HYGIENIC QUALITY OF SOME COOKED MEAT PRODUCTS

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ABBREVIATIONS

APC	Aerobic Plate Count.
BAM	Bacteriological Analytical Manual.
BHI	Brain Heart Infusion broth.
CDC	Center of Diseases Control.
CFU	Colony Forming Unit.
EIEC	Enteroinvasive *E. coli.*
EPEC	Enteropathogenic *E. coli.*
ETEC	Enterotoxigenic *E. coli.*
ETHE	Enterohaemorrhagic *E. coli.*
FDA	Food and Drug Administration.
ICMSF	International Commission on Microbiological Specification for Foods.
L-EMB	Levine's Eosin-Methylene Blue agar.
MYC	Total Yeast and Mould Count.
SPP	Species.
VRB	Violet Red Bile agar.
VRBG	Violet Red Bile Glucose agar.
VTEC	Verocytotoxigenic *E. coli.*
XLD	Xylose Lysine Desoxycholate agar.

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1. Introduction

Meat is an excellent source of protein, which builds and repairs body tissues, and is needed for growth and development of an individual and also contains all essential amino acids sufficient for the maintenance of life.
It is a good source of vitamins and minerals including iron, copper, zinc, sodium, potassium and magnesium.

Meat processing has been developed in order to supply large populations with meat and meat products. Canned meats are the first form of processed meat had been developed in meat industry. By time, other forms of processed meat had been developed such as; cooked frankfurters, luncheon, and such stuff.

Due to the recent international economy crisis, the consumption of fresh meat had been greatly diminished. Consequently, consumption of ready to eat processed meat products became an alternative solution. Not only the rise of prices is the real cause that directs consumers to ready to eat meat products, but also lack of time required for preparation of meal is an important factor.

There are other factors which direct the consumer for selecting meat products during his shopping; appearance, taste, tenderness and absence of extraneous additives are important factors; especially; there is an old belief in some communities that fresh meats are the best whatever the source.
On the other hand, meat processors try to reduce cost, and consequently products with low quality arise.

The expansion of catering and fast food business depends mainly upon precooked meat products, to serve meals in a minimal time. Consequently, microbiological condition of such meat products should be good.

Some studies reveal that under-cooked meat products, has been associated with number of outbreaks throughout the world. **(Bettelheim, 1996).** Other studies reveal that cross contamination of cooked meat from raw ground beef is one of most important source of contamination of cooked meat products. **(Canon *et al*, 1996).**
While, other studies reveal that post processing handling is considered as one of the most hazardous sources of contamination. Slicing of cooked products has been shown to be the most important source of contamination of meat products by both saprophytic and pathogenic bacteria. **(Mol *et al*, 1971).**
Others referred to sanitary practices at different stages in the food preparation and handling process as of great significance. **(Libby, 1975)**

For these reasons, many food safety and quality systems had been developed to insure safety of processed meat products.

From this point of view, focus on hygienic quality of cooked meat products is necessary to ensure that they are manufactured in good sanitary conditions; and consequently, insurance of food safety and health of consumers.

In Egypt, the consumption of Frankfurters, Hot dogs increased, In the last decade. These products were originally initiated in Germany.

Luncheon is the most widespread cooked meat product consumed in Egypt rather than other cooked meat products, as it is mostly lower in price.
The processing of the product starts by the same processing as frankfurters but its emulsion is filled in permeable casings. The filled rolls are subjected to long term cooking. Finally sold as intact rolls or sliced and packed into commercial packs. Whatever the form the product sold in, the product is consumed after slicing.

Pepperoni is a fermented cooked beef sausage. Its processing is different than other cooked meat products; it needs incubation period with a culture starter. It is sold as intact rolls or sliced.

