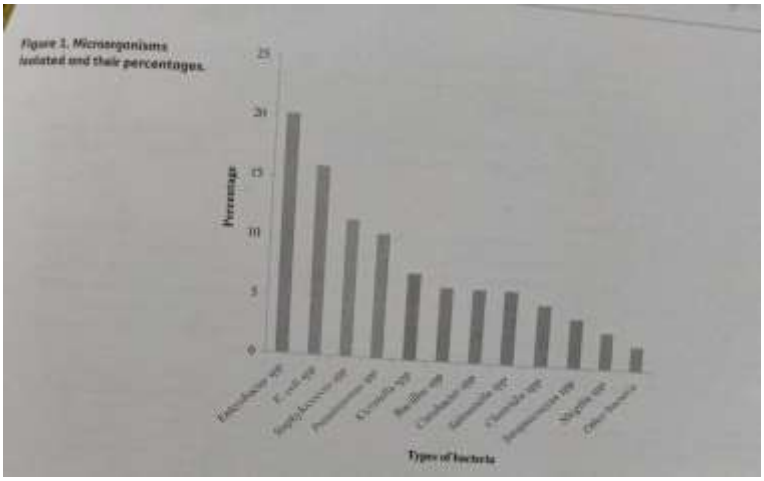


Image - 1 - Types of Bacteria

Source – Samuel Jerry Cobbina *et.al.*,2017

Food serves as an ideal medium for the growth and proliferation of microorganisms due to its nutrient-rich composition, moisture content, and favorable environmental conditions. Pathogenic microorganisms such as **Escherichia coli, Salmonella spp., Staphylococcus aureus, Campylobacter spp., Listeria monocytogenes,** and **Bacillus cereus** are commonly associated with foodborne illnesses. These microorganisms can contaminate food through various sources, including raw ingredients, contaminated water, improper handling, and unsanitary environments. Herawati highlighted that **Escherichia coli** is

widely used as an indicator organism for assessing hygiene conditions, as its presence suggests fecal contamination and the potential presence of other pathogenic microorganisms.(Herawati *et al.*,2023).

The presence of pathogenic microorganisms in food can lead to a wide range of illnesses, ranging from mild gastrointestinal symptoms such as diarrhea, vomiting, and abdominal pain to severe conditions such as systemic infections, organ failure.For example, research on popular street foods such as fuchka has identified the presence of drug-resistant **Escherichia coli** and **Staphylococcus species,** indicating a serious public health risk (Augustin *etal*.,2020). The presence of pathogenic microorganisms in food can lead to a wide range of illnesses, ranging from mild gastrointestinal symptoms such as diarrhea, vomiting, and abdominal pain to severe conditions such as systemic infections, organ failure, and death. The severity of these illnesses depends on various factors, including the type and concentration of the pathogen, the amount of contaminated food consumed, and the health status of the individual. For instance, Staphylococcus aureus produces heat-stable toxins that can cause food poisoning even after the bacteria have been destroyed by cooking, while **Salmonella spp**. and **Campylobacter spp**. are commonly associated with gastrointestinal infections. The presence of **Escherichia coli,** particularly pathogenic strains such as E. coli O157:H7, can lead to severe complications such as hemolytic uremic syndrome, which can be life-threatening.(Magambo.J.M.J *et al* 2025).The scientist identified various pathogenic microorganisms, including Salmonella, Shingella, and Staphylococcus aureus, in household dishcloths, highlighting their role as reservoirs and vectors for contamination. (Thalij,K.M., and Salman,N.M. 2025).

Bacterial pathogens are the most common cause of food-borne illnesses. ***Salmonella enterica*** is one of the leading causes of infection worldwide and is commonly associated with contaminated poultry, eggs, and dairy products. It causes symptoms such as diarrhea, fever, and abdominal cramps. Similarly, ***Escherichia coli,*** particularly pathogenic strains, can cause severe gastrointestinal illness and, in some cases, life-threatening complications.***Campylobacter spp.*** is another important pathogen commonly associated with under cooked meat and contaminated water. It is one of the leading causes of bacterial gastroenteritis globally. **Listeria monocytogenes** is particularly dangerous as it can grow at refrigeration temperatures and poses a high risk to pregnant women, newborns, and immuno compromised individuals**.** ***Bacillus cereus*** is a spore-forming bacterium commonly found in soil and food products such as rice and spices. It produces toxins that cause two types of illness: emetic (vomiting) and diarrhoea syndromes (Okito.A.M.,
et al.,2025).

Its ability to form heat-resistant spores makes it difficult to control through conventional cooking methods.Viral pathogens such as norovirus and hepatitis A virus are also significant contributors to food-borne diseases. These viruses are highly contagious and can spread rapidly through contaminated food, water, and surfaces. **Norovirus**, in particular, is known for causing outbreaks in community settings such as schools, hospitals, and food service establishments.Parasitic infections, although less common, also contribute to foodborne diseases. Parasites such as ***Giardia, Entamoeba histolytica*****, and** ***Toxoplasma gondii*** can cause gastrointestinal illness and other health complications. These infections are often associated with poor sanitation and contaminated water sources.The pathogenicity of these microorganisms depends on several factors, including their ability to produce toxins, invade host tissues, and evade the immune system. Some bacteria produce toxins in food before consumption, while others produce toxins after entering the human body. Understanding these mechanisms is essential for developing targeted prevention strategies.(Allam *et al*,2016).

The interaction between pathogens and the host is influenced by factors such as age, nutritional status, and immune function. Individuals with weakened immune systems are more susceptible to infections and may experience more severe symptoms. This highlights the importance of protecting vulnerable populations through improved food safety practices.(Ay.M. and Dagon.M.,2020)

Access to safe drinking water is a major challenge in several parts of the world. In areas where clean water supply is limited, individuals are forced to rely on unsafe sources such as rivers, lakes, and wells. These sources are often contaminated with human and animal waste, making them reservoirs for pathogens such as **Escherichia coli and Salmonella.** Poor water quality not only affects drinking water but also impacts food preparation and hygiene practices, thereby increasing the risk of food-borne infections.(Yu Ji Na *et al* ,2024).

1.3-CONTRIBUTING FACTORS FOR FOOD BORNE ILLNESS

One of the major contributing factors to food-borne diseases is poor sanitation and hygiene. In many developing regions, inadequate waste disposal systems, lack of clean water supply, and poor environmental conditions create an ideal environment for the growth and spread of pathogens. In such areas, food handlers often lack proper training and awareness regarding food safety practices, which further increases the risk of contamination.Food borne diseases also have significant economic implications. They lead to increased healthcare costs, loss of productivity, and financial losses for the food industry due to product recalls and reduced consumer confidence (FSIS, 2023).

Environmental factors play a crucial role in the transmission and persistence of food-borne pathogens. Contamination of food is often closely linked to the quality of water, soil, and surrounding environmental conditions. In many developing regions, untreated wastewater is commonly used for irrigation, which increases the risk of contamination of fruits and vegetables with pathogenic microorganisms. Similarly, the use of contaminated water for washing food items further contributes to the species read of food-borne diseases (Rossie ,E.M.,*et al* 2017).

Food handling practices are a critical factor influencing food safety. Improper handling, including inadequate hand-washing, use of contaminated utensils, and poor storage conditions, can lead to the introduction and growth of pathogens in food. Food handlers play a crucial role in maintaining hygiene standards, and their knowledge and practices significantly impact food safety outcomes.(Ali *et al*,2017).

In many food establishments, particularly in developing regions, food handlers often lack formal training in food hygiene and safety. This lack of knowledge can result in unsafe practices such as improper cooking, cross-contamination, and inadequate cleaning of equipment. These practices increase the likelihood of food contamination and pose a serious risk to consumers.(WHO,2018)

Personal hygiene, particularly hand hygiene, is one of the most critical factors influencing food safety. The hands of food handlers can act as carriers of pathogens, transferring microorganisms from contaminated surfaces to food during preparation. It was reported that approximately 97% of food-borne illnesses are associated with improper food handling practices, many of which are directly linked to poor hand hygiene. (Zaki *et al* .,2024).

Temperature control is a critical factor in preventing the growth of food-borne pathogens. Microorganisms grow rapidly within a specific temperature range, often referred to as the “danger zone,” which typically lies between 5°C and 60°C. Food stored within this temperature range for extended periods is at high risk of microbial growth. Therefore, maintaining appropriate temperatures during cooking, storage, and transportation is essential to ensure food safety.(Roh.T.,*et al* ,2024)

In addition, socioeconomic factors play a crucial role in influencing food safety practices and disease occurrence. Low-income populations are more likely to be exposed to unsafe food due to limited access to hygienic food options and lack of awareness. However, these factors are often not sufficiently addressed in research studies, leading to incomplete understanding of the problem.Food handlers play a critical role in ensuring food safety. However, lack of knowledge, poor hygiene practices, and inadequate training among food handlers contribute significantly to food contamination. Understanding their practices and identifying gaps in knowledge and behavior is essential for developing effective interventions.(Chen.Y.*et al*,2019).

Time is another important factor that influences microbial growth in food. Prolonged storage of food at room temperature provides favorable conditions for bacteria to multiply. This is particularly important in the case of ready-to-eat foods, which are often prepared in advance and stored for extended periods before consumption. Reducing the time between preparation and consumption can significantly lower the risk of contamination.(Augustin.J.C., *et al* , 2020).

In addition to the previously discussed factors, it is important to understand that food-borne diseases are not only influenced by microbial contamination but also by behavioral and systemic gaps in food safety practices. Human behavior, particularly negligence and lack of adherence to hygiene protocols, plays a significant role in the transmission of food-borne pathogens. Another critical factor influencing food safety is the design and infrastructure of food establishments. Poorly designed kitchens with inadequate ventilation, lack of proper waste disposal systems, and insufficient storage facilities can create conditions that promote microbial growth. For example, absence of refrigeration facilities can lead to improper storage of perishable foods, increasing the risk of spoilage and contamination. Similarly, overcrowded kitchens can lead to cross-contamination due to limited space for proper food handling.(Jevsnik *et al* ,2021)

Environmental conditions, including water quality, sanitation, and waste management, also play a vital role in determining food safety. Poor environmental hygiene can lead to contamination of food at various stages of preparation and handling. Therefore, it is important to consider these factors while assessing food safety practices.Another important concern is the increasing prevalence of antimicrobial resistance, which poses a serious threat to global health. The presence of antibiotic-resistant bacteria in food highlights the need for improved hygiene practices and better monitoring systems to prevent their spread.Given these challenges, there is a need for comprehensive studies that assess food handling practices, hygiene conditions, and associated risk factors in local food service settings. Such studies can provide valuable insights into the causes of food contamination and help in developing strategies to improve food safety.(Rossie.E.M., *et al* ,2017).

Food safety in India is also influenced by socioeconomic factors. A significant proportion of the population relies on low-cost food options due to financial constraints. This often leads to the consumption of food from unhygienic sources, increasing the risk of food-borne illnesses. Additionally, lack of awareness and education regarding food safety practices further contributes to the problem.(WHO,2017)

Water quality is a critical issue in many parts of India. Contaminated water is commonly used for cooking, cleaning, and washing food items, which increases the risk of microbial contamination. Inadequate sanitation infrastructure and improper waste management further worsen the situation. Open defecation, improper sewage disposal, and accumulation of waste create environments that facilitate the spread of pathogens.(Chen.Y.,*et al* ,2019)

1.4 - ASPECTS OF FOOD-BORNE ILLNESS

Urbanization and changes in lifestyle have significantly influenced food consumption patterns in recent years. With increasing work commitments and time constraints, people are increasingly relying on ready-to-eat (RTE) foods and street-vended foods. These foods are convenient, affordable, and widely accessible, making them popular among all socioeconomic groups. However, they are often associated with higher risks of contamination due to poor hygiene practices and lack of proper infrastructure (Augustin ,J.C., *et al*,2020).

Temperature control is an essential aspect of food safety. Cooking food at appropriate temperatures can effectively eliminate most pathogens. It has been reported that heating food above 60°C significantly reduces microbial contamination. However, improper cooking, inadequate reheating, and storage of food at unsafe temperatures can allow bacteria to survive and multiply.Some microorganisms, such as **Bacillus cereus**, are capable of forming heat-resistant spores that can survive cooking processes. These spores can germinate under favorable conditions and produce toxins that cause food poisoning (Thalij,K.M.,and M.Salman,N.M,2025).

Household food hygiene is another important aspect of food safety. Practices such as proper hand-washing, safe cooking, and maintaining clean kitchen environments can significantly reduce the risk of food-borne illnesses.In many cases, infections originate within households due to poor hygiene practices, highlighting the need for increased awareness and education.(WHO,2020)

Another important aspect that requires attention is the role of education and awareness programs in improving food safety. In many developing countries, food handlers often learn cooking and food preparation skills informally without any structured training in hygiene and safety practices. This leads to the continuation of unsafe traditional practices that may contribute to contamination. Implementing structured training programs, certification courses, and regular monitoring can significantly improve the hygiene standards in food establishments.(Augustin.J.C.,*et al*,2020)

Another important aspect is the role of local authorities and municipal bodies in maintaining food safety. Regular inspections, licensing of food establishments, and monitoring of hygiene practices are essential for ensuring compliance with food safety standards. However, limited manpower and resources often hinder effective implementation of these measures.Climate conditions in India also influence food safety. High temperatures and humidity in many regions create favorable conditions for microbial growth, increasing the risk of food spoilage and contamination. Seasonal variations, such as monsoon rains, can further contribute to contamination by affecting water quality and sanitation conditions.(Ay.M. and Dagon.M.,2020)

1.4.1- ROLE OF HANDLERS

Despite the high incidence of food-borne diseases, under-reporting remains a major challenge, particularly in developing countries. Many cases of food-borne illnesses involve mild symptoms that do not require medical attention, leading to significant gaps in epidemiological data. It was emphasized that the actual burden of food-borne diseases is likely to be much higher than reported figures, as many cases go unrecognized and unreported. This underestimation complicates efforts to design effective interventions and policies, as accurate data are essential for identifying risk factors, assessing the effectiveness of control measures, and allocating resources appropriately. Furthermore, the lack of awareness among consumers regarding the risks associated with food preparation and handling contributes to the persistence of unsafe practices, thereby increasing the likelihood of contamination and disease transmission.(Akshay Kumar *et al*,2018)

Street-vended foods play an important role in the daily diet of many individuals, particularly in developing countries. Despite their popularity, these foods are frequently prepared and sold under unhygienic conditions. Vendors often operate in open environments with limited access to clean water, proper waste disposal systems, and adequate storage facilities. As a result, these foods are exposed to environmental contaminants such as dust, flies, and polluted water, which can lead to microbial contamination.(Jevsnik *et al* ,2021)

