ASSESSMENT THE HYGIENIC QUALITY OF BASTERMA IN TWO PROCESSING PLANTS IN ALEXANDRIA GOVERNORATE

BY

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ABSTRACT

The assessment of hygienic quality of basterma (dry-cured meat product) during processing in two plants in Alexandria, Egypt, has been investigated. First plant (plant A) applies quality assurance program during processing while second plant (plant B) produces basterma by the traditional technique. The investigation was conducted through determination of Aerobic Plate Count (APC), isolation and identification of *Staphlococcus aureus* and Salmonella spp. of frozen raw meat, defrosted meat and final product samples. Also, estimation of moisture and sodium nitrite content of final product samples, as well as personal monitoring of processing environment in both plants was carried out. Results indicated that the bacteriological quality of raw meat in both plants nearly the same and within the acceptable limits. Bacteriological quality of defrosted meat in plant (A) was good and within the acceptable level while in plant (B) most samples has high APC and 40% were contaminated with *S. aureus*. Bacterial and chemical results of final products samples in plant (A) were within the legal limit except few

samples had high APC, while in plant B most samples were exceeded the acceptable limits of APC, moisture and sodium nitrite content as well as *S. aureus* could be isolated from 60% of samples. Salmonella spp. could not be detected in all examined samples. We could conclude that quality assurance program improves the hygienic quality of produced basterma, but few points still need strict control. The control measures and hygienic requirements needed to produce safe and high quality basterma in both plants were discussed and clarified to be employed.

INTRODUCTION

Basterma is a meat product considered an essential food tasty, easily digested and of high quality animal protein. It is an excellent meat product that contains a wide variety of nutrients, besides its high calorie value. It also supplies the consumers with different mineral and vitamins of high biological value [(1)].

The common meat products could be classified according to their storage & distribution temperatures into three main categories. The first category includes products that require cooling (such as slices or thin cuts of bastrami, salami ...etc.). The 2nd is that products require freezing (frozen meat products as minced meat, beef burger, beef paties ...etc.). The 3rd category are products that stored and handled at the ordinary room temperature (closed loaf of basterma, luncheon ...etc.).

In Egypt, locally manufactured meat products like basterma, sausage, luncheon ...etc. are gaining popularity to compensate the shortage in high

price fresh meat. Basterma may be defined as a dry-cured meat product prepared from fresh salted meat, coated with spices paste, stored at room temperature and intended to be cooked before consumption. It manufactured in some Middle East countries and mainly in Egypt in which it considered as one of the most popular meat product [2].

Before last three decades, basterma was produced from local fresh beef meat, and to a lesser extent from camel meat. Nowadays, imported deep frozen boneless meat blocks in the form of stored cuts became the basic raw material. Defrosting of raw meat for basterma manufacture is done in defrost room or in ordinary room (traditional defrost). So, basterma still constitute potential sources of diseases if it improperly prepared following the good hygienic practices [1].

Quality assurance program means application of Quality Management System including systemic control measures along the processing line of basterma that ensure and verify the production of safe and high quality product. Quality improvement and control is not easy, particularly for very small manufacturers. Many efforts were done to produce a product free from pathogens of public health hazard and with low microbial count in order to improve its keeping quality and keep its nutritive value to be safe [3].

Meat and meat products were incriminated in 26 outbreaks (20.9%) of total microbial food poisoning outbreaks admitted to Alexandria poison center at Alexandria main university hospital, from August 1997 to July 1998. *Staphylococus. aureus* was the most common isolated bacteria

(46.8%) also Salmonellae were involved in 2.7% of total food poisoning outbreaks [4].

In the modern technologies, the minimum amount of nitrite required to produce sufficient cured color in all meat products is 30 to 50 ppm depending on the type of product and that for inhibitory effect on the growth of many species of bacteria should be about 80 to 150 ppm [5]. The use of garlic in spices past coat of basterma is important because it probably inhibits undesirable gram negative bacteria and certainly undesirable moulds growth [6].