The study was dedicated to evaluate and determine the chemical and microbiological conditions of the mentioned cooked meat products

The study was planned to investigate the following:

A. Chemical Evaluation :

1. Fat percentage.
2. Protein percentage.
3. Moisture percentage.
4. PH.

B. Microbiological Evaluation :

1. Aerobic plate count.
2. Total *Enterobacteriaceae* count.
3. Total Coliform count.
4. Total yeast and mould count.
5. Isolation and identification of Salmonellae.
6. Isolation and identification of *E. coli*.

2. Review of Literature

2.1 Sources of contamination of cooked meat products:

Mol *et al.* (1971) reported that slicing was the most important source of contamination of meat products by both saprophytic and pathogenic bacteria.

Dempster *et al.* (1973) stated that sources of contamination during preparation of mixed food dishes, ingredients are cut up, chopped, ground, mixed or handled can be decreased by good practices of personal hygiene and equipment sanitation. Usually there is a combination of several of these operations. Raw beef cutting boards, knives, workers hands and curing brine were the main sources of contamination. They stated that inadequate cleaning was frequently reported as transmitter of pathogens.

Northalt and Schothorst (1974) found that the number of aerobic bacteria, lactobacilli and *Enterobacteriaceae* were higher in sliced vacuum packed products than unsliced products.

Bryan (1975) stated that contaminated water might add pathogens to foods if it is used as an ingredient or to wash or freshen the food. Also washing of equipment with such water may be the source of contamination.

Qvist (1976) stated that aerobic plate count of vacuum packed cooked meat samples immediately after slicing gives good indication of the sanitation and hygiene of the operation.

Salvato (1976) reported that if the food is properly protected after cooking and contamination by utensils or equipment during preparation is actually prevented; health problem should not arise.

(Niskanen and Pohja, 1977) stated that external contamination of raw meat is a constant possibility from the moment of bleeding until consumption. There are a large number of potential sources of contamination by microorganisms, these include contact with the hide, skin or feet, the contact of gastrointestinal tract, milk from udder, aqueous sources and the instrument used for dressing (knives, saws, cleavers or hooks) and even air-borne contamination in the processing and storage areas.

Schmidt and Beam (1978) declared that microorganisms that contaminate work surfaces and machines are constant be introduced either directly by contact with raw materials or indirectly through the rapid growth of microbes in soil residues.

Finzi and Costa (1979) mentioned that pests, equipments, air, water and workers are the routs of microbial contamination of food. The authors added that *Enterobacteriaceae, Bacillaceae and Pseudomonas* are the main bacteria causing hygienic problems in food industry.

ICMSF (1980) stated that polluted water is a common vehicle for transmission of pathogenic microorganisms, especially the enteric bacteria to man either directly or through food. The microflora of water frequently includes spoilage organisms such as the psychrotrophic bacteria that shorten the shelf life of refrigerated foods. Water remaining

after cleaning operations is intolerable, because it permits caking, sticking to surfaces, chemical change and growth of microorganisms.

Banwart (1981) stated that flies are serious potential carriers of disease producing organisms, which might contaminate the working environment. Flies pick up organisms on their hairy legs and feet then they contaminate man's food by walking or leaving their excreta on it. Flies have a role of spreading of *Salmonellae, Shigellae, vibrio, E. coli* and other disease causing organism as well as food spoilage type.

Wood *et al.* (1983) reported that food prepared in Mexican homes was associated with high potential risk of diarrhea. And it was reported that food obtained from Mexico homes showed generally higher counts of *Coliform*s and fecal *Coliform*s than those. And the foods in Mexico both from homes and commercial sources, commonly contained *E. coli* and occasionally enterotoxigenic *E. coli*.

Fliss *et al.* (1991) reported that Microbiological contamination of carcass is of high significance for quality and shelf life of meat. Serious contamination with these organisms takes place from soil and water. Also. Raw meat becomes contaminated from meat contact surfaces, equipment, utensils and handling by workers.

Fathi *et al.* (1992) stated that contamination of meat products with *E. coli* from raw meat, food handlers, food utensils, air, soil and water resulted from unhygienic conditions during manufacturing, packing and marketing of their products.

Reed (1993) reported that foods implicated in Salmonellosis include meat and meat products and other protein foods.