The role of raw ingredients in food contamination is also significant. Raw foods, including fruits, vegetables, meat, and spices, may carry microorganisms that can contaminate finished products. For example, spices have been identified as potential sources of contamination due to their exposure to environmental conditions during production and storage. If not properly treated or handled, these ingredients can introduce pathogens into prepared foods.(Chen,Y.,*et al*,2019)

Food handlers play a central role in maintaining food safety within food service establishments. Their personal hygiene, knowledge, and practices directly influence the quality and safety of food served to consumers. Poor personal hygiene, such as unwashed hands, dirty clothing, and improper handling of food, can introduce pathogens into food. In addition, behaviors such as handling money while preparing food, coughing or sneezing near food, and working while ill can further increase the risk of contamination.(Okito,A.M.,*et al*,2025)

The role of institutional support is equally important in ensuring food safety. Government agencies and regulatory bodies are responsible for establishing and enforcing food safety standards. However, in many cases, there is a lack of coordination between different agencies, leading to gaps in monitoring and enforcement. Strengthening institutional frameworks, improving inspection systems, and ensuring accountability are necessary steps toward enhancing food safety.(Magambo.J.M.J.,*et al*,2025)

Food processing techniques play an important role in reducing microbial contamination. Methods such as washing, peeling, cooking, and preservation can help eliminate or reduce pathogens in food. However, improper processing or inadequate application of these techniques can lead to contamination. For example, insufficient washing of vegetables or improper cooking of meat can allow pathogens to survive and cause illness.The role of equipment and utensils in food contamination is also significant. Improper cleaning and sanitation of utensils can result in the accumulation of microorganisms, which can be transferred to food during preparation. The use of contaminated cutting boards, knives, and storage containers can lead to cross-contamination between raw and cooked foods. Therefore, maintaining proper sanitation of equipment is essential for ensuring food safety.(Chen.Y., *et al*,2024)

Another emerging concern is the role of packaging materials in food safety. Improper or low-quality packaging can lead to contamination or chemical migration into food. Additionally, the reuse of packaging materials without proper cleaning can introduce pathogens. Therefore, ensuring the use of safe and hygienic packaging materials is an important aspect of food safety.(Jevsnik,*et al*,2021)

Cultural and social practices also play a role in food safety. In many communities, traditional methods of food preparation and storage are followed, which may not always meet modern hygiene standards. For example, consumption of raw or under-cooked foods, improper fermentation practices, and use of untreated water can increase the risk of contamination. Addressing these practices requires culturally sensitive awareness programs that promote safe alternatives without disregarding traditional values.(Roh,T., *et al*,2024)

The role of consumer perception and behavior should not be overlooked. Many consumers prioritize taste, cost, and convenience over food safety, which can lead to risky choices such as consuming food

from unhygienic sources. Increasing consumer awareness about the importance of food safety can influence their choices and encourage demand for safer food practices.(Ajekiigbe,V.O., *et al*,2025)

The role of research in improving food safety cannot be overstated. Continuous research is needed to identify emerging pathogens, understand transmission patterns, and develop effective prevention strategies. Localized studies are particularly important for understanding region-specific challenges and designing targeted interventions.(Herawati *et al*,2023)

Public health education plays a crucial role in reducing the burden of food-borne diseases. Awareness campaigns, community programs, and educational initiatives can help in improving knowledge and practices related to food safety. Collaboration between government agencies, educational institutions, and community organizations is essential for effective implementation of these programs.(Zaki *et al*,2024)

The Food Safety and Standards Authority of India plays a key role in regulating food safety in India. It has established guidelines and standards for food production, handling, storage, and distribution to ensure the safety of food products. Initiatives such as "Eat Right India" aim to promote safe and healthy eating practices among consumers and improve hygiene standards among food businesses. However, despite these efforts, challenges remain in effective implementation and enforcement of these regulations, particularly in informal sectors.(Prapti,B.B.R, *et al*,2025)

Public awareness campaigns play a crucial role in promoting food safety. Educating consumers about the importance of hygiene, safe food handling, and proper storage practices can help reduce the risk of food-borne diseases. Consumers who are aware of food safety practices are more likely to make informed choices and demand safer food options.The role of academic and research institutions is important in generating evidence-based data on food safety. Studies conducted at local and regional levels can provide valuable insights into specific challenges and help in designing targeted interventions. Collaboration between research institutions, government agencies, and the food industry is essential for effective implementation of food safety measures.(Allam *et al*,2016)

1.5 - FOOD SAFETY -FOOD HANDLERS , HYGIENE , PACKAGING

To address the complex challenges associated with food safety and antimicrobial resistance, the One Health approach has been widely recommended. This approach recognizes the inter-connectedness of human, animal, and environmental health and promotes collaborative efforts across multiple sectors . By integrating these sectors, the One Health approach aims to develop effective strategies for preventing and controlling food-borne diseases.(Cherekar,M.N., *et al*,2025)

This discrepancy between knowledge and behavior suggests that awareness alone is insufficient to ensure safe practices. Behavioral factors such as habits, attitudes, risk perception, and convenience play a significant role in influencing food handling practices. For example, individuals may prioritize convenience over safety, leading to shortcuts such as skipping hand-washing or using the same cutting board for raw and cooked foods. Additionally, cultural practices and beliefs may influence food preparation methods, further complicating efforts to promote safe practices. Therefore, effective interventions must address not only knowledge gaps but also behavioral factors that influence decision-making.(Machi Eunica *et al*,2025)

It was found that although consumers were aware of key food safety concepts, such as the importance of hand-washing, proper storage, and avoiding cross-contamination, they frequently failed to implement these practices during food preparation. Statistical comparisons indicated that individuals aged 36–55

years and women generally exhibited higher levels of knowledge, while younger adults (18–29 years) and older individuals above 60 years showed lower awareness levels. Despite this variation in knowledge, improper practices such as inadequate cooking, improper storage, and cross-contamination were observed across all groups.(Augustin.J.C., *et al*,2020).

Sanitation infrastructure is another key determinant of food safety. Inadequate sewage systems and improper waste disposal practices lead to environmental contamination, which facilitates the transmission of pathogens. In densely populated urban areas, these problems are often more severe due to overcrowding and insufficient infrastructure. The accumulation of waste and stagnant water creates favorable conditions for the growth of microorganisms and attracts vectors such as flies and rodents, which can further spread contamination.In many cities, including those in developing countries, food establishments often operate without proper regulatory oversight. Restaurants, street vendors, and small food outlets may lack basic facilities such as clean water supply, refrigeration, and waste management systems. These limitations significantly compromise food safety and increase the likelihood of contamination. Studies have shown that inadequate hygiene practices in food establishments are strongly associated with the occurrence of food-borne diseases.(WHO,2022)

Lack of training and awareness among food handlers is a common issue, particularly in informal food sectors. Many food handlers are not educated about safe food handling practices, including proper cooking temperatures, prevention of cross-contamination, and safe storage methods. This lack of knowledge contributes to unsafe practices and increases the risk of food borne illness outbreaks. Therefore, training and education programs are essential to improve food safety standards.(Chen,Y., *et al*,2019)

Refrigeration is an effective method for slowing down microbial growth, but it does not eliminate pathogens completely. Improper refrigeration, such as storing food at temperatures above recommended levels or overloading refrigerators, can reduce its effectiveness. Similarly, repeated reheating of food or prolonged storage of leftovers can increase the risk of contamination. These practices are commonly observed in both household and commercial settings.(Ay.M. and Dagon.M., *et al*,2020).

Another important gap is the limited awareness and training among food handlers. Many individuals involved in food preparation and service do not receive formal education or training in food safety and hygiene practices. This leads to unsafe behaviors such as improper hand-washing, cross-contamination, inadequate cooking, and unsafe storage of food. These practices significantly contribute to the occurrence of food-borne illnesses but are often overlooked in research and policy-making.(Prapti,B.B.R, *et al*,2025)

Even when knowledge about food safety exists, improper implementation of practices such as inadequate hand-washing, improper use of protective clothing, and unsafe food storage can result in contamination. Therefore, bridging the gap between knowledge and practice is essential for effective food safety management.(Rossie,E.M.,
et al,2017).

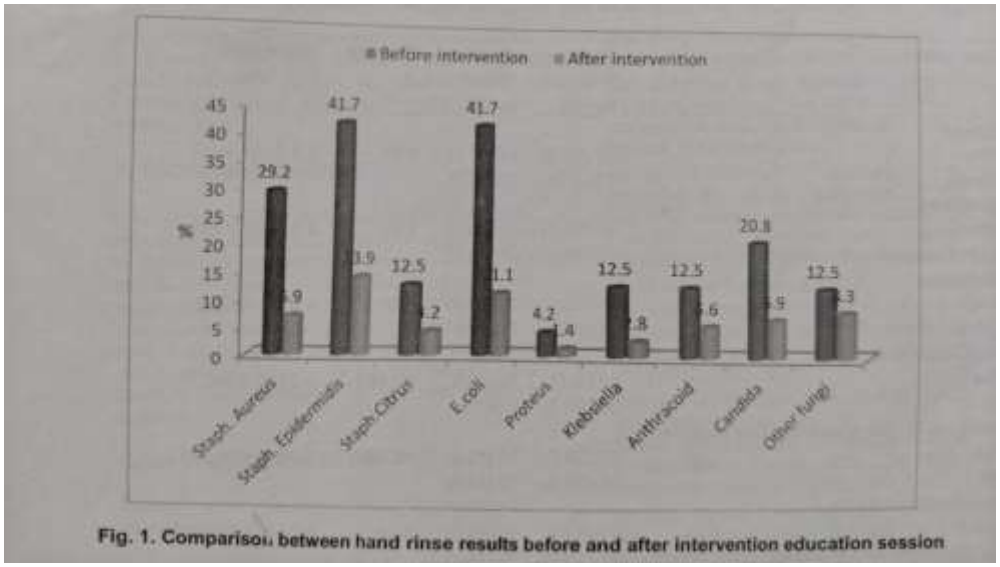


Fig. 1. Comparison between hand rinse results before and after intervention education session

Image - 2 – Comparison between hand rinse before and after intervention education session
Source – Allam H.K *et.al.*, 2016 (British Microbiology Research Journal)

1.6 - CROSS - CONTAMINATION OF FOODS

Cross-contamination is one of the major causes of food borne illnesses. It occurs when microorganisms are transferred from contaminated surfaces, utensils, or raw food to cooked or ready-to-eat food. For example, using the same cutting board for raw meat and vegetables without proper cleaning can result in the transfer of pathogens. Similarly, improper storage of raw and cooked foods together can lead to contamination. Preventing cross-contamination requires strict adherence to hygiene practices and proper separation of food items during preparation and storage.(Thalij ,K.M., and M.Salam,N.M.,2025)

Cross-contamination is another major contributor to food-borne diseases and occurs when microorganisms are transferred from one surface or food item to another. The study demonstrated that kitchen surfaces, utensils, and cleaning materials such as dishcloths and sponges often harbor significant levels of microbial contamination. Their findings indicated bacterial counts as high as 3.0×10^{10} organisms in dish cloths , making them one of the most contaminated item in kitchen environment. (Augustin,J.C.,*et al*,2020).

1.7 - TECHNIQUES

Antimicrobial resistance (AMR) has emerged as a major global health concern in recent decades. The misuse and overuse of antibiotics in human medicine, veterinary practices, and agriculture have led to the development of resistant strains of microorganisms (Okito,A.M., *et al*.,2025).

Advancements in microbiological techniques have improved the detection and identification of food-borne pathogens. Molecular methods such as polymerase chain reaction (PCR) and genomics sequencing allow for accurate identification of pathogens and tracking of outbreaks. These technologies play a crucial role in surveillance and control of food-borne diseases.The growing issue of antimicrobial resistance (AMR) also highlights a critical gap in food safety research. While several studies have reported the presence of antibiotic-resistant bacteria in food, there is limited understanding of how food handling practices contribute to the spread of these resistant strains. This is particularly important in the context of street foods and ready-to-eat foods, where hygiene practices are often compromised.(Ajekiigbe.V.O., *et al*,2025)

Technological advancements have provided new opportunities for improving food safety. Innovations such as rapid diagnostic methods, improved preservation techniques, and digital monitoring systems can help in early detection and prevention of contamination. However, the adoption of these technologies is often limited in developing regions due to cost and lack of awareness.(Chen,Y., *et al*.,2019)

1.8 - STATISTICAL ANALYSIS

Statistical findings from their study revealed contamination rates of up to 50% in certain food samples, indicating a strong correlation between poor hygiene practices and microbial contamination. Similarly, another study reported contamination levels as high as 80% in specific food products, further emphasizing the widespread nature of the problem.Several studies have reported the presence of pathogenic microorganisms in street foods. For example, research on popular street foods such as fuchka has identified the presence **Escherichia coli** and **Staphylococcus species,** of drug-resistant indicating a serious public health risk (Herawati *et al.,* 2023).

A study reported that domestic kitchens accounted for approximately 39.1% of food-borne outbreaks with strong evidence, indicating that home environments are a major source of food-borne illnesses. Their study, which involved 380 participants and included both questionnaire-based assessments and observational analysis of food preparation practices, provided valuable insights into consumer behavior and hygiene conditions in home kitchens. Microbiological examination of kitchen surfaces revealed that 12.7% of households had elevated levels of total bacteria, coliforms, and **Escherichia coli,** indicating poor hygiene conditions. Furthermore, analysis of 112 kitchen surfaces showed that while 74.1% met acceptable hygiene standards, approximately 25% exceeded recommended contamination limits.(Akshay Kumar

et al., 2018)

Statistical analysis of ATP readings revealed significant variability in cleaning practices among households, with some surfaces exhibiting high levels of contamination despite appearing visually clean. This highlights the limitation of visual inspection as a method for assessing cleanliness and underscores the importance of objective measurement techniques. Interestingly, the study found no significant differences in contamination levels between different age groups in terms of ATP and total colony count levels. However, it was observed that all inadequately cleaned kitchens belonged to older consumers, suggesting that age-related factors such as habits, perceptions, and resistance to change may influence hygiene practices.(Allam, *et al*,2016)

Statistical analysis further indicated that around 25% of staphylococcal food poisoning cases were attributed to cross-contamination from the hands of food handlers. These findings highlight the importance of proper hand-washing techniques as a fundamental preventive measure.These findings emphasize the need for proper cleaning and maintenance of kitchen equipment to reduce the risk of contamination.(Rossie.E.M.,

et al,2017)

The findings of this study will be useful for public health authorities, policymakers, and food safety regulators in designing effective interventions and improving existing food safety standards. Additionally, the study will contribute to raising awareness among food handlers and consumers regarding the importance of maintaining hygiene practices.(Chen.Y.,*et al*,2024).