Egyptian Organization for Standardization (ES)[7] stipulated the hygienic requirement for basterma that it should be free from *Staphylococcus aureus,* Salmonella and other pathogens or their toxins, aerobic plate count should not exceed 10^4/gm., moisture percent should not exceed 60 % and sodium nitrite content should not exceed the international permissible limit (125 ppm.).

Therefore, the aim of this work was directed to investigate the hygienic quality of basterma in a modern plant that applying quality assurance program as well as in a traditional plant. Also, we tried to discuss the control measures and clarify suitable suggestions, to be employed, aiming to improve the hygienic quality in both plants to produce safe and high quality product that complying the legal requirements of Egyptian Standard.

MATERIAL AND METHODS

A total of one hundred and fifty random samples of basterma were collected from two manufacturing plants. The first plant (plant A), applies quality assurance program during processing while the second plant (plant B), produces basterma by the traditional technique. The collected samples were frozen raw meat "resembling 25 batches", defrosted meat and final product (25 samples of each) from each plant.

The samples were transferred directly to the laboratory in an insulated ice box under aseptic condition without any delay and subjected for the following bacteriological and chemical examinations:

1- Bacteriological examination of all samples:

A. Determination of total Aerobic Plate Count (APC) [8].

B. Isolation and identification of *Staphylococcus aureus* [9].

C. Detection of Salmonella spp. [10].

2- Chemical analysis of final product samples:

A. Determination of moisture percent [11].

B. Quantitative estimation of sodium nitrite (NaNo2) [12].

Process Flow Diagram (PFD) of locally manufactured basterma in two meat processing plants at Alexandria Governorate (personnel monitoring)

Receiving and storage of frozen meat (raw meat) → Defrosting (in defrost room "plant A" or ordinary room "plant B") → Trimming (slicing

and removing of fat and visible connective tissues) → Salting (meat slices covered by sodium chloride and sodium nitrite "125 ppm" for 24 hrs.) → Washing (removing of residual salt crystal by current tap water) → Pressing (by heavy load for 12-24 hrs.) → Drying (in oven at 45°C/24 hrs.) → Coating by spices paste (made mainly from garlic, trefoil seed "Helba", mustard, pepper and coriander) → Final drying (in oven at 45°C/12 hrs. "plant A" or at ordinary temp. & sunlight for 3 weeks "plant B") → Distribution to retails (at atmospheric temperature).

Statistical analysis of obtained results was carried out using student t-test to evaluate the differences in means ± SE (Standard Error) values of APC, moisture percent and sodium nitrite content between plant (A) and (B).

RESULTS

The obtained results in table (1) revealed that the Aerobic Plate Count (APC) of examined frozen raw meat samples (25 from each plant) in plant (A) ranged between (1.7×10) and (2.5×10^2) with a mean value of (1.06×10^2). On the other hand, in plant (B), it ranged from (2.4×10) to (3.1×10^2) with a mean value of (1.25×10^2).

T-test confirmed that there was no significant difference of APC in the examined raw meat samples between both plants. *Staphylcoccus aureus* could not be detected and also Salmonella spp. could not be isolated from examined raw meat samples of both plants.

Results were compared with Egyptian Standard for frozen raw meat [13].

Table (1): Bacteriological examination of frozen raw meat samples in two meat processing plants compared with Egyptian Standard (ES) [13]:

Criteria	Plant (A)	Plant (B)	ES Limit
Aerobic Plate Count:			
- Range	$1.7\times10 - 2.5\times10^2$	$2.4\times10 - 3.1\times10^2$	$<10^5$
- Mean ± SE	$1.06 \times 10^2 \pm 0.82 \times 10^2$	$1.25 \times 10^2 \pm 0.93\times10^2$	$<10^5$
- t-test* of APC	0.771**		
Incidence of pathogens:			
- *Staphylococcus aureus*	0%	0%	0%
- Salmonellas spp.	0%	0%	0%

*Student t-test between plant (A) and (B). ** Statistically non significant.