Tebbutt (1993) investigated the microbial contamination of cooked meats and selected environmental sites in butcher's shops by aerobic plate counts and the detection of *E. coli* and *Enterobacteriaceae*. There was a significant association between all three microbial parameters for environmental sites (hands, clothes and surfaces) in premises where cooked meats were produced. In foods, the presence of *E. coli* was related to *Enterococcous Faecalis* but not to total aerobic counts. No close relationship was found between microbial parameter and risk assessment inspections.

Tarr (1994) stated that the infection of *E. coli* 0157:H7 in western United states was linked to consumption of hamburger. Similar outbreaks were reported on California, Nevada, and Idaho. The clinical studies confirmed that infection with *E. coli* 0157:H7 was virulent and life threatening, and could affect large number of people when contaminating foods.

Blanco *et al.* (1996) stated that most outbreaks of hemorrhagic *coli*tis resulted from the consumption of under cooked minced beef, fresh beef and hamburger samples, and three (5%) of 58 beef samples positive for EHEC 0157:H7.

Canon *et al.* (1996) implicated hamburgers which purchased at a fast food restaurant chain as the source of *E. coli* 0157:H7 infection. Their studies didn't reveal any deficiencies in cooking procedures, but identify opportunities for cross contamination from raw ground beef. They also added that thorough cooking of ground beef to an internal temperature of 68 ˚C before consumption is recommended.

Kukay *et al.* (1996) mentioned that the three most common hazardous areas in meat processing plants were identified as employee hygiene, cross contamination and control of heating/storage temperature.

Sharma *et al.* (1996) stated that unacceptable meat products samples were attributed to defects in the hygiene of processing, transport or storage procedures.

Uyeyama *et al.* (1997) identified hamburgers as a source of contamination of *E. coli* O157:H7. Many sporadic cases of hemorrhagic colitis occurring in USA which were associated with isolation of *E. coli* O157:H7.

Mead *et al.* (1997) stated that patients with *E. coli* O157:H7 infections were more likely than healthy control to have eaten a hamburger in the week preceding illness. 80% of the hamburgers eaten by ill persons were prepared at home. Food preparers in case of households were less likely than those in control households to report washing their hands and work surfaces after handling raw ground beef. It was concluded that hamburger prepared at home are an important source of sporadic *E. coli* O157:H7 infections. They estimated that adequate hand washing by food preparers could have prevented 34% of *E. coli* O157:H7 infections.

Vernozyrozand and Rayguerior (1997) reported that the mode of transmission of *E. coli* O157:H7 is primarily through food (eg. Undercooked minced beef products, especially beef burgers, studies to date indicate that the control of VTEC infection is broadly similar to the measure need to control other gastrointestinal infection.

Katasaras (1998) reported that adhesion of bacteria to surfaces can be observed everywhere in nature. In food industry, the adhesion of bacteria is regarded as contamination of relevant surfaces such as glass, rubber, aluminum, Teflon, high-grade steel (processing machinery), ceramics (factory floor)… ect... in this respect; *Katasaras* stated that the adhesion of microorganisms to inorganic material is very important as the "bio-contamination" results in continuing contamination of the food coming into contact with it. There are particularly far-reaching results if pathogenic species are present and survive factory cleaning and disinfection. The contamination of surfaces with non pathogenic organism is however generally of great importance too, whether it is of biological surfaces, as this can lead to food spoilage and thus to economic losses.

Parry *et al.* (1998) stated that consumption of beef burger from catering premises other than from a fast food chain and consumption of cold cooked sliced meat from caterers but not butchers as associated with *E. coli* O157:H7 infection. There was evidence of person to person speared and transmission of *E. coli* O157:H7 infection to animals.

Slutsker *et al.* (1998) stated that a multi-variant analysis (consumption of hamburgers, under cooked hot dogs, eating at a fast food restaurant and having a household member with diarrhea) only eating under cooked hamburger remained associated with *E. coli* O157:H7 infection. Seven (8%) of 93 patients developed hemolytic uremic syndrome and 1 died. Prevention strategies aimed at modifying risk factors may help to reduce the risk of infection with *E. coli* O157:H7.

