

Effect of Good Manufacturing Practices (GMPs) Application on the Bacteriological Status of Butcher's Area in Small Scale Meat Processing Plant

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Abstract: Most local health departments utilize visual, but not microbiological methods when inspecting hygienic status of butcher's area in small scale meat processing plants. To identify the main points of bacteriological contamination in butcher's area in small scale processing plants, six plants located in Gairo and Giza cities- in Egypt were examined. Two hundred and forty (240) samples of minced meat, swabs from mincers, knives and worker's hand were collected from the 6 plants. Each plant was visited five times with two weeks intervals to evaluate its hygienic status, the samples and swabs were inoculated on different selective media and standard procedures were applied to identify the pathogenic bacteria. Furthermore, Good Manufacturing Practices (GMPs) principles for employees, equipments and places were applied and the hygienic status was re-evaluated through another five visits. Minced meat showed the highest level of contamination among examined samples. In addition *Salmonella* could be detected from minced meat only, while *E. coli* was isolated from minced meat, mincers, knives and worker's hand in 6.6, 3.3, 3.3 and 3.3% respectively. Application of GMPs principles proved significant reduction in both pathogens and bacterial load of all examined samples.

Key words: Butcher's area • Processing plants • GMPs principles • Swabs • Mincers • Knives • Bacteriological examination • Minced meat

INTRODUCTION

Bacteriological quality of meat products is strongly influenced by the prevailing hygienic condition during their production and handling [1]. Food-borne diseases have been considered as an imperative health problem in different countries [2]. In developing countries like Egypt, there is no precise data about the incidence of food-borne outbreaks and it seems to be higher in comparison with developed countries. This high incidence could be attributed to the unfavorable setting of preparation, storage as well as the probable direct contact with contaminated equipment and low health education level of workers in the food processing sector [3]. World health organization (WHO) has reported that 50 million children under five years of age get diarrheal diseases each year, due to the contaminated water and food stuffs [4].

Hygienic and quality control methods of meat and meat products, especially in food catering have been recommended in many countries [4]. Without proper hygienic control, the environment in butcher's area

in the processing plant can act as an important source of bacterial contamination [5]. The most efficient way of reducing contamination and microbial growth in meat and meat products is to establish quality control programs such as Good Manufacturing Practices (GMPs) and Hazard Analysis Critical Control Point (HACCP), which can be conducted by seeking indicator microorganisms that predict the presence of pathogens and bacteria causing spoilage [7].

This work involved an evaluation of the bacteriological quality of butcher's area in some small scale meat processing plant based on the presence of indicator microorganisms in sample from minced meat used for production of raw products as beef burger and fresh oriental sausage. Also swabs from meat mincers, knives and worker's hand were taken. Another goal was to identify the main points of contamination and adaptation of good manufacturing practices (GMP) in the butcher's area to improve the microbial quality of minced meat used for burger and sausage production.

MATERIALS AND METHODS

Sampling: Samples were collected from butcher's area in small scale meat processing plants (A to F) in Cairo and Giza governorates. Each plant was visited five times with two weeks intervals to evaluate its hygienic status. In each processing plant's visit, four samples were taken from minced meat (100 g) which used for manufacturing of beef burger and fresh sausage. In addition three swabs were taken from meat mincers, knives used for cutting and denuding of meat and worker's hand.

GMPs principles for raw meat, equipments (knives and mincers) and workers were applied as described by *USDA(8)* to improve the hygienic condition in butcher's area and consequently improve the produced minced meat and meat products quality. Hygienic status was re-evaluated through another five visits with two weeks intervals.

Application of GMPs (USDA) [8]: No sanitation program was applied in the plants; employees have no clear knowledge about general principles of personal hygiene and no rules for hand washing. Equipments were cleaned at the end of the day, wooden cutting boards were used. Water and ordinary soap were the main cleaning tools. So that simplified instructions were written, illustrated and hanged on butcher's area. Detailed training and discussion about it with the employees make them able to perform the required tasks. The instructions include:

- Hands must be washed and sanitized before each time handling of food materials.
- Personal hygiene for workers as washing hands by using warm water, sanitizer soap and dry with disposable towel must be conducted. and worker must wear a stainless steel gloves during meat handling.
- Cutting boards must be Washed and sanitized.
- Plastic board must be used. Cutting knives must be washed and sanitized before each use.
- Meat must be Chilled and placed in clean and sanitized containers and stored properly to avoid cross contamination.
- Mincers must be Washed and sanitized with suitable cleaning agents for each use and must take a time to a drain water.