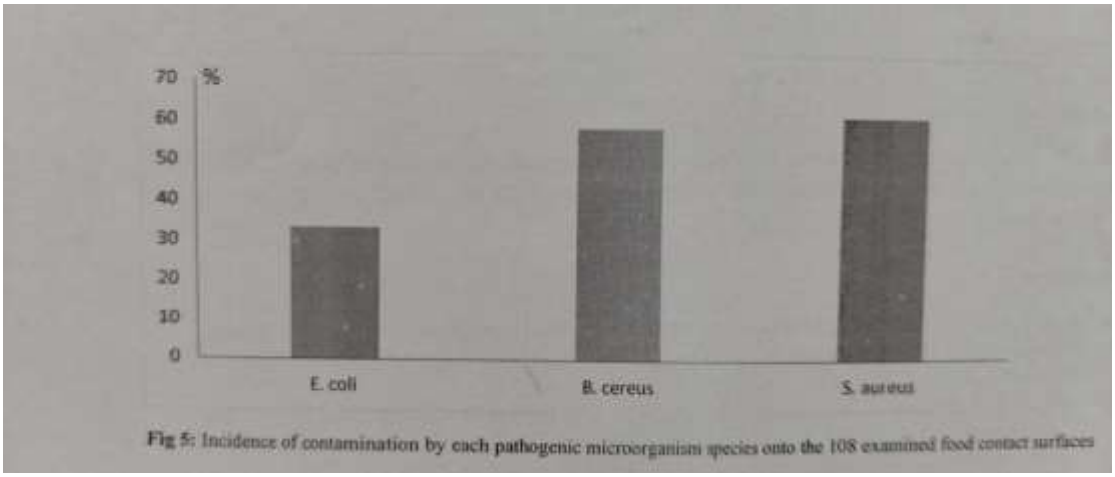


Image – 3 – Percentage of Pathogenic microorganisms
Source – Akram M.E. *et al* ,2024 (Journal Of Chemistry and Nutritional Biochemistry.

NEED OF THE STUDY :

With rapid growth of cloud kitchen and online food delivery services,ensuring food safety and hygiene has become increasingly important. Unlike conventional restaurant ,cloud kitchens operate primarily for delivery , making direct consumer assessment of hygiene practices difficult . Poor food handling , inadequate sanitation , and microbial contamination can increase the risk of food borne illnesses . Therefore , there is a need to evaluate the hygiene practices , food safety measures , and microbial quality of foods prepared in cloud kitchens . The findings of this study can help identify existing gaps in food safety management , create awareness among food handlers , and contribute to improving the quality and safety of food provided to consumer .

The study was undertaken to assess food safety and hygiene practices and evaluate the microbial quality of foods prepared in cloud kitchen . As the cloud kitchen industry is expanding rapidly , monitoring food safety standards is essential to protect consumer health and prevent food borne diseases . The study helps identify areas requiring improvement and promotes safer food preparation and handling practices.

BROAD OBJECTIVE :

To assess the association between food handling , food hygiene practices and the level of contamination in cloud kitchen's.

SPECIFIC OBJECTIVES :

1. To assess the food handling hygiene practices of food handlers working in cloud kitchen's.
2. To determine the microbial load of selected ready-to-eat foods prepared in cloud kitchen's.
3. To evaluate the association between food handling hygiene practices and microbial contamination levels in foods.
4. To identify key hygiene-related risk factors contributing to food contamination in cloud kitchen settings.

CHAPTER - II
REVIEW OF LITERATURE :

Food contamination and poor hygiene practices among food handlers have emerged as major public health concerns, particularly in rapidly expanding food service sectors such as cloud kitchens (World Health Organization [WHO], 2022;). Cloud kitchens mainly operate through online food delivery systems, where high food production, shared kitchen environments, and time pressure may increase the risk of microbial contamination if proper food safety measures are not strictly followed.Studies have reported that inadequate personal hygiene, improper food handling practices, poor sanitation, and lack of food safety awareness among food handlers contribute significantly to food borne illnesses and contamination of prepared foods (Centers for Disease Control and Prevention [CDC], 2021).

In addition, factors such as improper hand hygiene, unclean utensils and surfaces, inadequate storage conditions, and cross-contamination further influence the microbiological quality and safety of foods prepared in cloud kitchens (Food Safety and Standards Authority of India [FSSAI], 2021). Despite the increasing popularity of cloud kitchens, limited studies have comprehensively assessed the association between personal hygiene practices of food handlers and microbial contamination of food in these settings. Therefore, there is a need to evaluate food handling practices, personal hygiene status, and microbial contamination levels in cloud kitchens to identify existing gaps and develop effective food safety interventions (WHO, 2022; FAO, 2020).

In the view of above importance and justification , review of literature is discussed below :

Herawati *et al* (2023) investigated the association between sanitary hygiene , food handlers behaviour and the presence of Escherichia coli contamination in foods sold to children at elementary and Madrasah Ibtidaiyah using an analytical survey with a cross-sectional design . The study population comprised 78 food vendors , from which 43 respondents were selected through purposive sampling based on defined inclusion and exclusion . Data collection involved structured observation sheets and interviews to assess hygiene practices and behavioral factors . Microbiological examination was conducted to detect E.coli contamination in food samples , likely using standard culture techniques such as total plate count and selective media including MacConkey agar or EMB agar for isolation and confirmation of E.coli . Statistical analysis included uni-variate analysis to describe frequency and percentage distribution and bi-variate analysis using the chi square test to determine associations between variables .The findings revealed that 72.1% of respondents met sanitary hygiene requirements and 76.7% demonstrated appropriate food handling behaviour , while 20.9% of food samples were contaminated with E.coli contamination (P= 0.00) , as well as between food handlers behaviour and contamination status (P= 0.00) . The results indicate that inadequate hygiene practices and improper handling behaviour contribute to microbial contamination.The study underscores the critical need of consistent implementation of poor sanitation , hygiene training and monitoring among street food vendors to prevent E.coli contamination and ensure food safety in school environment .

Allam *et al* (2016) conducted a study titled “Hand contamination among food handlers’’ to evaluate the level of hand contamination and the impact of health education among food hand working in University and hospital kitchens.Food handlers recognized as a major source of food contamination, as hands can transmit pathogenic microorganisms and pose a significant risk to public health .In this 72 food handlers were assessed using a structured questionnaire that included Socio-demographic characteristics, personal hygiene practices, and risk factors related to food handling . Microbiological analysis of hand rinse samples revealed that Staphylococcus Epidermis and E.coli were the most prevalent organisms,

each accounting for 41.7% followed by Staphylococcus aureus at 29.2% , indicating inadequate hand hygiene practices among the handlers.The study further identified illiteracy , failure to wash hand after toilet use or contact with contaminated materials, and long fingernails as significant risk factors contributing to hand contamination.These findings emphasizes the importance of continuous health education, proper hand hygiene and regular monitoring of food handlers to reduce microbial contamination and improve food safety standards in institutional food service establishments.

Yu Ji Na *et al* (2024) carried out a comparative and monitoring-based study to evaluate hygiene management practices and regulatory frameworks for shared kitchen across different countries.The investigation involved environmental and food sample monitoring to assess chemical hazards,along with a survey of shared kitchen operators,indicating the use of observational and questionnaire based methods,sampling appeared to follow facility based purposive sampling of shared kitchen type.Microbial analysis were performed to determine contamination levels in prepared foods and environmental surfaces, likely including total Aerobic plate count and detection of indicator organisms using standard culture media such as Nutrient agar for total and selective media for specific pathogens.Chemical hazard assessment were also conducted to ensure compliance with safety standard.Statistical analysis included comparative testing with significance determined at $p<0.05$, suggesting the use of inferential tools such as t-test or ANOVA to compare hazard levels between shared kitchen's and regular restaurants,as well as between different shared kitchen types.The findings demonstrated that microbial and chemical hazard levels in shared kitchen's were within standard specifications and q11significantly lower than those observed in conventional restaurants($P<0.05$).Concurrent use and time-division open shared kitchen exhibited comparatively lower hazard levels than separated-individual kitchen,reflecting better hygiene management.Survey data further supported improved compliance in open shared kitchen models.Despite favourable hygiene outcomes,operators reported frequent cleaning,disinfection, inspections and mandatory insurance requirements increased operational costs,affecting competitiveness .The study emphasizes the need for regulatory reassessment to balance food safety assurance with economic suitability while promoting safe and efficient shared kitchen operations.

Rossie,E.M., *et al* (2017) assessed microbial contamination and the implementation of good manufacturing practices in school kitchen through an observation cross sectional study. The investigation included microbiological sampling from cutting board(n=12), kitchen sinks (n=12) ,Dish clothes (n=12),kitchen sponges (n=12) ,food handlers hand(n-22) , milk(n=10) and water (n=10) indicating facility based sampling of selected schools.In addition, a structured questionnaire was administered to food handlers to evaluate their knowledge, profile and daily hygiene practices. Microbial analysis were performed using standard culture techniques,including total heterotropic plate count to determine overall bacterial load ,and selective media such as Manitol salt Agar for Staphylococcus aureus detecting an appropriate coliform testing methods for fecal coliform identification.The findings revealed that all tested samples,including surfaces,utensils,milk and water were contaminated with heterotrophic bacteria,indicating inadequate sanitation practices.Staphylococcus aureus was isolated from sink,dish cloth,cutting boards and food handlers hands while fecal coliform were detected in sink , milk and water samples, suggesting possible fecal contamination and cross contamination risk .Statistical analysis was primarily descriptive involving frequency and percentage distribution of contamination levels.Survey results demonstrated that although food handlers possessed knowledge regarding GMP(good manufacturing practices) principles,they

failed to consistently implement these practices in daily operations.The study highlights the gap between knowledge and practice and underscores the need for continuous monitoring, training and strict enforcement of hygiene protocols to ensure food safety in school kitchen environments.

Ay.M., and Dagon,M, (2020) evaluated the impact of kitchen hygiene on reducing personnelassociated microbial contamination through an interventional pre-post experimental study design .The research involved collecting a total of 70 hand swab samples from kitchen personnel before and after the hygiene training sessions,indicating repeated sampling of the same group to assess training effectiveness.Microbiological examination was performed to detect indicator pathogenic bacteria including Staphylococcus aureus,E.coli, Coliform.Standard bacteriological methods were used for isolation and enumeration likely involving total plate count techniques and selective media such as Manitol salt agar for S.aureus and MacConkey Agar for E.coli and Coliform detection. Comparative microbial analysis was conducted between Pre-training and post-training sample to determine reduction in contamination levels,suggesting the use of inferential statistical comparison method to assess differences in microbial counts.The results showed that prior to training, E.coli and coliform and S.aureus were present on personnel hand surface.Following the hygiene education intervention E.coli and Coliform bacteria were no longer detected,and a significant 65% reduction in S.aureus counts was observed. These findings indicate the structured hygiene training significantly improves hand hygiene practices and reduces microbial contamination among kitchen staff.The study emphasizes the importance of regular training programme,monitoring and reinforcement of personal hygiene measures as essential strategies for minimizing cross contamination and enhancing food safety in food service establishment .

Ali *et al* (2017) conducted a case study research to evaluate hygienic practices and the microbiological quality of food in an institutional food service establishment at SHAUTS , Allahabad, India. The study adopted a cross-sectional design involving total enumeration sampling of 25 food handlers working in two women hostel kitchens and 72 cooked food samples were collected for microbiological analysis . Data on food safety knowledge , attitudes and practices (KAP) were gathered using structured questionnaire administered through in person interview . Microbiological examination of cooked food samples was performed to determine total aerobic mesophilic bacteria (APC) Coliform and E.coli using standard total plate count methods on Nutrient Agar for APC and selective media as MacConkey agar for coliform and E.coli detection .Statistical analysis primarily included descriptive statistics such as frequency and percentage distribution to interpret knowledge levels and contamination status . The findings revealed that the majority of food handlers demonstrated poor knowledge, attitude and hygiene practices related to food safety . Laboratory results showed that all cooked food samples exceeded acceptable limit for APC,Coliforms and E.coli , indicating significant microbial contamination and inadequate hygiene during food preparation . The study highlights a direct relationship between poor food handling practices and increased bacterial load , in prepared foods. The authors emphasized the need for strict supervision , enforcement of food safety standards , and periodic training programs on personal hygiene and good food handling practices to improve the safety and quality of meals served in institutional kitchens.

Akshay Kumar *et al* (2018) investigated a food-borne illness outbreak linked to a rural community kitchen in Patiala district,Punjab ,India.Using a descriptive epidemiological study combined with a retrospective cohort design.The study population included 261 village residents,and cases were identified through house-to-house active surveillance based on predefined case definition.Exposure

assessment was conducted via interviews, and risk factors were analysed through a retrospective cohort approach. Statistical analysis involved calculation of attack rates (44%) , risk ratio (RR) and 95% confidence intervals to determine associations between food exposure and illness.Laboratory investigations included microbiological examination of specimens for enteric pathogens and water sample analysis for fecal contamination,likely using coliform testing method such as most probable number technique or culture on selective media like MacConkey agar .Although no pathogens were isolated from stool samples all three water samples tested positive for Coliform contamination, indicating compromised water quality.Epidemiological findings demonstrated that illness was significantly associated with consumption of food,particularly mixed vegetables,prepared and served in community kitchen.Environmental assessment revealed improper food storage practices, as cooked food had been left at room temperature prior to serving,creating favourable conditions for microbial proliferation .The study concluded that inadequate storage and sanitation practices contributed to the outbreak and emphasized the importance of strict food safety enforcement , safe water supply , proper temperature control and monitoring of community kitchen to prevent similar food-borne disease outbreak.

Zaki *et al* (2024) conducted a study to assess the microbial status and sanitation levels of food contact surfaces in university restaurant kitchens across three public universities in central-Delta region Egypt.A total of 108 swap samples were collected from various food related surfaces,including preparation tables,dining tables and cutting boards,cooking utensils such as pots,knives,trolley tank,scoops and kitchen equipment's like peeling machine, steam pots and bain-marie.The samples were analysed for total aerobic colony,total coliform count, yeast and mould,E.coli,Staphylococcus aureus Bacillus cereus , Salmonella and Shingella species. The microbial findings revealed variation in sanitation levels among the kitchen.The FCS's of K-1 demonstrated the highest compliance with good hygiene standards.However,the sanitation levels of K-2 and K-3 were categorized as unsatisfactory ,indicating higher microbial contamination and inadequate hygiene practices.The study concluded that insufficient sanitation of food contact surfaces poses a potential risk for food contamination and food bone illness .