2.2 Microbial load of cooked meat products :

Franksen *et al.* (1969) determined the bacterial counts and bacteria spp. In 100 organoleptically perfect commercial frankfurter type sausage samples. On the basis of the results obtained; the following microbiological standards were suggested for these products: maximum aerobic count, 10^5/g, and absence of pathogenic microorganisms.

Surkiewiez *et al.* (1972) isolated Salmonellae from 28% of 529 samples of pork trimming used for sausage and from 28% of 560 finished sausage samples.

Kool and Bes (1973) found that 12% of 60 examined sausage and minced meat were contaminated by *Salmonellae*. A total of 16 *Salmonellae* serotypes were isolated.

Guarino *et al.* (1974) reported that *Salmonellae* failed to be detected from all examined sausage samples.

Libby (1975) stated that bacterial numbers in foods are of great significance and its conduction at regular intervals and at different stages in the food preparation and handling process is necessary to detect violation of sanitary practices and permit corrective action.

Chambers *et al.* (1976) considered the Coliform count as reflection of environmental contamination during slaughter, processing and or product handling while **Freeman (1960)** reported that *E. coli, Coliforms* and the presence of one or more of the indicator microorganisms in great numbers can easily give rise to public health hazard. In this respect, **Decun *et al.* (1975)** determined the incidence of *E. coli* in 293 samples of meat, meat product and meat processing plants. And found that 46 samples had count of $\leq 2 \times 10^5$/gm, 13 samples contained pathogenic *E. coli* at counts $\leq 1.6 \times 10^4$/gm.

Miskimin *et al.* (1976) reported that *E. coli* count was suitable as an indicator of the microbiological quality of foods, but to assure safety of a food product, specific pathogen testing is necessary.

Duitschaever (1977) examined 159 samples of luncheon meats collected from Ontario (Canada). He found that aerobic plate count in 46.5% of examined samples exceeded 10^6/g.

Duitschaever (1978) examined bacteriologically 180 units of frankfurter and found that 67% and 48% of samples had aerobic plate counts in the range of $10^7 - 10^9$ and $10^8 - 10^9$ /g, respectively while in 4 samples exceeded 10^9/g.
He also could isolate *E. coli* from sausage samples of 180 units of examined frankfurter type sausage.

Fruin (1978) could not isolate Salmonellae from 50 samples of luncheon meat obtained from markets. Also, **Tiwari and Kadis (1981)** examined 124 samples of delicatessen meat products including luncheon. *Salmonella*e were not detected in any sample. The same results reported by **(Abd El All; 1993, Edris, 1993; Mousa et al., 1993; Fathi et al., 1994; Tolba, 1994 and Aiedia, 1995)**.

Hansson *et al.* (1978) examined bacteriologically 228 and 540 samples of commercial sausage meat during 1973 and 1976, respectively and found a marked increase in the total aerobic and Coliforms counts in 1976 than in 1973. More than 50% of examined samples failed to meet the standard.

Bartenschlager-Blasing (1979) examined bacteriologically samples of natural and synthetic (bovine corium casings) sausage and found that the mean aerobic plate count was 10^6/g in the raw mixture, falling by 10^2 in freshly prepared sausage (after scalding). The composition of the bacterial flora of sausage was similar to that refrigerated meat. The type of casing had no effect in bacterial contamination of the products.

Masters (1979) reported that the prevalence of Salmonellae in fermented type meat products were relatively low and rarely fermented meat have been attributed as episodes of Salmonellosis.

Peitzsch (1979) reported that there were 14848 isolates of Salmonellae from animals and foods. Feeds in federal republic of Germany in 1977 comprising 204 different serotypes. Among the facts arising from the data are the increased numbers of isolations from eat products.