Data in table (2) showed that the APC in examined **defrosted meat** sample ranged between (1.5×10) and (5.2×10^3) with a mean value of (5.18×10^2) in plant (A) while in plant (B) ranged between (9×10^5) and (3.5×10^8) with a higher mean value of (5.5×10^7). There is a significant difference in APC of examined samples between plant (A) and plant (B). *Staphylococcus aureus* could not be detected in plant (A), while in plant (B) it was detected in high incidence (40%).

Salmonella spp. could not be isolated from both plants.

Table (2): Bacteriological examination of defrosted meat samples in two meat processing plants

Criteria	Plant (A)	Plant (B)
Aerobic Plate Count: - Range - Mean ± SE	**$1.5 \times 10 - 5.2 \times 10^3$** **$5.18 \times 10^2 \pm 0.1 \times 10^2$a**	**$9 \times 10^5 - 3.5 \times 10^8$** **$5.5 \times 10^7 \pm 0.9 \times 10^7$b**
- t-test* of APC	**2.947****	
Incidence of pathogens: - *Staphylococcus aurous* - Salmonella spp.	**0%** **0%**	**40%** **0%**

*Student t-test between plant (A) and (B). ** Statistically non significant.

Results present in table (3) indicated that the mean value of APC was ($1.37\ 10^4$) in examined **final product** samples of plant (A) with a range of (1.2×10^3) and (1.14×10^5) from which few (five) samples exceed the legal limit. In plant (B), APC ranged between (1.2×10^7) and (3.6×10^9) with high mean value of (1.5×10^8) and most samples exceed the acceptable limit. T-test confirmed that there was a significant difference between plant (A) and plant (B) in APC, moisture and sodium nitrite contents of final product samples. *Staphylococcus aureus* could not be detected in plant (A) while in plant (B) was detected in high incidence percent (60%). Salmonella spp. could not be isolated from final basterma products samples of both plants.

Chemical criteria of final product samples in table (3) revealed that the range of moisture percent and sodium nitrite content in plant (A) were from 52% to 60% and from 80 to 120 ppm with mean values of 56.8% and 107.9

ppm, respectively. While in plant (B) were from 58% to 72% and from 120 to 200 ppm with mean values of 65.28% and 161.6 ppm, respectively. Results were compared with Egyptian Standard for requirement of basterma [7].

Table (3): Bacteriological and chemical examinations of final product samples in two meat processing plants compared with Egyptian Standard [7]:

Criteria	Plant (A)	Plant (B)	ES Limit
Aerobic Plate Count:			
- Range	$1.2\times10^3 - 1.1\times10^5$	$1.2\times10^7 - 3.6\times10^9$	$<10^4$
- Mean ± SE	$1.37\times10^4\pm0.2\times10^4$	$5.1\times10^8\pm0.8\times10^8$	$<10^4$
- t-test* of APC	**2.947****		
Incidence of pathogens:			
- *Staphylococcus aurous*	0%	60 %	0%
- Salmonella spp.	0%	0%	0%
Chemical analysis:			
Moisture percent:			
- Range	52% - 60%	58% - 72%	<60%
- Numerical mean	56.8%a	65.28%b	
Na No2 (ppm):			<125ppm.
- Range	80 - 120	120 - 200	
- Numerical mean	107.9a	161.6b	

*Student t-test between plant (A) and (B). ** Statistically non significant.

Numerical means with different letters were significantly deferent,

DISCUSSION

Aerobic plate count is usually used to assess the over all sanitation and storage conditions of raw meat and meat products, so it included in all meat regulations for hygiene and quality grading.

The obtained results indicated that frozen raw meat in plant (A) and plant (B) showed nearly similar APC. The applied statistical t-test confirmed that there was no significant difference, and both were within the acceptable limit of APC stipulated by the Egyptian Standard for frozen raw meat [13]. Nearly similar result of APC, in frozen raw meat, was obtained by some authors [14, 15, 16], while higher results were recorded by others [6, 1].