Roh.T., *et al* (2024) proposed an integrated quality prediction model to enhance food quality management in shared kitchen by utilizing E.coli as a primary microbial indicator. Considering the dynamic and multi-stakeholder nature of share kitchens,the study aimed to establish a qualitative monitoring system capable of predicting microbial risk. Stakeholder and quality - related factors influencing food safety were first identified and structured into measurable variables. The researchers applied advanced statistical and mathematical modeling tools particularly the modified "Gompertz growth curve" model to describe microbial growth patterns and the transfer rate equation to estimate contamination spread within the kitchen environment.E.coli was selected as an indicator organism due to its reliability in assessing sanitary conditions. Standard microbiological techniques such as total plate count and selective culturing methods using MacConkey Agar,Eosin Methylene Blue Agar were considered for bacterial enumeration and confirmation.Qualitative predictive analysis was performed to validate the model's effectiveness in forecasting contamination trends.The findings suggested that integrating microbial testing with mathematical growth modeling provides a structured data-driven approach to maintaining hygiene standards and strengthening food safety management in the emerging shared kitchen.

Ajekiigbe,V.O., *et al*,(2025) investigated the relationship between the expanding fastfood industry and the occurrence of food borne illnesses caused by Escherichia coli. The authors reported that rapid

urbanization and busy lifestyles have increased the consumption of fast foods, thereby influencing consumer food habits and expectations regarding food quality and safety. Although many strains of E. coli are harmless and support digestion, pathogenic strains such as E. coli O157:H7 were identified as major causes of severe food borne illnesses and public health concerns. The study also explored consumer behavior in response to food safety risks and found that increasing awareness about food borne pathogens has encouraged consumers to prefer fast-food outlets that follow better hygiene and food safety practices. At the same time, the authors highlighted that improper food preparation methods in fast-food establishments, including under cooking of food, cross-contamination, and poor hygiene among food handlers, significantly contribute to the spread of E. coli. In addition, several case studies of E. coli outbreaks linked to fast-food chains were analysed to identify gaps in industry practices and consumer awareness that may increase the risk of contamination. The findings emphasized the need for preventive strategies such as strict food safety protocols, improved food handling practices, and greater hygiene awareness among food workers. The authors concluded that reducing the prevalence of E. coli infections requires shared responsibility between fast-food establishments and consumers, and highlighted the importance of industry reforms and consumer education programs to strengthen public health protection and prevent future outbreaks.

Chen.Y.,*et al*. (2019) conducted a cross-sectional study in Anhui Province, China, to determine the status of food handling practices among women and their association with food borne acute gastroenteritis. The study was carried out from September 2015 to August 2016 using a structured questionnaire to collect information on food handling behaviors and the occurrence of food borne illness. Among the 630 respondents, about 16.0% reported experiencing symptoms of acute gastroenteritis within the previous four weeks that could have been related to food consumption. The study identified several common unsafe food handling practices among women, including infrequent boiling of kitchen utensils for disinfection, inadequate reheating of cooked food purchased from outside, improper storage of leftovers in refrigerators, and frequent purchase of stale raw vegetables, meat, and other ingredients. Significant differences were also observed between urban and rural respondents in their food handling practices. Furthermore, the study reported strong associations between food borne gastroenteritis and certain risky behaviors such as infrequent heating of milk, improper reheating of refrigerated leftovers, insufficient cooking of kidney beans, storing raw and cooked meat in the same container, and frequent consumption of raw seafood. The findings indicated that inappropriate food handling practices at the household level play a major role in increasing the risk of food borne acute gastroenteritis, highlighting that improper heating of food and unsafe storage practices are among the most critical risk factors.

Augustin,J.C., *et al,* (2020) examined the contribution of different foods and food handling practices to the food borne disease burden (FBDB) associated with 26 major biological hazards in France. The study aimed to identify the role of food categories and final food preparation practices in order to support the development of effective food safety interventions and awareness campaigns. The findings revealed that Campylobacter species and non-typhoidal Salmonella were responsible for more than 60% of the total FBDB. Around 30% of the burden was attributed to eleven other hazards, including bacteria, viruses, and parasites. Among different food categories, meat was identified as the major contributor, accounting for approximately 50–69% of the total food borne disease burden. The study also indicated that about 33–44% and 9–21% of the FBDB were related to the initial contamination of ready-to-eat foods without involvement of final food handlers. However, a significant proportion of the burden was associated with poor food handling practices during the final stage of food preparation. The authors emphasized that the

proper implementation of good hygiene practices at the final food preparation stage could potentially reduce the overall food borne disease burden by nearly 67–85%. The findings highlighted the importance of improving food handling practices and strengthening food safety measures to reduce the risk of food borne illnesses and enhance public health protection.

Chen.Y., *et al.* (2024) conducted a study to assess the relationship between self-reported food borne diseases and food safety practices among food handlers working in various food service facilities in Wuhu City, Anhui Province, China. A cross-sectional survey was carried out from March 1 to December 30, 2022, and data were collected through face-to-face interviews using a self-structured questionnaire administered to selected food handlers. A total of 1072 participants were included in the study, among which 88 (8.2%) reported experiencing symptoms of food borne diseases within the previous four weeks. The results identified several food safety practices that were significantly associated with the occurrence of food borne illnesses. These included infrequent use of three compartment sinks for separately cleaning different raw food materials, improper removal of non-edible parts of aquatic products outside designated food processing areas, failure to immediately refrigerate cold dishes prepared in advance, storing perishable foods at temperatures between 8–60°C after cooking and before consumption, inadequate reheating of cooked perishable foods stored for more than two hours, and storing raw and cooked foods in the same container. The collected data were analysed using descriptive statistics, chi-square test, and logistic regression analysis to determine the association between food safety practices and the occurrence of food borne diseases. The findings suggested that unsafe food handling and storage practices among food handlers contribute significantly to the risk of food borne illnesses, highlighting the need for stronger supervision and improved adherence to food safety practices in food service facilities.

Jevsnik *et al*, (2021) explored the perceptions of food handlers regarding the maintenance of food safety and the challenges encountered while implementing safe food practices in catering establishments. The study adopted a qualitative case study approach involving ten food handlers working in Slovenian catering facilities. Data were collected through semi-structured interviews to obtain detailed insights into the barriers influencing food safety practices. As part of the methodology, participants were asked to read a short fictitious newspaper report describing a food borne disease outbreak at a tourist farm, which served as a discussion prompt to understand their perceptions and responses to food safety issues. The clinical findings indicated that several barriers affected proper food safety implementation, particularly lack of adequate knowledge related to food safety training, improper testing of food safety knowledge, and insufficient understanding of critical control points (CCPs). In addition, deficiencies in food hygiene skills such as improper hand washing techniques and incorrect food defrosting practices were observed. Work-related factors such as low job satisfaction, inadequate salary, weak interpersonal relationships, and lack of motivation also contributed to poor adherence to food safety practices. The study further highlighted that inadequate food safety knowledge and ineffective training methods were the most significant barriers affecting the successful implementation of the Hazard Analysis and Critical Control Points (HACCP) system in practice. Since the research followed a qualitative case study design with a small sample size, the findings could not be generalized to the entire population of food handlers in Slovenia. The data were analysed using qualitative thematic analysis and descriptive interpretation to identify common patterns and perceptions among participants. The results emphasized the need for improved training programs and better awareness among food handlers to strengthen food safety practices in catering establishments.

Okito.A.M., *et al* , (2025) evaluated the safety risks associated with food and water contamination by Salmonella enterica and Escherichia coli in Bukavu city, Democratic Republic of Congo, where poor sanitation and improper waste management contribute to the spread of infectious diseases. The study included field observations to identify restaurant locations, followed by a probabilistic model to determine the number of establishments to be surveyed. A simple random sampling technique was used to select 206 food handlers from restaurants across the three municipalities of Bukavu city. In addition, 415 food samples from restaurants, 34 milk samples from dairy farms, and 104 water samples from taps, tanks, and wells were collected and analyzed. Cultural and biochemical methods were used to isolate and identify Salmonella enterica and Escherichia coli. The clinical findings revealed that Salmonella enterica was present in 38.2% of pork, sausage, and ugali samples, 35.5% of bread samples, 32.4% of beef and potato samples, and 24.4% of bean samples. Escherichia coli was not detected in beans, beef, potatoes, sausages, or vegetables but was most prevalent in fish samples (11.8%). Furthermore, well water showed a high level of contamination, with 57.1% of samples positive for Salmonella enterica and 35.7% for E. coli, which was attributed to wells being located near waste disposal areas, sewage systems, and commonly used pathways. Statistical analysis using descriptive statistics and significance testing (p-values) indicated that the presence of S. enterica and E. coli was not significantly different between food and water samples ($p = 0.15$ and $p = 0.58$ respectively). However, food contamination was significantly associated with food handling practices such as the frequency of cooking food and reheating food before serving customers ($p < 0.05$). The findings highlighted that hygiene practices in Bukavu restaurants were inadequate to ensure food safety, particularly during the serving stage, emphasizing the need for improved public health guidelines, better sanitation infrastructure, and stricter food safety measures to reduce contamination risks.

Prapti .,B.B.R *et al,* (2025) assessed the microbiological quality of fuchka, a widely consumed street food in Bangladesh and the Indian subcontinent, and identified foodborne bacterial contamination along with their antibiotic resistance patterns within a One Health framework. The study involved the collection of 60 samples comprising fuchka, salad, hand-wash water, and dish-wash water from street vendors, shops, and restaurants in the Mymensingh City Corporation area (4 samples from each of 15 locations). Microbiological analysis included determination of total viable count (TVC), total coliform count (TCC), and total staphylococcal count (TSC). Bacterial isolates were identified using advanced techniques such as polymerase chain reaction (PCR) and matrix-assisted laser desorption ionization time-of-flight mass spectrometry (MALDI-ToF-MS), and their antibiotic susceptibility patterns were evaluated. The clinical findings showed that the highest bacterial load was observed in shop-based fuchka samples (10.5 ± 4.7 log CFU/g), while the lowest contamination levels were found in restaurant hand-wash samples. A total of 123 bacterial isolates were identified, among which Klebsiella pneumoniae was the most prevalent (24.4%), followed by Staphylococcus species, Escherichia coli, Enterobacter species, and Citrobacter freundii. The antibiogram results revealed high levels of antimicrobial resistance, with 100% of Gram-negative isolates showing resistance to amoxicillin. Multidrug resistance was detected in 90% of K. pneumoniae, 57% of E. coli, 50% of Staphylococcus species, and 8.7% of Enterobacter species, while no multi drug resistance was observed in C. freundii. The multiple antibiotic resistance (MAR) index ranged from 0.1 to 0.6, indicating varying levels of resistance among isolates. Statistical analysis using descriptive statistics and significance testing ($p \leq 0.05$) revealed significant differences in total coliform count and total staphylococcal count among the different sample categories. The findings highlighted serious public health concerns related to street

food hygiene and emphasized the need for improved food safety practices and integrated control measures under the One Health approach to reduce microbial contamination and antimicrobial resistance.

Cherekar,M.N., *et al,* (2025) examined the role of culinary spices as potential reservoirs for Bacillus cereus contamination in restaurant-prepared foods, particularly in starchy food matrices such as cooked rice. The study involved the collection of twenty samples, including ten cooked rice variants and ten spice samples obtained from seven dining establishments in Bengaluru, India. Microbiological isolation of Bacillus cereus was carried out using Mannitol Egg Yolk Polymyxin (MYP) agar, followed by phenotypic characterization. Molecular confirmation was performed through polymerase chain reaction (PCR), targeting the 16S rRNA gene (548 bp) for taxonomic identification and the nonhemolytic enterotoxin gene (500 bp) to evaluate pathogenic potential. The clinical findings indicated high microbial loads in certain spice samples, particularly Saunf (fennel), which recorded 41.2×10^5 CFU/g, and meat masala with 37.5×10^5 CFU/g, demonstrating that raw spices can act as significant sources of contamination. Additionally, cooked rice samples showed a seasonal increase in bacterial counts, rising from log10 2.08 CFU/g in February to log10 4.25 CFU/g in April. Genomic screening revealed a 100% prevalence of the enterotoxin gene among the isolates, establishing a strong epidemiological connection between contaminated spices and finished food products. Statistical analysis using descriptive statistics and significance testing ($p < 0.05$) confirmed a significant seasonal variation in bacterial load within cooked rice samples. The findings suggested that spices can function as persistent carriers of enterotoxigenic Bacillus cereus, enabling survival even after standard cooking processes. The study emphasized that effective risk reduction requires validated spice decontamination procedures and strict temperature control within the food "danger zone" (5°C–60°C) to prevent bacterial growth and food-borne intoxication.

Machi Eunica, (2025) assessed the association between household food hygiene practices and the prevalence of Helicobacter pylori infection among residents, highlighting its significance as a global public health concern, particularly in areas with poor sanitation and food safety conditions. The study collected data through structured questionnaires that evaluated household practices related to food preparation, storage, and handling, while laboratory testing was performed to detect the presence of H. pylori infection among participants. The clinical findings indicated that households demonstrating poor hygiene behaviors—such as inadequate hand washing, unsafe storage of food, and improper cooking practices—showed significantly higher rates of H. pylori infection compared to households maintaining better food safety practices. These observations suggested that contaminated food and poor hygienic handling could contribute to the transmission of the bacterium within households. Statistical analysis of the collected data was carried out using descriptive statistics, chi-square test, and logistic regression analysis to determine the relationship between food hygiene practices and infection rates. The results revealed a significant association between inadequate household food hygiene practices and increased prevalence of H. pylori infection. The study emphasized that improving household food hygiene through targeted public health education and awareness programs could play a crucial role in reducing the transmission and overall burden of H. pylori infection.

Thalij,K.M., and Salman,N.M., (2025) assessed the microbial quality of shawarma sandwich samples obtained from restaurants in Dohuk city to determine the level of bacterial contamination and potential risks to public health. The study involved the collection of 100 shawarma samples from ten restaurants, including five open and five closed establishments. Microbiological analysis was performed to

determine the total viable bacterial count and to identify microbial contaminants present in the samples. The clinical findings revealed that shawarma samples, as well as restaurant environments including buildings, equipment, and food handlers, showed significant microbial contamination. Pathogenic microorganisms such as Escherichia coli, Staphylococcus species, Salmonella species, and fungi were detected in most samples at levels exceeding acceptable standards for safe human consumption. However, samples obtained from restaurant F2 did not show microbial contamination. The microbial load recorded in contaminated samples reached approximately log 5.30 CFU/g for total viable bacteria and log 4.5 CFU/g for certain isolates. Morphological, microscopic, and biochemical characterization of the isolates further identified several bacterial and yeast species, including Staphylococcus spp., Salmonella spp., E. coli, Klebsiella spp., and Pseudomonas spp. Statistical analysis using descriptive statistics and microbial count comparison indicated that contamination from restaurant environments, equipment, and food handlers significantly contributed to the increased microbial load in shawarma samples. The study concluded that the presence of these microorganisms at unacceptable levels poses a potential health risk and emphasized the importance of maintaining proper hygiene, sanitation, and food handling practices in restaurants to prevent food borne contamination.