Bacteriological Examinations

Preparation of Minced Meat Homogenate: Minced meat homogenate was prepared by homogenizing ten grams from each sample in sterile bag with 90 ml Peptone Water (oxoid CM9) for 1 minute using stomacher (Lab blender400, Seward, UAC House black Friars road, London, SE 19 UG-Model No.6021). From the original homogenate ten fold decimal dilutions were prepared using the same diluents [9].

Preparation of Swab Samples: Sterile swabs were used (quick swabs, 3 μ microbiology st., Paul, MN, USA). Swab samples were put in 9 ml Peptone Water and decimal serial dilution were prepared in the same diluent.

All dilutions of the minced meat and swabs were investigated bacteriologically for:

- *Total aerobic* count [10].
- *Staphylococcus aureus* count [11] *Coliforms* count using Most probable number (MPN) technique ([12].
- Isolation and identification of *E. coli* [13].
- Isolation and identification of *Salmonella* [14].

Statistical Analysis: All data were analyzed using Statistical Analysis System [15]. Comparisons between sample within each analysis were tested using analysis of variance (ANOVA) test. Significance was determined by the F-test and least square means procedure. Main effects were considered significance at $P < 0.05$.

RESULTS AND DISCUSSION

Start with a Brief Introduction Remark: Food safety is a matter of great public health concern worldwide and crucial to the contamination level of environment in which the food is handled. Furthermore, minced meat as food of animal origin is highly susceptible to microbial invasion and food poisoning. The data recorded in Table (1) and Fig. (1) pointed out that before application of GMPs principals, minced meat samples were contaminated with higher levels of APC, Where, APC was ranged from 5.21 ± 0.23 to $6.48 \pm 0.36 \log_{10}$ cfu/g with mean values of $5.81 \pm 0.16 \log_{10}$ cfu/g in different butcher's area. These higher levels may be due to unhygienic practices during meat production in slaughter houses, also using of low quality meat or non selected trimmings for production of

Table 1: Mean values of total aerobic plate count (APC) in butcher's area (A - F) before and after applications of GMPs

	Minced meat/g		Mincers/cm ²		Knives/knife		Worker's hand/hand	
	Before	After	Before	After	Before	After	Before	After
A	5.68±0.32	5.21±0.23	4.3±0.24	3.3±0.19	4.48±0.25	4.0±0.23	3.4±0.19	2.8±0.13
B	5.21±0.23	4.8±0.27	4.9±0.28	4.3±0.24	4.9±0.28	3.9±0.22	3.8±0.21	3.0±0.17
C	6.48±0.36	5.5±0.31	3.9±0.22	3.1±0.17	4.48±0.25	4.0±0.23	4.3±0.24	3.8±0.21
D	6.0±0.34	5.21±0.23	5.4±0.31	5.1±0.29	5.0±0.28	4.0±0.23	3.2±0.18	2.83±0.13
E	6.3±0.36	5.8±0.33	5.69±0.32	5.2±0.30	3.8±0.21	3.2±0.28	3.5±0.20	2.9±0.16
F	5.21±0.23	5.0±0.28	4.6±0.26	4.2±0.24	3.9±0.22	3.0±0.17	3.6±0.20	3.0±0.17
Mean	5.81±0.16	5.25±.12	4.79±0.17	4.2±0.21	4.42±0.14	3.68±0.12	3.63±0.11	3.06±0.1

Table 2: Mean values of staphylococcus aureus (S.aureus) count in butcher's area (A - F) before and after applications of GMPs

	Minced meat/g		Mincers /cm ²		Knives /knife		Worker's hand/hand	
	Before	After	Before	After	Before	After	Before	After
A	3.9±0.22	3.0±0.17	1.99±0.11	2.0±0.07	3.3±0.19	2.5±0.14	3.48±0.19	2.2±0.01
B	3.2±0.18	3.2±0.16	2.0±0.11	1.8±0.06	2.3±0.13	2.0±0.11	2.3±0.13	2.0±0.11
C	3.3±0.19	2.8±0.13	2.8±0.13	2.0±0.11	2.8±0.13	2.0±0.11	2.6±0.15	2.0±0.12
D	3.3±0.19	3.0±0.17	3.0±0.17	2.1±0.12	3.3±0.19	2.2±0.12	2.3±0.13	2.0±0.11
E	3.3±0.19	3.0±0.17	3.0±0.17	2.0±0.11	2.9±0.16	2.0±0.11	2.6±0.15	1.9±0.11
F	3.6±0.20	2.8±0.13	2.8±0.13	2.0±0.11	2.9±0.16	2.2±0.12	2.9±0.11	2.0±0.11
Mean	3.43±0.09	2.92±0.05	2.61±0.11	1.76±0.09	2.92±0.09	2.51±0.06	2.69±0.11	2.41±0.20

Table 3: Mean values of coliforms count MPN (g) in butcher's area (A - F) before and after applications of GMPs