Results showed that frozen raw meat in plant (A) and plant (B) were free from *Staphylcoccus aureus*. In contrast, some authors could isolate *Staphylcoccus aureus* from frozen imported meat at various levels [17, 18]. Also, results confirmed that Salmonella spp. could not be detected in frozen raw meat samples of both plants and these results are in agreement with a study on frozen meat [19]. In contrast other authors conducted a survey of the microbiological quality of Australian frozen boneless beef and they reported that Salmonella was detected in 0.1% of samples [15]. In addition, a recent study reported that Salmonella could be isolated from 1 out of 1082 samples of frozen boneless beef [16].

Our results concluded that frozen raw meat in both plants was of high quality and comply with legal requirement. Meat may be derived from a source free from microbial contaminants but becomes contaminated during course of manufacture, transport or sale of food handlers. Unclean utensils,

air, soil and incomplete hygienic conditions during manufacturing like packaging, storing, slicing and marketing of such products promote the growth and multiplication of various bacteria [20].

Defrosting means frozen meat kept neatly in chilling room at 10°C till the temperature of the meat reach 7.5°C within proper time according to the thickness of meat cut. A good indicator for well tempered meat is that the foil can be removed easily or the knife blade can inserted on the meat. Our results clarify that APC was increased during defrosting of frozen meat in both plants and there was a significant difference of APC between both plants in the examined defrosted meat samples. However, in plant (A) there was a limited increase of APC in addition *Staphylococcus aureus* and Salmonella spp. could not be isolated. These results may refer to the almost proper defrosting conditions regulated by the applied quality assurance program in plant (A). In this plant thawing takes place in chilling room (controlled time and temperature regarding Process Flow Diagram "PFD"), using perfect clean and disinfected utensils, seals and floors in addition to well trained worker and high standard personal hygiene (personal monitoring). Chilling below 10°C inhibit growth of most pathogenic bacteria and suppress the growth of spoilage microorganisms. Thawing of frozen meat in a refrigeration temperature is preferred as most microorganisms were not growing at chilling temperature [3, 21].

In contrast, there was unlimited increase of APC of meat after defrost in plant (B) reaching a level that may constitute a public health issue as well as *Staphylococcus aureus* was detected in 40% of samples while Salmonella

spp. could not be recovered. The practicized traditional defrosting technique in plant (B) provide favorite environment for microbial growth including pathogens where thawing was done under improper conditions at ordinary room with high temperature and uncontrolled long time (PFD) and inadequate cleaning and disinfection. Also, there was inadequate knowledge or practices of personal hygiene (personal monitoring). Food regulatory agencies advise against thawing frozen meat and poultry at room temperature. They added, thawing of frozen meat at higher temperatures and/or for longer times cannot be recommended and provide realistic predictions of pathogen growth during thawing of frozen beef and chicken [22].

Our personal monitoring clarify that in small factories basic hygienic rules are neglected and workers are prime determinants of final product quality. Meat handling area, in these factories, where meat is hoisted over the shoulders of porters wearing unclean and blood stained coat, still consider a potential public health hazard due to spoilage bacteria.

Results denoted that mean value of APC in examined final basterma product samples of plant (A) lies within the acceptable limit of legal requirement [7]. Attention should be taken to the few samples (5 samples) those exceeding the legal limit as the final product of this plant directly distributed to retails (without storage or enough ripening period "PFD") giving no chance for reduction of microorganisms during progressive increase of salt and lactic acid. All microbial groups, with the exception of Enterobacteriaceae and enterococci, reached maximum counts both on the surface and in the interior of the meat pieces at the end of the post-salting

stage and afterwards progressively dropped during the drying-ripening stage [23].