Magambo,J.M.J *et al,* (2025) evaluated the hygiene handling practices and microbiological quality of vegetable salads served in restaurants in Ilemela Municipality, Tanzania, where the consumption of ready-to-eat vegetable salads has been increasing in urban food service establishments. A survey was conducted from May to June 2024 in thirty randomly selected restaurants to assess hygiene practices among food handlers. Information regarding hygiene handling was collected by interviewing restaurant operators, while thirty vegetable salad samples were collected simultaneously for microbiological analysis. The samples

included both raw and mildly heat-treated vegetable salads, which were analyzed for total plate count (TPC) and the presence of Escherichia coli. The clinical findings indicated that many food handlers had a high level of illiteracy and lacked formal food hygiene training. Essential hygiene practices such as the use of gloves, protective clothing, and safe water during food preparation were rarely observed. Microbiological results showed that all 30 raw salad samples had high TPC contamination levels ranging from 3.2 to 4.6 log CFU/g, exceeding recommended safety limits, while none of the mildly heat-treated vegetable salad samples showed such contamination. Furthermore, E. coli was detected in 14 out of 30 raw salad samples, whereas all mildly heat-treated salads were free from E. coli contamination. Statistical analysis was carried out using descriptive statistics and comparative microbial analysis to evaluate differences in contamination levels between raw and mildly heat-treated salads. The study concluded that raw vegetable salads served in restaurants were microbiologically unsafe for consumption due to poor hygiene practices and lack of food safety awareness among food handlers, emphasizing the need for food hygiene training, regulatory monitoring, and the application of mild heat treatment and food-grade antimicrobial agents to improve food safety and quality.

CHAPTER - III
METHODOLOGY

The methodology of the present study was planned to systematically evaluate the association between food handling practices, personal hygiene status of food handlers, and microbial contamination of food prepared in cloud kitchens. The study was conducted using a structured research design to obtain reliable and accurate data regarding hygiene practices followed in food preparation areas. A standardized personal hygiene and

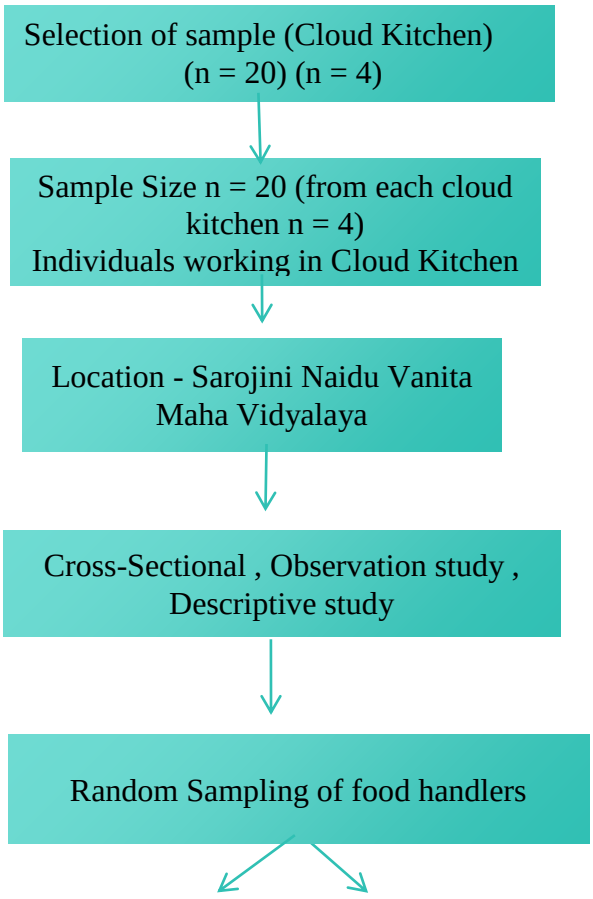
food handling checklist was used to assess the cleanliness, sanitation practices, and hygienic behavior of food handlers working in selected cloud kitchens. Food samples collected from the cloud kitchens were analyzed micro-biologically to determine the presence and level of microbial contamination. The findings obtained from the checklist assessment and laboratory analysis were compiled and statistically analyzed to identify the relationship between food handling practices, personal hygiene, and microbial quality of food. The methodology was designed to provide scientific evidence regarding the importance of proper hygiene and safe food handling practices in reducing food contamination and ensuring food safety in cloud kitchens.

The Methodology of the study , encompasses key components :

1. Research Design
2. Sample Selection
3. Data Collection
4. Study Area
5. Study Protocol
6. Statistical Analysis

Each of these elements is crucial in ensuring a comprehensive and systematic approach to achieving research objective

1. Research Design : The present study was a cross-sectional, observational and descriptive study conducted to assess the association between food handling practices, personal hygiene of food handlers and microbial contamination of food prepared at cloud kitchens.



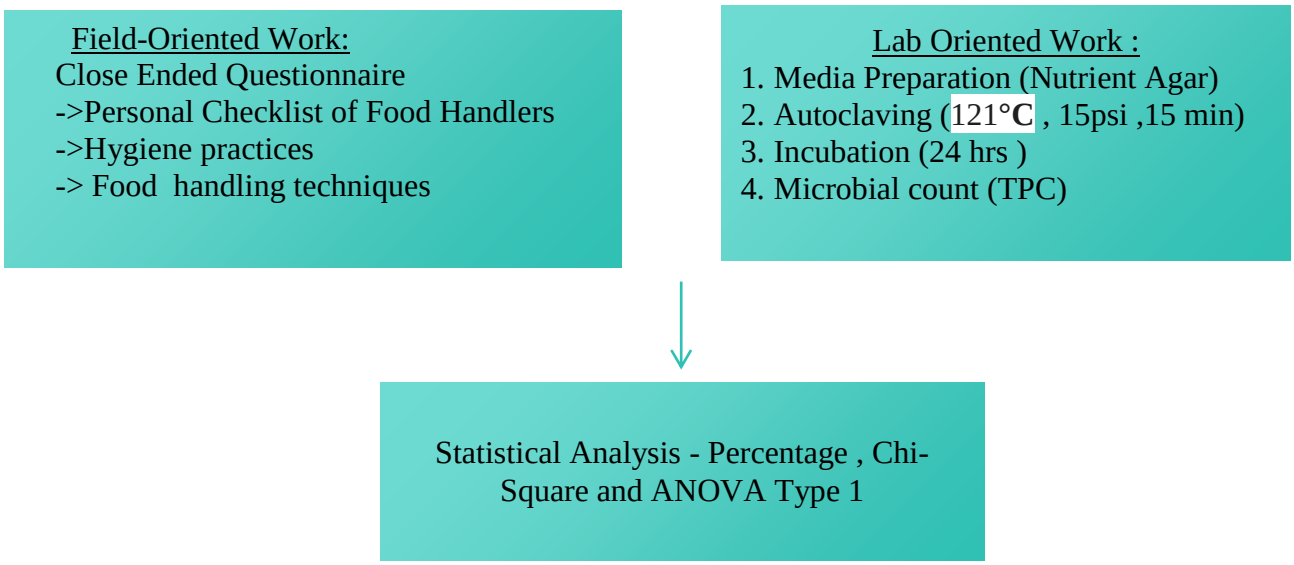


FIG - 1 - Research Design Flow Chart

2. Sample Selection : The subjects selected for the study included female individuals of age (22-70 years) and the sample size of (n=20) participants.

Inclusion and Exclusion Criteria :

Inclusion :

- Women working at cloud kitchens.
- Exclusively cloud kitchens.

Exclusion :

- Women working at other food service units apart from cloud kitchens.

3. Data Collection Method : (Appendix - I)

Sampling Technique - The samples chosen in the study using Random sampling technique to ensure it accurately reflects the target population with sample of n=20 participants .

4. Study Area : For collecting the samples (Dal and Sambar) , 5 different Cloud kitchen's of nearby locality were selected in Hyderabad.

5. Study Protocol :

5.1- Socio-Demographic Details
5.2 - Personal Hygiene Practices
5.3- Health-Related Issues
5.4- Hand washing and Sanitizing Practices
5.5- Food Handling Practices
5.6- Utensils and Equipment Hygiene
5.7- Storage and Environmental Conditions

1. Statistical Analysis : (Appendix - II)

A) **Chi - Square Test** - To compare the association between hygiene practices and microbial contamination of the cloud kitchens among the samples.

B) **ANOVA Type-I** - To compare the microbial growth with hygiene practices of the cloud kitchens among the samples.

Image - 4 Data Collection of respondent from IVASA Cloud kitchen

Image - 5 Data Collection of respondent from IVASA Cloud Kitchen

Image - 6 Sample of Sambar and Dal collected from 5 different cloud kitchens

Image - 7 Sterilized Equipments under laminar air flow

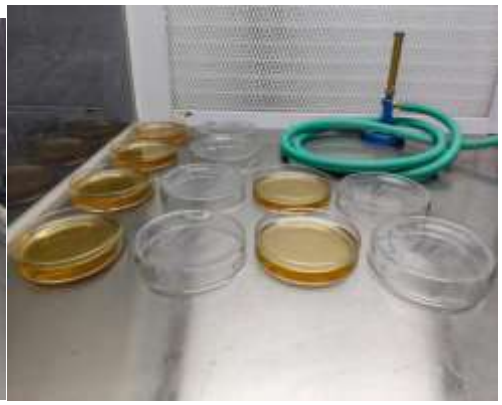


Image - 8 Petri plates with nutrient agar under laminar air flow

Image - 9 Inoculation of sample by spread plate method

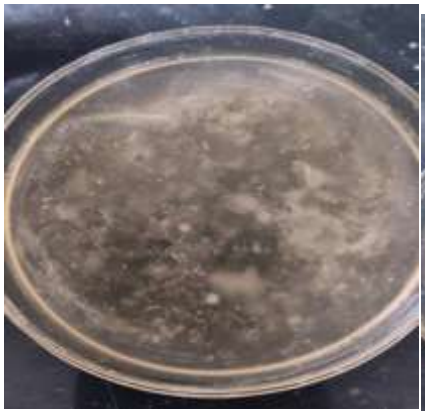


Image - 10 Growth of microbes of dal from "IVASA Cloud kitchen"

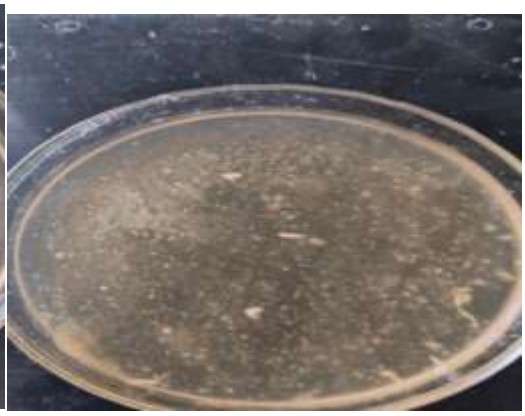


Image - 11 Growth of microbes of sambar from "IVASA Cloud kitchen"

Image - 12 Growth of microbes of dal Sample from "Sravani Homely Cloud Kitchen"

Image - 13 Growth of microbes of sambar sample from "Sravani Homely Cloud kitchen"

Image - 14 Growth of microbes of dal sample from "Cloud kitchen for U"

Image - 15 Growth of microbes of sambar sample from "Cloud kitchen for U"

Image - 16 Growth of microbes of dal sample from "Amma Ruchulu"

Image - 17 Growth of microbes of sambar sample from "Amma Ruchulu"

Image - 18 Growth of microbes of dal sample from "Anuradha aunty foods"

Image -19 Growth of microbes of sambar from "Anuradha aunty foods"

CHAPTER - IV

RESULTS AND DISCUSSION :

Key Points -

I - SURVEY BASED RESEARCH RESULTS

4 - Introduction

4.1 - Socio - demographic details

4.2 - Personal Hygiene Practices

4.3 - Health-Related Issues

4.4 - Hand washing and sanitation practice

4.5 - Food Handling Practice

4.6 - Utensils and Equipment Hygiene

4.7 - Storage and Environment Condition

II - STATISTICAL ANALYSIS

4.8 - Chi - square test analysis between the personal hygiene and Microbial count (TPC)

4.9 - ANOVA Type - 1 test analysis between the personal hygiene and Microbial count (TPC)

The Result and Discussion chapter presents the findings obtained from the assessment of food handling practices, personal hygiene of food handlers, and microbial contamination of food prepared at selected cloud kitchens. This section includes the systematic presentation, analysis, and interpretation of the collected data to understand the association between hygiene practices and microbial contamination in cloud kitchen settings. Since cloud kitchens operate through online food delivery systems, maintaining proper food handling and hygiene practices is essential to ensure food safety and reduce the risk of contamination.

The assessment of food handling practices and personal hygiene was carried out using a structured checklist to evaluate compliance with hygiene and sanitation standards. Parameters such as hand hygiene, cleanliness during food preparation, protective measures, and food handling and storage practices were observed to understand their influence on food safety. Additionally, microbial analysis of food samples was conducted to determine contamination levels and compare variations among selected cloud kitchens. The findings are discussed in relation to food safety standards and previous literature to understand the possible association between food handling, personal hygiene, and microbial contamination.

I - SURVEY BASED RESEARCH RESULTS :-

4.1-Socio Demographic Information :

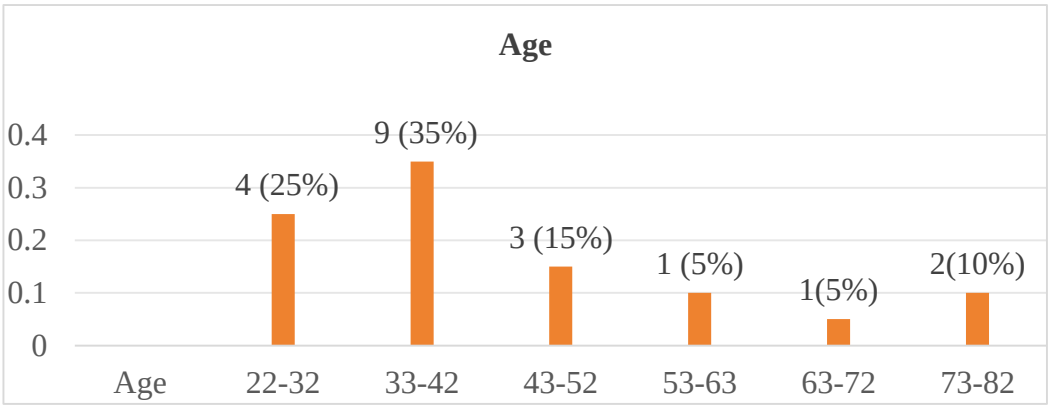


FIG - 2 - Representation of Age of the women working at Cloud Kitchens

The above bar graph, shows the age distribution of women working in cloud kitchens. The highest proportion of participants belonged to the 33–42 years age group 9 (35%), followed by the 22–32 years age group 4 (25%). The proportion of participants generally declined with increasing age, with comparatively fewer women represented in the older age groups.