Sumner *et al.* (1979) examined bacteriologically 59 samples of fresh sausage and 42 samples of sausage meat and found that aerobic plate count (25˚C) ranges from 10^6 – 10^7/g for both types, with about 30% of samples in excess of 10^7/g.

Caserio and Patano (1980) examined bacteriologically 36 sausage samples (8 types) to ascertain the efficiency of hygienic measures and found that the total counts were excessively high, with positive *Salmonellae* counts in 3 samples. High incidence of fecal *E. coli* and Coliforms was recorded. The authors proposed the following bacterial limits for Italian sausages. Aerobic plate count 10^7/g. total Coliforms 2000/g, *E. coli* 150 – 200/g, *Salmonellae* negative.

Fu Kuda *et al.* (1980) examined bacteriologically 77 samples of commercial frozen foods (including meat products) and could isolate *E. coli I €and E. coli II.*

Reis *et al.* (1980) could isolate 1200 colonies of *E. coli* from sausage. A number of 18 of 1200 colonies were found to produce heat labile enterotoxin.

Elnawawi and Nouman (1981) revealed in bacteriologically survey conducted on 25 fresh sausage samples collected from Cairo and Giza that, the mean values of aerobic plate and pseudomonas count were 3-6x10^6/g, and 2.2x10^6/g respectively. Whereas 72% of samples were found contaminated with less than 10^3 Aeromonas organisms/g. the same authors reported that all samples contained Coliforms and Enterococci with mean values of 2.1x10^6 and 3.1x10^6, respectively.

El-Khateib (1982) revealed during bacteriological study of 25 samples from locally manufactured fresh sausage collected from Assiut city; that mean values of aerobic plate count, Psychrotrophic, Coliform (MPN), *E. coli* (MPN), Enterococci, *Strept. fecalis. Strept. faecium* and *Strept*. intermediate counts, per gram were 4.4x10^6, 8.2 x10^2, 226.2, 57.6, 1.4x10^5, 14.1x10^4, 26.9x10^2, and 42.3x10^2, respectively.

El-Cherif (1983) examined bacteriologically 10 samples of sausage. The mean values of aerobic plate count, *Enterobacteriaceae*, Coliform, fecal Coliforms, *E. coli* and *S. aureus* counts/g were $12.2x10^6$, $3.3x10^6$, $14.11x10^5$, $5.25x10^5$, $7.04x10^3$ and $1.53x10^3$, respectively.

Roushdy (1985) studied the bacteriological quality of 50 sausage samples with special reference to *Enterobacteriaceae*. The Author found that Coliforms (MPN/100g) ranged from 70 to $11x10^6$ in all examined samples.

Hassan (1986) studied the microbiological quality of 10 samples of sausage. The mean values of aerobic plate count and *Enterobacteriaceae* count were $4x10^5$ and $2x10^4$, respectively, while the incidence of Coliforms and *E. coli* were 60% and 30%, respectively.

Hemeida *et al.* (1986) examined bacteriologically local luncheon and they found the aerobic plate count was $0.9x10^4$/g.

Lotfi *et al.* (1986) examined bacteriologically 25 random samples of sausage for *Enterobacteriaceae* count collected from markets in Sohage and Assiut cities. The average count of *Enterobacteriaceae* was $9.1x10^4$/g, 15 (60%) of them were positive for *E. coli*.

Singh (1986) reported that in India from 1958 to 1981 a review of literatures reveals as many as 7962 *Salmonellae* isolate from human origin and 2113 of animal origin. In animals. S.*typhimurum* was the most common (12.2%) followed by S.*enteritidis* (8.7%). He also examined 8700 samples of meat of different species, during the period 1970 to 1984 and of which 229 (3.45%) yielded *Salmonellae.*

Tolba (1986) revealed that 52.5% of examined sausage samples contain *E. coli*. The author could isolate *Salmonellae* from examined sausage samples (10%), the isolated Salmonellae serotypes were S.*Stanley* (2), S.*Sandieago* (1) and S.*scheissheim* (1).