Nearly similar results of APC in the final basterma samples of plant (A) were obtained by some authors [24, 25], while higher count was reported by others [26, 27]. As well as other researchers carried out a study on basterma produced from three plants and they recorded nearly the same APC in basterma samples of the 1st plant while they found slight higher count in samples of 2nd and 3rd plants [28].

Staphylococcus aureus could not be detected in plant (A), this may be due to the good hygienic practices and high standard personal hygiene of applied quality assurance program. An author could not isolate *Staphylococcus aureus* from basterma samples [29], while others could isolate this pathogen in various percentages [24, 27, 30].

On the other hand, in plant (B) most samples exceed the legal limit of APC and the mean value reaching a higher level (5.1×10^8) which can cause spoilage of the product, as well as constitute public health hazard. *Staphylococcus aureus* was present in high incidence (60%) in the examined final basterma samples of plant (B). So, most samples were not complying with the legal requirements for basterma that should have APC not more than 10^4/gm. and should be free from pathogens [7]. These results may be attributed to the improper processing condition and incomplete ripening period [only three weeks "including final drying period" as shown in the PFD], as most microorganisms declined and may completely disappeared during elongated ripening period during which moisture and APC decreased. Basturma (a spiced beef product intended to be cooked before consumption) prepared by dry-curing, rinsing, pressing and drying appears

to present little risk of foodborne infection because these processes are potentially very important pathogen-reduction steps [31]. Also, another study indicated that the salt during salting process of dry-cured hams offers an ecosystem suitable for the survival of the staphylococci and micrococci. In addition ripening period of dry-cured meat products is very important as these group declined during ripening as lactic acid and salt content increased [32]. Nearly similar results of high APC in basterma of plant (B) were obtained in some studies [25, 26, 33, 34]. Many authors could also isolate *S. aureus* from basterma in varying percentages [24, 27, 30].

Staphylococci are present in the nasal passages, throats and on the hair and skin of 50 percent or more of healthy individuals. This incidence is even higher for those who associate with or who come in contact with sick individuals and hospital environment. Although food handlers are usually the main source of food contamination in food poisoning outbreaks, equipment and environmental surfaces can also be sources of contamination with *S. aureus* [35].

Processed meat products may constitute a public health hazard either due to presence of spoilage micro-organisms responsible of objectionable change or pathogenic bacteria leading to infection and intoxication [36]. *Staphylococcus aureus* contamination and enterotoxin production is a potential food safety hazard during the drying step of production of air-dried fresh meat products [37].

Also, our results showed that we failed to detect Salmonella spp. in the final basterma samples of both plants and these also were reported by many authors [6, 24, 30, 38] while an auther could detect Salmonella in 1.7% of

basterma samples [25], as well as others could detect salmonella in 33.33% of their examined basterma samples [39].

Chemical analyses of final product samples indicated that moisture percent in samples of plant (A) was legally accepted which may be related to the effective final drying inside the plant. In contrast, most samples of plant (B) exceeded the legal limit of moisture percent, <60%, which may be attributed to the inadequate short drying period. Nearly similar moisture percent in basterma of plant (A) was recorded [34]; in addition, other authors found nearly similar results in their investigation in samples of 1st and 2nd basterma plants, but slight higher moisture percent in 3rd basterma plant [28], which goes in parallel with our plant (B) results.

Nitrites are added to meat to delay rancidity, stabilize flavour, and establish the characteristic pink colour of cured meat as well as for its bacterial inhibitory effect especially on *Clostridium botulinum* [5, 40].

Sodium nitrite content in the final basterma product of plant (A) was within legal permissible limit (125/gm. [7]) which reflects the control of adding and mixing the salts during salting process. Vice versa in plant (B), most samples exceeding the legal permissible limit of sodium nitrite content which may be due to the improper and uncontrolled adding or mixing the preserver during salting process. This exceeded level in samples of plant (B) is very dangerous and constitute a major critical control point that should be monitored and strictly controlled. Because of the possibility of generating higher levels of nitrosamines, the most potent group of carcinogens, in addition people who regularly eat cured meats are more likely to have

symptoms of lung disease; the nitrite content of cured meat has been proposed to be behind the observations [40, 41].