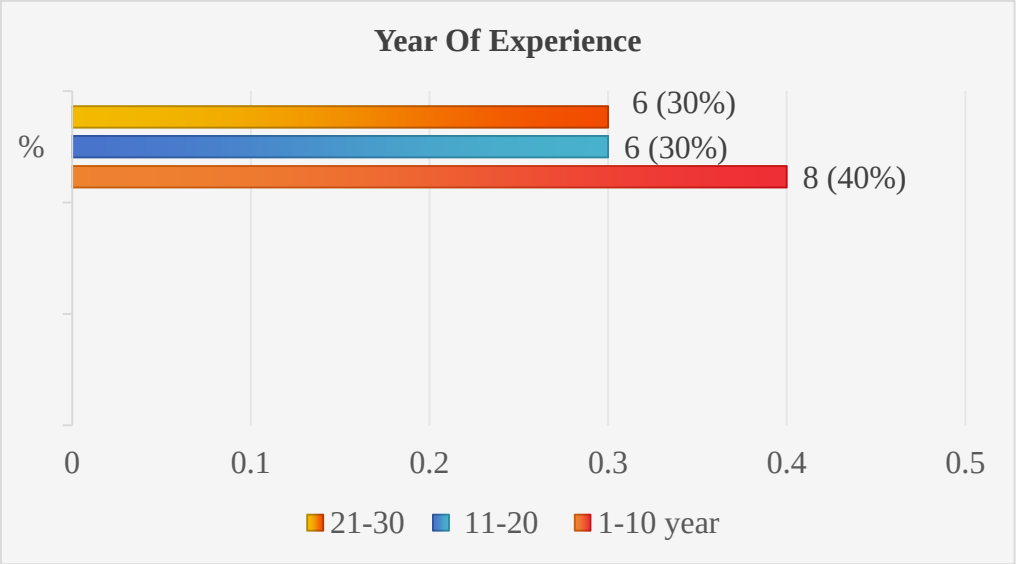


FIG - 3 - Representation of Year of Experience of the women working at cloud kitchen

The bar graph, shows the work experience of women in cloud kitchens, with 8 (40%) having 1–10 years of experience, indicating accessibility for newcomers due to flexible work opportunities. Higher proportions in 11–20 years 6 (30%) and 21–30 years 6 (30%) suggest good retention of experienced workers and long-term employment opportunities in the sector.

4.2 - Personal Hygiene Practices

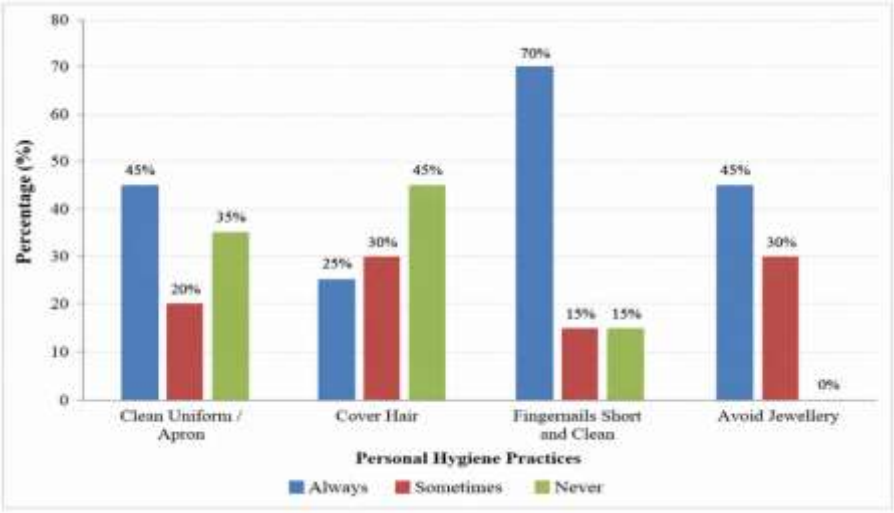


FIG - 4 - Representation of Personal Hygiene Practice of women working at cloud kitchen

The grouped bar graph indicates that maintaining short and clean fingernails had the highest compliance among food handlers 14 (70%), while covering hair showed the lowest compliance, with 9 (45%) of

participants never following this practice. Overall, adherence to personal hygiene practices varied among the food handlers.

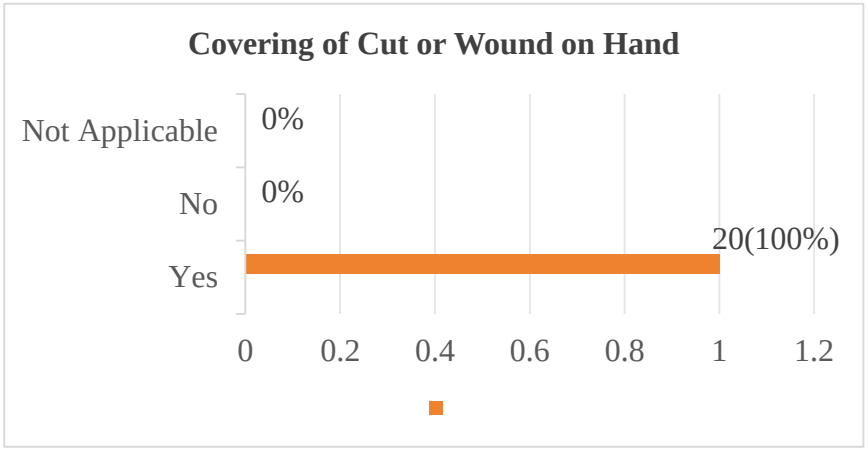


FIG - 5- Representation of covering of cut or wounds on hands of food handlers at cloud kitchens

The bar graph, shows that 20 (100%) of women working at cloud kitchens reported with covering any cuts and wounds on the hand.The finding highlights the importance of maintaining proper hygiene and safety measures during food handling to minimize the risk of contamination and ensure safe food preparation practices.

4.3 - Health Related Issues

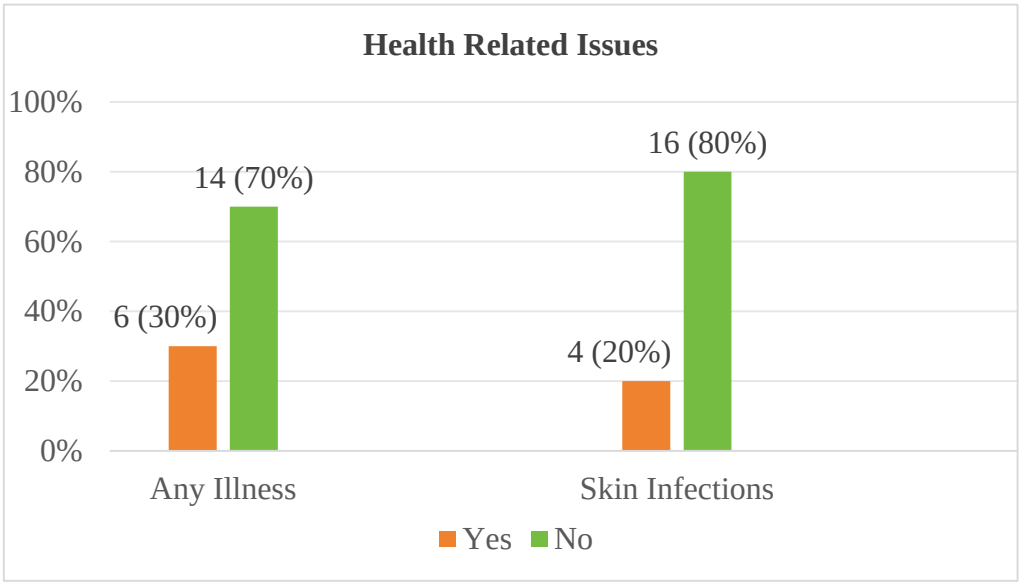


FIG - 6 - Representation of health - related issues of women working at cloud kitchen

The bar graph, shows that the majority of women in cloud kitchens reported no health-related issues 14-16 (70–80%), while a smaller proportion reported the presence of health issues 4-6 (20–30%). The lower percentage of reported health issues may indicate generally good health status among workers; however, the presence of some health concerns highlights the need for regular health monitoring and hygiene practices to ensure safe food handling.

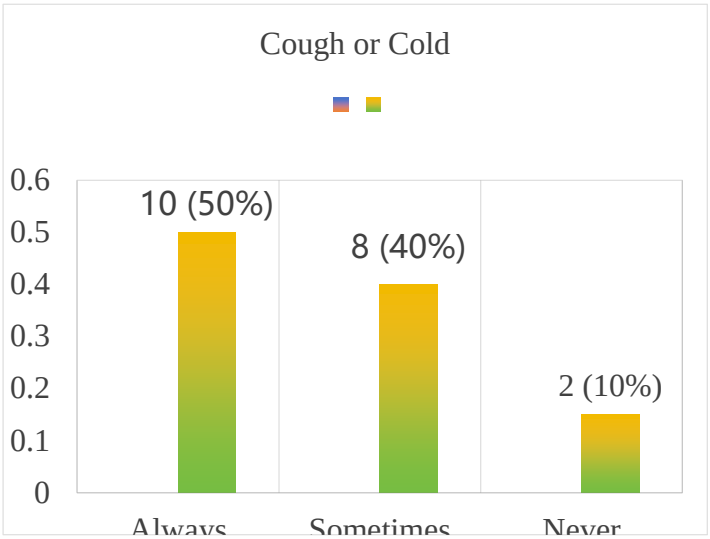


FIG - 7 - Representation of food handler's with cold or cough working at cloud kitchen

The bar graph, shows that cough or cold symptoms were reported as "always" by 10 (50%) of women, "sometimes" by 8 (40%) , and "never" by 2 (10%) . The higher occurrence of cough or cold may be associated with frequent exposure to environmental conditions and work-related factors. This finding highlights the importance of maintaining proper hygiene and health monitoring to ensure safe food handling practices in cloud kitchens.

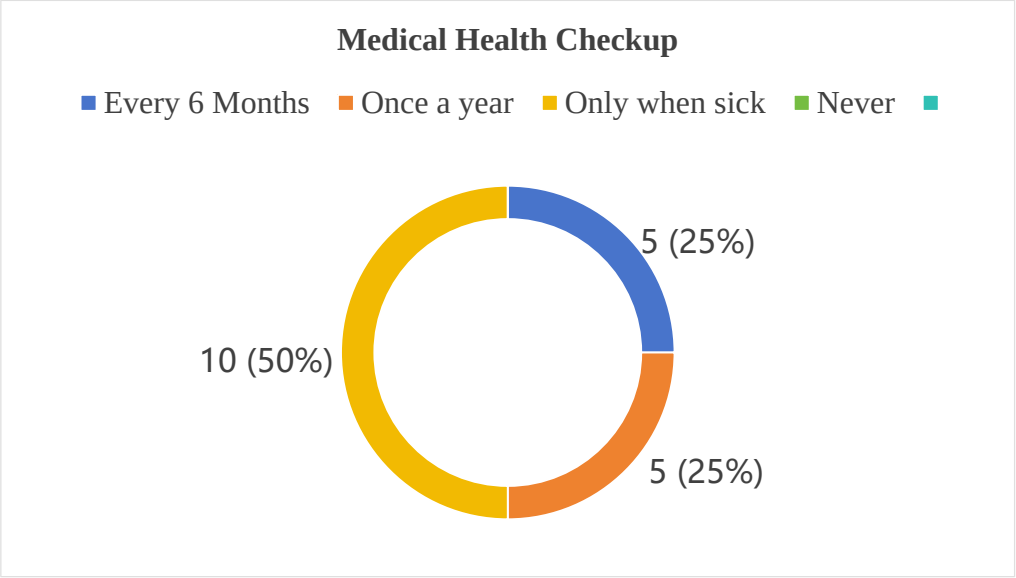


FIG - 8 - Representation of medical health checkup of women working at cloud kitchens

The doughnut graph, shows that 10 (50%) of women in cloud kitchens undergo medical health checkups only when sick, while 5 (25%) undergo checkups every 6 months and 5 (25%) once a year. The higher percentage of checkups only during illness may indicate limited routine health monitoring, whereas regular checkups among some workers reflect awareness regarding health and hygiene maintenance in food handling practices.

4.4 - Hand Washing and Sanitizing Practice

FIG - 9 - Representation of Hand washing and sanitizing practices at cloud kitchens

The bar graph, shows that hand washing and sanitation practices among women in cloud kitchens were highly followed, with most responses recorded as “always” 18 - 20 (90–100%) and only a small proportion as “sometimes” 2 (10%). The high compliance may be due to awareness regarding hygiene and food safety practices, highlighting the importance of proper hand sanitation in preventing food contamination.