	Minced meat/g		Mincers/cm ²		Knives /knife		Worker's hand/hand	
	Before	After	Before	After	Before	After	Before	After
A	4.20±0.24	4.0±0.23	2.34±0.01	<3	1.96±0.11	<3	3.04±0.05	<3
B	3.30±0.19	2.30 ±0.13	1.99±0.11	<3	1.96±0.11	<3	1.99±0.11	<3
C	3.00±0.17	2.50±0.14	2.34±0.13	1.9±0.11	1.96±0.11	<3	3.04±0.05	1.9±0.03
D	4.30±0.24	3.30±0.19	3.4±0.13	1.9±0.11	1.96±0.11	1.9±0.05	1.99±0.11	1.9±0.04
E	4.30±0.24	3.04±0.17	2.34±0.13	1.65±0.09	1.96±0.11	1.9±0.04	2.34±0.07	<3
F	4.77±0.27	3.6±0.20	2.77±0.15	1.65±0.09	1.60±0.09	<3	1.99±0.11	<3
Mean	3.94±0.16	3.15±0.16	2.19±0.11	1.2±0.21	1.90±0.04	0.63±0.09	1.55±0.10	0.63±0.07

Table 4: Analysis of variance of the mean values of APC, *S. aureus* and coliform count in the six butcher's area (A - F) before and after applications of GMPs.

	APC		<i>S. aureus</i>		Coliform C	
	Before	After	Before	After	Before	After
Minced meat/g	5.81±0.16 ^a	5.25±.12 ^b	3.43±0.09 ^a	2.92±0.05 ^b	3.94±0.16 ^a	3.15±0.16 ^b
Mincers/cm ²	4.79±0.17 ^a	4.2±0.21 ^b	2.61±0.11 ^a	1.76±0.09 ^b	2.19±0.11 ^a	1.2±0.21 ^b
Knives/knife	4.42±0.14 ^a	3.68±0.12 ^b	2.92±0.09 ^a	2.51±0.06 ^b	1.90±0.04 ^a	0.28±0.09 ^b
Worker's hand/hand	3.63±0.11 ^a	3.06±0.1 ^b	2.69±0.11 ^a	2.01±0.20 ^b	1.55±0.10 ^a	0.27±0.07 ^b

Means in the same cell with unlike superscripts are different (p< 0.05).

Table 5: Incidence of *E. coli* and *salmonella* in different butcher's area before and after applications of (G.M.P.s) n=240

	<i>E. coli</i>				<i>Salmonella</i>			
	Before		After		Before		After	
	N=60	%	N=60	%	N=60	%	N=60	%
Minced meat/g	4	6.6	2	3.3	2	3.3	-	-
Mincers/cm ²	2	3.3	1	1.6	-	-	-	-
Knives/knife	2	3.3	-	-	-	-	-	-
Worker's hand/hand	2	3.3	-	-	-	-	-	-