In former times the quality assurance of food was based on the investigation of the finished product. Today the development of new concepts is intended to control the process in the whole production line by the analysis the hazard and the quality control parameters, by defining the quality and critical control points and taking corrective action to ensure that the non conformance does not occur again [3].

Conclusion and Recommendation

Our investigation posed that although application of quality assurance program during processing could improve the hygienic quality of produced basterma, some critical points and practices still need highlighting. The suitable applications and precaution procedures those clarified to be employed for plant (A) are; careful monitoring and recording of drying temperature as well as elongation of ripening period (one month at least before marketing) to ensure control of APC. Traditional technique for basterma production in plant (B) emphasized the need for application of a quality assurance program of a systemic control measures to ensure and verify the hygienic criteria along the production line. The recommended practices to be employed for plant (B) are; periodical training of workers, regular cleaning and disinfection program, defrosting of frozen raw meat in chilling room, careful measuring and mixing of sodium nitrite and perfect final drying in oven in addition to the above mentioned points for plant (A).

Finally, Hazard Analysis Critical Control Point (HACCP) system is the suitable precaution procedures and should be implemented during manufacture of basterma depending on the above determined critical points to produce safe and high quality product as well as ensuring compliance with legislation.

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الملخص العربى

تقييم الجودة الصحية للبسطرمة فى مصنعين فى محافظة الأسكندرية

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تم هذا التقييم أثناء التصنيع داخل مصنعين لأنتاج البسطرمة فى محافظة الإسكندرية حيث أن المصنع الأول يطبق برنامج توكيد الجودة والثانى ما زال يصنع بالطريقة التقليدية من خلال التحليل البكتريولوجى (العد الكلى للبكتيريا الهوائية ، عزل الميكروب العنقودى الذهبى وأيضا عزل ميكروب السالمونيلا) لعينات اللحم الخام المجمد، اللحم بعد التسييح والمنتج النهائى (بعدد 25 عينه من كل مرحلة من كلا المصنعيين) وأيضا التحليل الكيميائى (تقدير كمية الرطوبة و نيتريت الصوديوم) فى عينات المنتج النهائى بالأضافة الى المعاينة الحقلية لبيئة التصنيع داخل المصنعين.
أوضحت النتائج أن الجودة البكتيرية فى اللحم الخام المجمد متماثلة تقريبا فى المصنعين وهى فى الحدود المسموح بها أما فى اللحم بعد التسييح فكانت جيدة فى المصنع الأول لكن فى المصنع الثانى معظم العينات كان العد الكلى للبكتريا الهوائية عالى و40% منها ملوثه بالميكروب العنقودى الذهبى. و أوضحت نتائج التحليل البكتيرى والكيميائى لعينات المنتج النهائى فى المصنع الأول أنها فى الحدود المسموح بها عدا بعض العينات كان العد البكتيرى بها عالى بينما فى المصنع الثانى زادت معظم العينات عن الحدود المقبولة فى العد الكلى للبكتريا الهوائية ونسبة الرطوبة وكمية نيتريت الصوديوم بالأضافة الى عزل الميكروب العنقودى الذهبى فى 60% من العينات. وكانت جميع العينات خالية من ميكروب السالمونيلا.
نستطيع أن نستخلص من هذة الدراسة أن تطبيق برنامج توكيد الجودة قد رفع الجودة الصحية للبسطرمة المنتجة رغم وجود بعض النقاط ما تزال تحتاج الى مراقبة. هذا و قد نوقشت المعايير الموصى بها فى النظافة والأشتراطات الصحية و الممارسات الجيدة فى تصنيع البسطرمة لتطوير وتحسين الحالة الصحية فى المصنعين لانتاج منتج آمن وعالى الجودة وقد أفرزت لأمكانية تطبيقها.