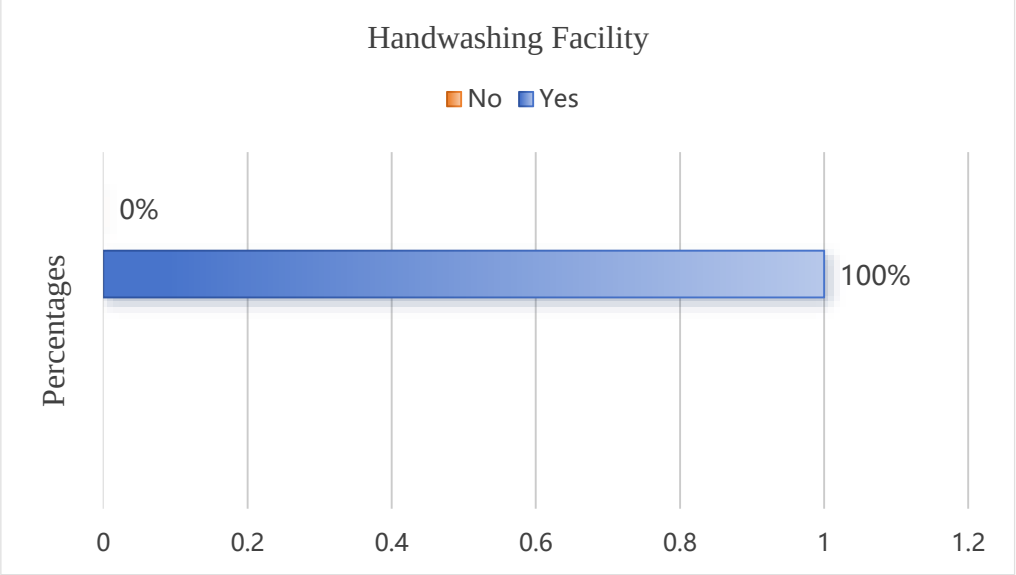


FIG - 10 - Representation of Hand washing facility at cloud kitchens

The bar graph, shows that hand washing facilities were available to all women in cloud kitchens, with 20 (100%) reporting the presence of such facilities. The complete availability of hand washing facilities may indicate awareness regarding hygiene and sanitation practices, which are essential for maintaining food safety and reducing the risk of contamination during food preparation.

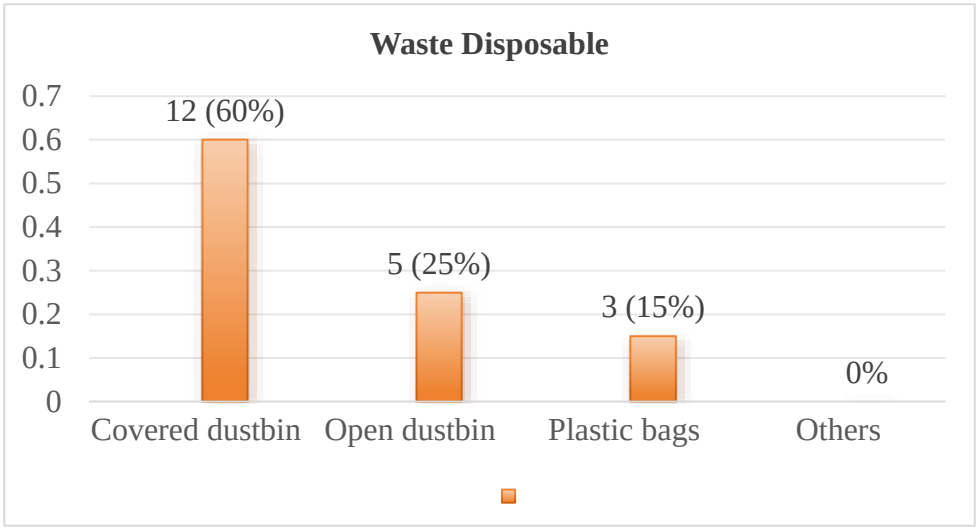


FIG - 11 - Representation of waste disposable at cloud kitchens

The bar graph, shows that covered dustbins were the most commonly used method of waste disposal 12 (60%), followed by open dustbins 5 (25%) and plastic bags 3 (15%). The higher use of covered dustbins may be due to better hygiene and waste management practices, while lower use of other methods indicates variation in waste disposal practices among cloud kitchens.

4.5 - Food Handling Practices

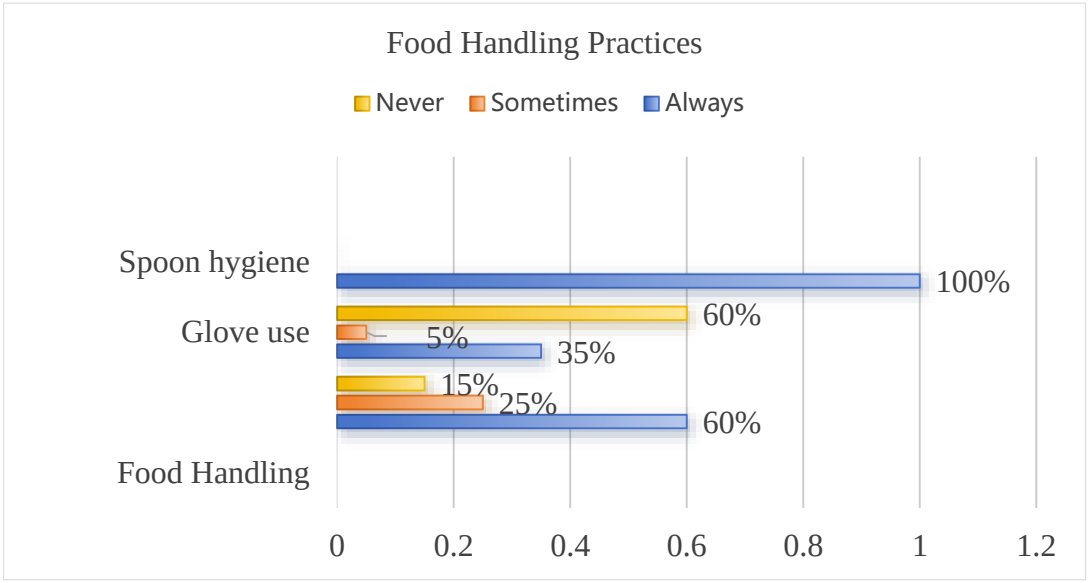


FIG - 12 – Rep+resentation of Food Handling Practices of women working at cloud kitchens

The above clustered bar graph shows varying compliance levels across three food handling measures. The first measure declines from 3 to 12 (60% to 15%) , reflecting moderate adherence. The second measure is weak with only 9 (35%) at the highest level versus 60% at the lowest. The third measure achieves full compliance at 20 (100%) . Overall, the graph highlights highly inconsistent adherence across measures, with complete compliance in one area but critical gaps in others, indicating a need for targeted intervention.

4.6 - Utensil and Equipment Hygiene

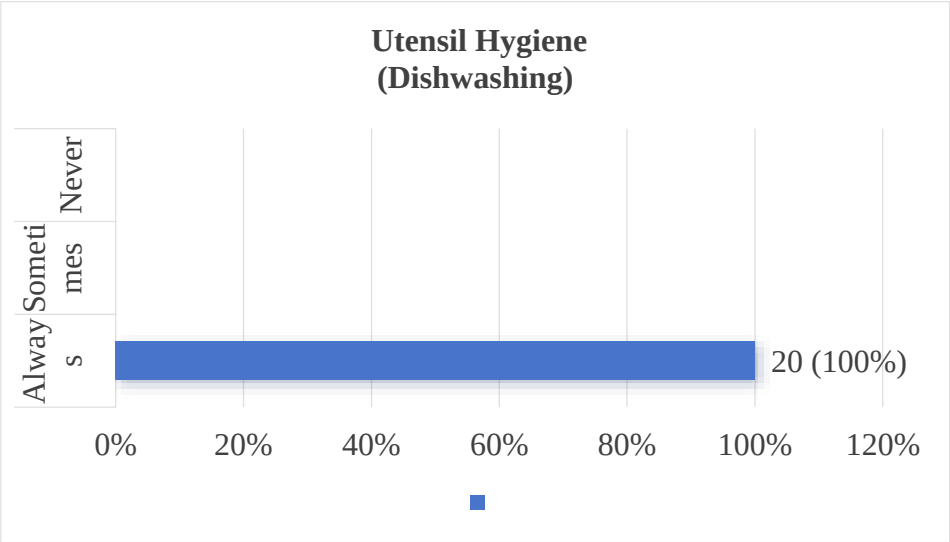


FIG - 13 - Representation of utensil and equipment hygiene at cloud kitchen

The bar graph illustrates compliance levels for utensil hygiene. The first category reaches 20 (100%) , while the remaining two categories are at 0%. The trend shows complete dominance of the highest level with no representation in lower levels. Overall, the graph demonstrates perfect adherence to utensil hygiene protocols, indicating full compliance across all observed cases with no gaps identified.

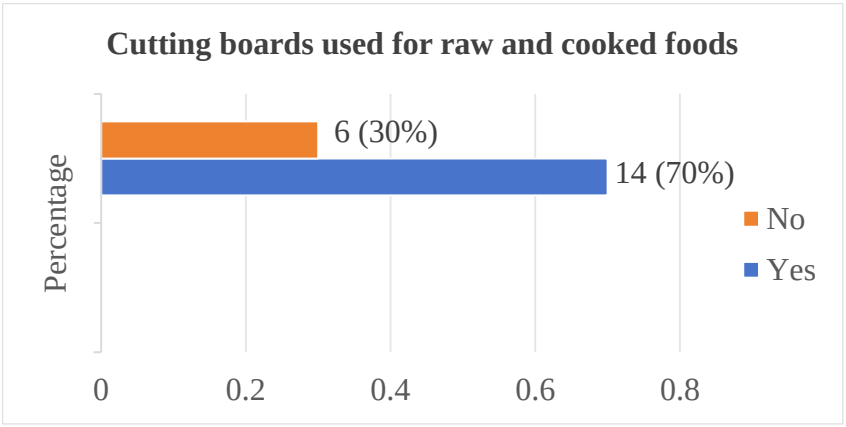


FIG - 14 - Representation of cutting boards used for raw and cooked foods at cloud kitchens

The bar diagram represents the status of cutting boards. One major segment constitutes 70% of the total, indicating it covers the majority of cases. The remaining portion accounts for 30%, showing a smaller but still significant share. Since pie charts display proportional data rather than sequential trends, no increasing or decreasing pattern applies. Overall, the chart shows that 14 (70%) of cutting boards fall under one dominant category, while 6 (30%) fall under another, suggesting partial compliance that requires improvement in the lesser portion.

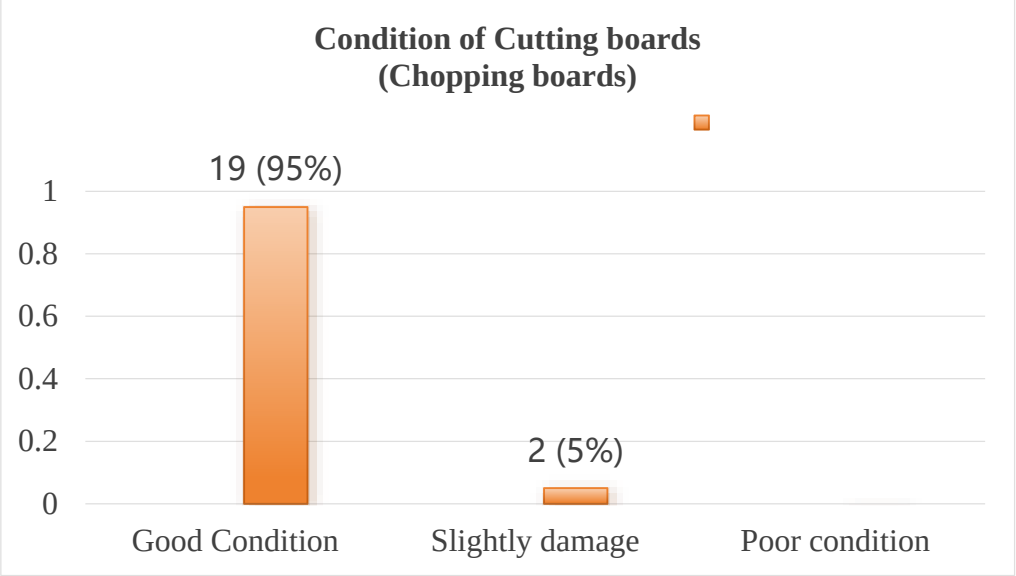


FIG - 15 - Representation of condition of cutting boards used at cloud kitchens

The bar graph displays the condition of cutting boards across three categories. The first category reaches 19 (95%) , followed by a sharp drop to 1 (5%) in the second category and 0% in the third. The trend decreases steeply from the highest to the lowest level. Overall, the graph indicates excellent maintenance with 19 (95%) in top condition and no instances at the poorest level, though the 1 (5%) showing minor damage still requires corrective action to achieve complete compliance.

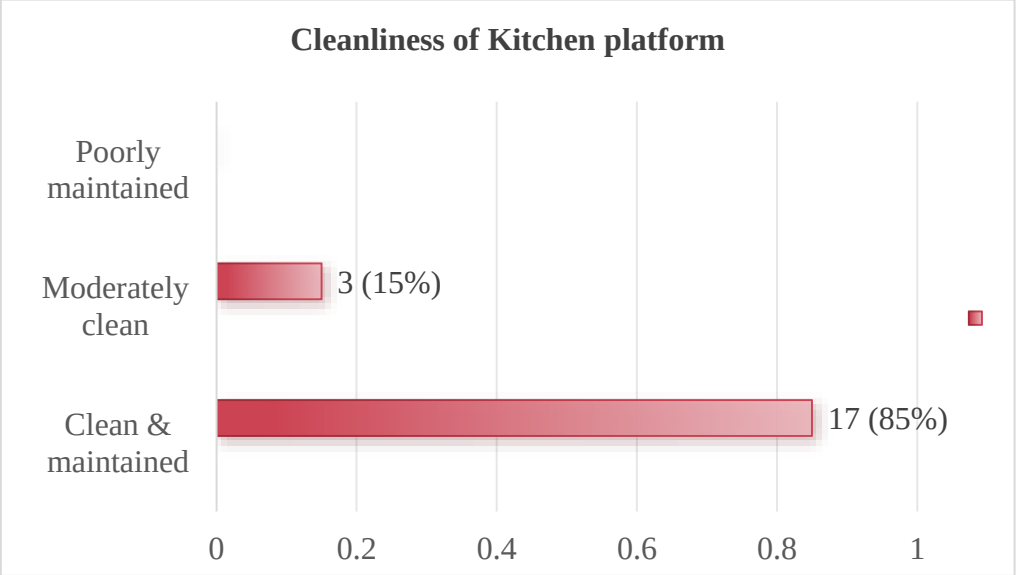


FIG - 16 - Representation of cleanliness of kitchen platform at cloud kitchen

The horizontal bar graph depicts cleanliness levels of the kitchen platform across three categories. The highest category reaches approximately 17 (85%) , followed by a smaller portion at around 3 (15%) in the middle category, and 0% in the lowest category. The trend shows a steep decline from the top level to zero. Overall, the graph indicates strong compliance with cleanliness standards in 85% of cases, with no instances at the poorest level, though the 15% in the middle range highlights an area that needs improvement to reach full adherence.