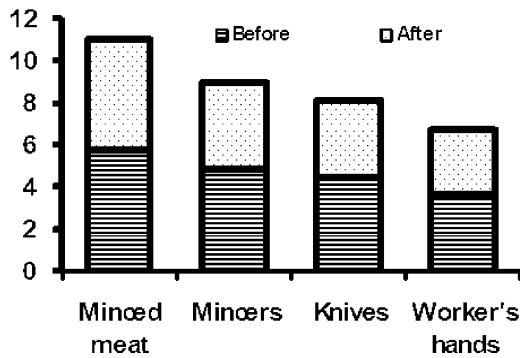


Fig. 1: APC in butcher area before and after applications of GMPs

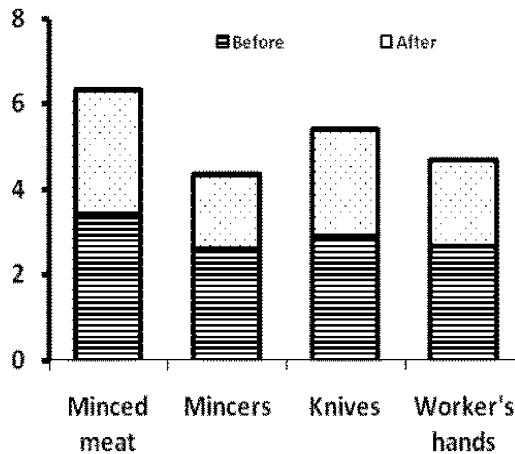


Fig. 2: S.aureus count in butcher area before and after applications of GMPs

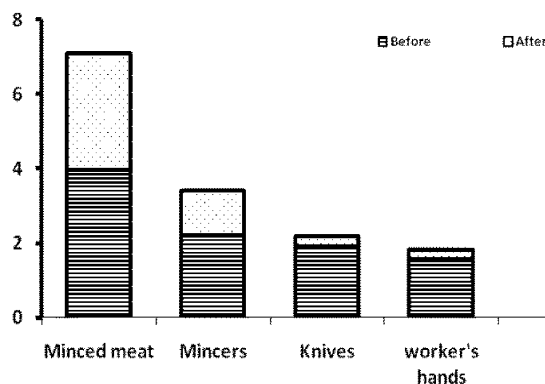


Fig. 3: Coliforms count in butcher area before & after applications of GMPs

fresh meat products [16]. These levels significantly ($P < 0.05$) decreased after conducting GMPs principals to be ranged from 4.80 ± 0.27 to 5.80 ± 0.33 log₁₀ cfu/g with mean values of 5.25 ± 0.12 log₁₀ cfu/g.

Gill *et al.* [5] proved that samples of minced meat contaminated with APC of $6 \log_{10}$ cfu/g indicates a deterioration process with off odour and reduction of shelf life and when contamination reach $7 \log_{10}$ cfu/g slime formation is already evident. Also, table 1 reveals that the mean values of APC/cm² of equipments (mincers and knives) are also high reached to 5.69 ± 0.32 log₁₀ cfu/cm² for mincers and 5.0 ± 0.28 log₁₀ cfu/knife for knives. These results recognized that knives and cutters of mincers were not well washed and sanitized and the only practice of cleaning is immersing knives in soap and water for 5 minutes. Cenci *et al.* [17] stated that Mincers have some difficulties to be cleaned thus accumulate large amount of organic matter which favoring microbial growth and reducing the efficacy of sanitation procedures. On the other hand, the application of GMPs procedures such as hands washing with hot water and sanitiziner soap, frozen storage of selected meat cuts till use, washing of knives and mincers with hot water, using of efficient sanitizers in cleaning before each use and wearing a stainless steel gloves in dealing with meat are significantly effective of reducing the bacterial load of all examined samples [18].

Tables 2 and 3 show that, mean value of S.aureus and coliforms count of minced meat are 3.43 ± 0.09 log₁₀ cfu/g and 3.94 ± 0.16 log₁₀ cfu/g respectively. These counts are higher than the limits found in ESS [19]. Moreover, swabs from mincers, knives and workers hands showed higher counts of aforementioned microorganisms. These higher counts may be attributed to unsanitary practices performed in the plant, employee's ignorance by personal hygiene and contaminated floors which considered important sources of contamination since they transfer contaminations to worker's shoes [1] the workers intern circulate inside the establishment thereby disseminating the contamination. The drains and floors can offer a favorable environment for microbial growth and an important source of propagation of microorganisms [20] especially if cleaning is done with water under pressure, this practice can spread contamination by suspending microorganisms in the air droplets of water. Higher counts of S. aureus in worker's hand indicates ignorance of workers and butchers by the personal hygiene rules. Moreover, A condition like injured hands or having abscess grealty enhance S. aurues contamination.

Application of GMPs principles as mention before in addition to rising employees' awarness by rules of personal hygiene could significantly reduce S.aureus and coliform count in the examined samples.

Data in Table (5) showed that Before application of GMPs procedures, minced meat and swabs from mincers, knives and worker's hands are contaminated with pathogenic bacteria including *E. coli*. the incidence of *E. coli* were 6.6% for minced meat samples and 3.3 %for other swab samples,. While, after application of GMPs procedures, the incidence of *E. coli* was clearly decreased to 3.3 and 1.6% for minced meat samples and swabs of the mincers respectively. Regarding to salmonella isolation, minced meat is the only positive samples with 3.3% before GMPs application and couldn't be detected in any samples after GMPs application. Our results were in line with previous studies as those recorded by Soriano *et al.* [21] and Luby *et al.* [22]. Also, table (5) reveals that salmonella failed to be detected in samples from mincers, knives and worker's hand.

In this regard previous studies as those recorded by Kassa *et al.* [23] and Lee *et al.* [24] have shown that approximately 86% of food service operations had enteric bacteria in food contact surfaces as cutting board and equipments.

CONCLUSION

From the obtained result it was concluded that minced meat is the point displaying the highest levels of contamination in butcher's area in the examined meat processing plant. Use of good storage condition to selected meat cuts, plastic board instead of wooden board and clean sanitized knives -used for filleting and cutting of meat for minced meat production- can reduce that level. Moreover, the contaminated minced meat is used for fresh sausage and beef burger indicating that food safety procedures must be applied to the entire meat production chain from slaughter house, processing plant, to the consumption. Therefore it is imperative for quality tools such as good manufacture and hygienic practices and microbiological risk evaluation and quality management to be integrated in the meat processing sector.

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