Abd El-Aziz (1987) examined 10 samples of sausage. The average aerobic plate count, total Coliforms and *Staph. aureus* counts per gram had a log of 7.61, 5.6 and 6.83, respectively. The author could detect *E. coli* in 50% of examined sausage samples.

Dominguez *et al.* (1988) evaluated 6 of the most widely consumed brands of bologna sausage in Sonora, Mexico, (Chemically and bacteriologically). It was found that incompletely met required standards. Aerobic mesophilic count and the MPN of Coliforms varied widely between and within brands.

El-Khateib (1988) stated that the mean values of the aerobic plate count and psychrophiles for poultry frankfurter were 10^6/g and 10^4/g, respectively.

Khalafalla (1988) examined 25 samples of sausage for detection of *Salmonellae*. He found that 8% of examined samples contained *Salmonellae*. The isolated serotypes were *S. typhimurium* and *S. newport*.

Yassien (1988) stated that the mean counts of aerobic pate, *Enterobacteriaceae*, Psychrotrobic, Coliforms (MPN), fecal Coliforms (MPN) of luncheon samples were $3.8x10^4 \pm 1.4x10^3$, $1.4x10^3 \pm 9.7x10^2$, $3.7x10^3 \pm 1.9x10^3$, 34.1 ± 23.9 and 2.3 ± 0.5 /gm respectively. He couldn't detect Gram-negative microorganisms from examined luncheon samples.

Bello-Perez *et al.* (1990) examined 336 meat samples collected from 9 towns in the state of Guerrero, Mexico for presence of *Salmonellae*. 109 samples (32-44%) were proved to be contaminated with *Salmonellae*, and the microbiological qualities of these samples were somewhat deficient. He recommended improvement in the hygienic condition in butchering and distribution of meat to prevent health risk as many cases of gastroenteric and diarrheal diseases are the result of *Salmonellae* in food in the state of Guerrero, Mexico. Kinds of meat contaminated were sausage, pork and cured meat.

Read *et al.* (1990) stated that the prevalence of verocytotoxigenic *E. coli* in beef and pork was at least 36.4% and 10.6% respectively. No VTEC of serotype O157:H7 were isolated.

Zaki (1990) stated that the incidence of *E. coli* in sausage was 40% by direct plate count technique (DPC) and 48% by using MPN. 17 of *E. coli* isolates were identified as biovar I and 9 strains of biovar II by using DPC and 21 of *E. coli* isolate were identified as biovar I and 9 strains of biovar II by using MPN.

Fathi *et al.* (1992) analyzed 16 sausage samples. The Coliforms were found in all samples with average count of $7.6x10^3$/g. While he detected *E. coli* in 4 (25%) of examined sausage samples with average count of $7x10^2$, while He also examined 12 luncheon samples, the Coliforms was found in all samples with average count of $7.4x10^3$, while *E. coli* was detected in 5 (41.67%) of examined samples with average count of 18.68/g.

Abd El-All (1993) examined bacteriologically luncheon samples, and reported that, the incidence of *E. coli* was 28.57%.

Edris (1993) isolated *E. coli* (biovar I and II) from luncheon samples in 4 and 3 out of 35 examined samples. The biovar I was O86:K61 (B7) and O124:K72 (B17), which is enteropathogenic, enteroinvasive.

Hartung (1993) presented the results of questionnaire based evaluations of 2272 cases from 101 outbreaks. Of these 92% were caused by S.*enteritidis* and 10% of the cases were caused by meat and meat products.

Mousa *et al.* (1993) collected 35 random samples of luncheon from different supermarkets and butcher's shops in Cairo and Giza governments and examined them bacteriologically. The mean value of total mesophilic count/g was $5.5x10^8$ while the mean value of *Enterobacteriaceae* per gram was $7.0x10^4$. On the other hand, the mean value of Coliforms/g was $1.4x10^3$ He could isolate *E. coli* at a high percentage (52%) from examined luncheon samples. While he isolates *E. coli* at high percentage 45% from raw sausage samples.