4.7 - Storage And Environment Condition

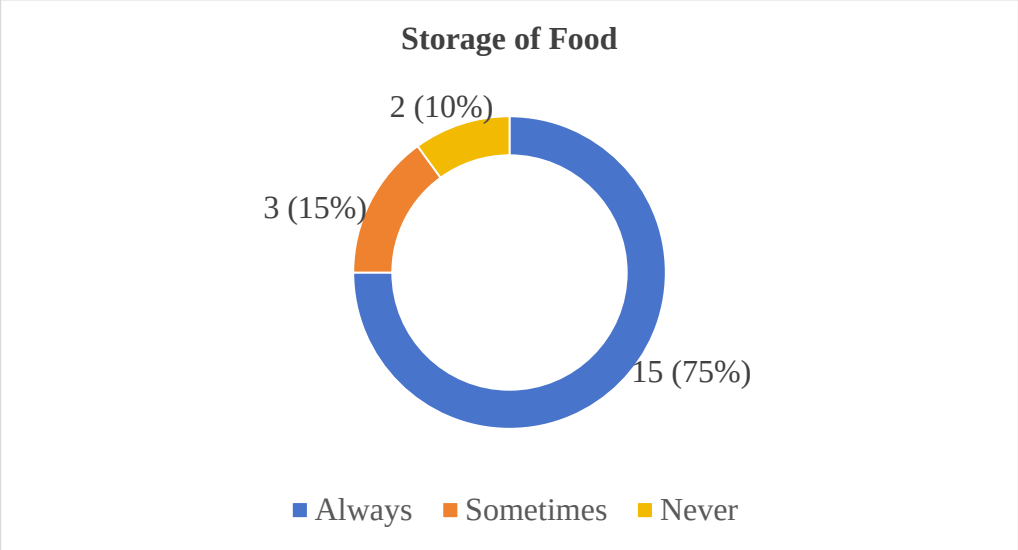


FIG - 17 - Representation of Storage of food at cloud kitchens

This doughnut chart illustrates compliance levels for storage of food. The largest segment represents 15 (75%) , showing dominant adherence to proper storage. The smaller segments account for 3 (15%) and 2 (10%) , indicating minimal lapses. Overall, the chart reflects very strong compliance with storage protocols, though the combined 5 (25%) in lower categories suggests minor gaps that still warrant attention for achieving complete adherence.

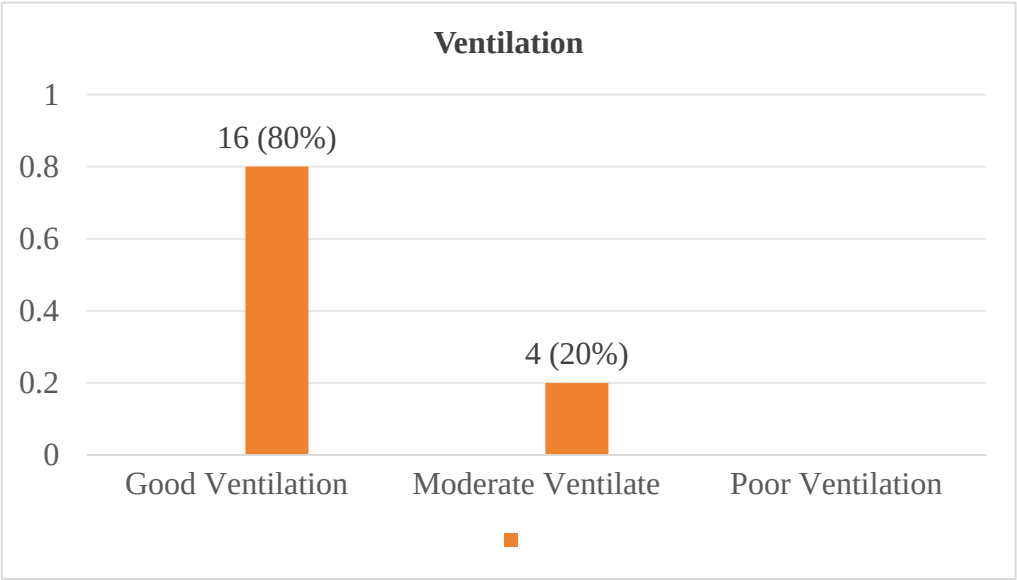


FIG - 18 - Representation of Ventilation at cloud kitchens at cloud kitchens

The column graph depicts ventilation conditions across three categories. The first category stands at 16 (80%) , showing a steep decline to 4 (20%) in the second, and reaching 0% in the third. The trend is sharply decreasing from the highest to the lowest level. Overall, the graph indicates excellent ventilation standards in 80% of cases, with no instances at the poorest level, though 4 (20%) still fall into a middle range that could be improved.

II. STATSTICAL ANALYSIS :

4.8 - Correlation between Personal hygiene and microbial growth of samples :

Table :1 - Chi - Square test analysis between the parameter Personal hygiene and TPC (microbial count)

Personal Hygiene	n (%)	Total Microbial Count	n (%)
Wear clean uniform or apron	9 (45%)*	277	25.34%*
Cover hair with cap or hairnet	6 (25%)*	110	10.06%*
Keep finger nails short and clean	16 (70%)*	152	13.91%*
Avoid wearing jwellery	11 (45%)*	254	23.24%*
Cut or wounds on hands	20 (100%)*	300	27.45%*

Figures in paranthesis {( )} are percentages (* indicates significant difference at 0.05 level).

Since the calculated value is greater than the table value , alternate hypothesis is accepted . Hence there is a significant relation between the personal hygiene and microbial growth of food prepared at Cloud kitchen's.

The results depict that the personal hygiene and microbial contamination are inter-related to each other.The good hygiene practices directly impact the low count of microbes.

Table - 2 ANOVA - 1 analysis between and within the parameter Personal hygiene and TPC (microbial count)

Source of Variance (SV)	Sum of Squares (SS)	Degree of Freedom (df)	Mean sum of Squares (MSS)
Between the Sample	SSC - 143863	(K-1) 1	143863
Within the Sample	SSR - 34305.2	(n-k) 1	34305.2

Since the calculated value of 0.24 is less than the table value (f 0.05 = 3.24).Hence there is no significant difference between and within the personal hygiene and microbial contamination. Thus, the alternate hypothesis is rejected .

CHAPTER - V

SUMMARY AND CONCLUSION

The present study entitled **"Association Between Food Handling Practices, Food Handlers Personal Hygiene checklist, and Microbial Contamination of Food Prepared at Cloud Kitchens"** was carried out to assess the association between food handling practices, personal hygiene practices, and the level of microbial contamination in cloud kitchens. The study was conducted among 20 food handlers working in 5 selected cloud kitchens. The age of the participants ranged from 22 to 82 years, with the highest proportion belonging to the age group of 33–42 years 9 (35%). A structured questionnaire was used to collect information on socio-demographic characteristics, personal hygiene, health-related issues, utensil and equipment hygiene, hand washing practices, food handling practices, storage, and ventilation. Microbial analysis was carried out using the Total Plate Count (TPC) method. A total of 10 ready-to-eat food samples were collected, including 5 dal samples and 5 sambar samples. The study aimed to assess food handling hygiene practices, determine the microbial load of selected foods, evaluate the association

between hygiene practices and microbial contamination, and identify hygiene-related risk factors contributing to food contamination in cloud kitchens.

The findings showed that most food handlers followed important personal hygiene practices such as trimming nails 14 (70%), wearing clean uniforms 9 (45%) , using gloves 9 (35%) , and avoiding jewellery while handling food (45%). However, only a few workers consistently followed certain food handling practices such as separate handling of raw and cooked foods, use of different chopping boards, and proper reheating of foods. The microbial analysis showed variation in microbial load among the cloud kitchens. The highest microbial count in dal samples was observed in **IVASA Cloud Kitchen (106 CFU)**, while the lowest count was observed in Anuradha Cloud Kitchen (7 CFU). In sambar samples, the highest microbial count was recorded in **Cloud Kitchen For U (263 CFU)**, whereas the lowest count was found in Sravani Cloud Kitchen (52 CFU).

Statistical analysis was performed using the chi-square test and one-way ANOVA.The chi-square test showed that the calculated value (137.8) was greater than the table value (26.296) at $p < 0.05$, indicating a significant association between personal hygiene practices and microbial contamination levels. Therefore, the alternate hypothesis was accepted. ANOVA result showed that the calculated value (0.24) was less than the table value (3.24), indicating no significant difference between and within the personal hygiene practices and microbial count among the selected cloud kitchens.Therefore, the alternate hypothesis was rejected.

The study concluded that personal hygiene and food handling practices play an important role in influencing the microbial quality of food prepared in cloud kitchens. Kitchens adhering to proper hygiene protocols exhibited reduced microbial contamination, whereas inadequate practices correlated with elevated microbial counts. The study highlights the importance of maintaining proper hygiene standards, regular monitoring, and safe food handling practices to ensure food safety and reduce the risk of food contamination.

RECOMMENDATIONS :

• The Study may include a larger sample size and a greater number of cloud kitchens for better generalization of results.

• Additional microbiological tests such as coliform count, yeast and mould count, and pathogen-specific analysis may be carried out for a more detailed assessment of food safety.

• Advanced statistical methods such as correlation and regression analysis may be used to better understand the relationship between hygiene practices and microbial contamination.

- Further research may compare microbial contamination levels between cloud kitchens and conventional restaurants.
- Seasonal variations in microbial contamination and food handling practices may be investigated in future studies.
- Environmental factors such as water quality, kitchen sanitation, and air quality may be included as additional variables.
- Future studies may assess the effectiveness of food safety training programmes on improving hygiene practices and reducing microbial contamination.
- A wider variety of ready-to-eat food samples may be included to obtain a more comprehensive understanding of microbial contamination in cloud kitchens.

CHAPTER - VI
BIBLIOGRAPHY

1. Ajekiigbe,V.O.,Ogieuhi,I.J.,Anthony,C,S.,Bakare,I.s.,Anyacho,S.,Ogunleke,P.O.,Fatokun,D.I.,Akin meji,O.,Ruth,O.T.,Olaore,A.K.,Amusa,,O.,Agbo,C.E.(2025). Consumer behaviour and its role in Escherichia coli outbreaks: The impact of fast-food preparation practices and hygiene awareness.Matters Arising.2025;53;27.
2. Akshay Kumar,A.,Grover,G.S.,Dikid,T.,Kaur,S.,Patil,A,group.Foodborne illness outbreak linked to a rural community kitchen in a rural area of Patiala District,Punjab,India.2018.Indian Journal of Public Health,65(Supplement 1) ,S41-S45.
3. Ali,A.I.,and Immanuel,G.Assessment of hygienic practices and microbiological quality of food in an institutional food service establishment.Journal of Food Processing and Technology,2017;8(8).
4. Allam,H.K.,AI-Batannony,M.A.,Seif,A.S., and Award,E.T.Hand contamination among food handlers.British Microbiology Research Journal,2016;13(5),1-8
5. Augustin,J.C.,Kooh,P.,Bayeux,T.,Guilliner,L.,Meyer,T.,Jourdan,Silva,N.,Villena,I.,Sanaa,M.,and Cerf,O.Contribution of foods and poor food-handling practices to the burden of foodborne infectious diseases in France Foods.2020
6. Ay.M.,and Dagon,M.Investigated of the effects of kitchen hygiene training on reducing personnel-associated microbial contamination.IGUSABDER,2020;11,161-177.
7. Chen,Y.,Wan,G.,Song,J.,Dai,J.,Shi,W.,and Wang,L.Food safety practices of food handlers in China and their correlation with self-reported food borne illness.Journal of Food Protection,2024,87(1),100202.
8. Chen,Y.,Wen,Y.,Song,J.,Chen.,Wang,L.,Ding,S.,Ding,L.,Dai,J.Food handling behaviors associated with reported acute gastrointestinal disease that may have been caused by food.Journal of Food Protection,2019.82(3),494-500.
9. Cherekar,M.N., and Kuptekar ,R. Seasonal prevalence and Molecular characterization of Enterotoxinogenic Bacillus cereus in cooked rice and culinary spices from Indian public restaurants Advanced Natural Sciences:Life and Health Sciences,2025;2(2),64-73.
10. Herawati,C.,Endayani,H.,Indragiri,S.,Kristanti,I.,Supritatin,N.T.,Dani,A.H.,and Hikmawati,I.Sanitary hygiene and behaviour of food handlers in the presence of Escherichia coli bacteria.Jornal pangan dan Agroindustri,2023;17(4),2098-2103.
11. Jevsnik,M,and Raspoor,P.Food safety knowledge and behaviour among food handlers in catering establishments:A case study.British Food Journal,2021,124(10),3293-3307.
12. Machi Eunica ,Jevsnik ,Pirc ,Ovca ,Santic ,Raspor ,Torkar. A Multimethod Study On Kitchen Hygiene , Consumer Knowledge And Food Handling Practices At Home.Processes.2025.10,2104.
13. Magambo,J.M.,and Raymond,M.K.Evaluation of hygiene practices and microbiological quality of raw and mildly heat-treated vegetable salads from restaurants within Ilemela municipality of Mwanza,Tanzania.Journal of Food Safety and Hygiene.2025
14. Okito,A.M.,Wagacha,J.M.,LukhobaC.W.,Lina,A.A.,Mukabana,W.R.Food and water safety risks for Salmonella enterica and Escherichia coli contamination in Bukava City,Democratic Republic of the Congo.2025.
15. Prapti,B.B.R.,Ahmmed,M.T.,Proma,N.G.,Aunu,D.Z.,Shampa,Rahman,S.I.,A.,Islam,M.S., and Siddiqui,M.p.Bacterial load assessment and multi-drug resistant Bacteria isolation from Fuchka in Mymensingh City,Bangladesh.One Health,2025;21,101170.

16. Roh,T.,Song,Y., and ,B.Integrated quality prediction model for food quality management based on E.coli in shared kitchens.Foods,2024;13(24),4065.
17. Rossie,E.M.,Belike,L.,and Barreto,J.F. Microbial contamination and good manufacturing practices at school kitchen.J Food Saf 2017.
18. Thalij,K.M.,and Salman,N.M.Identification and enumeration of microbiological contamination in shawarma sandwich samples from various restaurants in Dhoku City.Tikrit Journal for Agricultural Sciences.2025.
19. Yu Ji Na,Y.J.,Baek,J.Y.,Gwon,S.Y.,and Yoon,K.S.Assessment of hygiene management practices and comparative analysis of regulatory frameworks for shared kitchens across different countries.Foods.2024;13:918
20. Zaki,A.M.E.,Saeed,G.S.,Youssef,K.M.,and Shatta,A.A.Microbial status and sanitation level of food contact surfaces (FCSs) of three universities at Central-Delta region in Egypt.Journal of Chemistry and Nutritional Biochemistry,2024;5(2),49-65.
21. https://www.who.int (2015 - 2022)
22. https://www.fsis.usda.gov