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IMPACT OF MICROWAVE AND AUTOCLAVE DECONTAMINATION ON PASTRAMI QUALITY AND TRACKING CCPS

Rehab M. El-Mougy[1*]; A. M. El-Shawaf[1]; A. El-Makhzangy[1]; S. M. Abd-Elghany[2]

1. *Department of Food and Dairy Science, Faculty of Technology and Development, Zagazig University, Egypt.*
2. *Department of Food Hygiene and Control, Faculty of Veterinary Medicine, Mansoura University, Mansoura 35516, Egypt.*

[*]*All corresponding address to elmougy_2005@hotmail.com*

ABSTRACT

The goal of current research is determining the impact of ingredients decontamination using microwave and autoclave on pastrami final product, which finally leads us to track CCPs along the manufacture process to get final product of zero defects. The research focused on pastrami product as a famous widely used dry-cured meat product in the Egyptian market. The raw meat that used in pastrami production was purchased in three forms; fresh, frozen, and chilled meat from Egyptian market (local market in Mansoura city). The pastrami was manufactured in two groups; the first group was produced via microwave sterilization for 60 seconds of all non-meat ingredients with submission of wholesome circumstances, and the second group was fabricated through autoclave sterilization (120℃ for 15 min) of all constituents with application of sanitary conditions. The pastrami was examined along the manufacture process for total viable count (TVBC) and E. coli. The final product of each group was inspected for mold and yeast presence. Another group of pastrami was manufactured using frozen meat (imported from Brazil) only with applying three spices treatments. The first treatment was pastrami production without any spices addition. The second treatment was pastrami fabrication using spices which were purchased from local spices shops and subjected to autoclave sterilization (120℃ for 15 min). The third treatment was pastrami manufacture using high quality spices which were bought from reliable supplier and underwent to autoclave disinfection (120℃ for 15 min). The final product of each sample was checked for occurrence of aflatoxins. Sensory evaluation of the best product from microbiological aspect was carried out. The best-fabricated group from microbiological

aspect was the second autoclaved one. For pastrami group that was fabricated via three different spices treatments, the first treatment indicates that the raw meat itself contain a certain level of aflatoxin. The second treatment comprises very high unacceptable limit of aflatoxin. The third treatment (meat manufactured using high quality spices from reliable supplier) is the most compatible one with permissible aflatoxin limit in meat products (20 ppb). The sensory evaluation of autoclaved group revealed that the pastrami final product is wholly accepted except the pastrami produced using frozen raw meat had low rating for color and texture.

Key words: Pastrami, manufacture, dry curing, spices, decontamination, microwave, autoclave, meat, aflatoxins, CCPs.

INTRODUCTION

It was proven that meat-processing sector is an important fraction of overall economy advancement for any country. The meat-processing sector has the ability to produce variable meat products that participates in providing job opportunities and enhance manufacturers' income (Panghal *et al*., 2018). Therefore, we have to find the best methods to produce high quality meat products of zero defects in order to assist manufacturers and owners of meat-processing plants to produce high quality products.

The research adopted pastrami as one of unique dry-cured, non-thermally heated and fermented well-known and widely used meat products in Egypt and Middle East (Erdemir and Aksu, 2017). *Pastramă* is a Romanian word means keep or preserve. It may be originated from Latin word *pastor* denotes *shepherd's meat* of sheep. It is manufactured from whole muscles (*M. Longissimus dorsi*) of beef or buffalo (Daniela and Adrian 2015; Karabıyıklı *et al*., 2015).

Pastırma is originated from Turkish verb ''bastırma'' which means stress. The period of pastrami production takes about one month according to meat cuts size (Kilic, 2009). The pastrami final product is of high nutritional value contains about 30% protein, 45% moisture, 15% fat with serviceable shelf life more than 3 months (Aksu and Kaya, 2001).

Pastrami is defined in ESS (2005/1042) as dry-cured meat product treated by nitrite or nitrate salts, seasoned and coated with garlic and fenugreek (ESS, 2005/1042). The used additives in salting and curing of pastrami are so effective in pastrami quality. Table salt with nitrate or nitrite with some other chemicals and different type of spices are used in meat curing (Aksu *et al*., 2015).

Therefore, the research goal is to find the best method of sterilization along manufacture process of pastrami through studying the impact of microwave sterilization, and autoclave sanitation of used ingredients on final product microbiological quality, and aflatoxin contents. Hence, it became so easy to identify CCPs along the manufacture course.

MATEIALS AND METHODS

Materials

1) Meat Cuts:

The *longismus dorsi* muscle of beef was bought from Mansoura local market (frozen, fresh, and chilled). All meat cuts were handled under strict hygienic conditions using gloves, sterile knives, containers, and transmitted using icebox.

2) Table salt:

The table salt was purchased from local markets in Mansoura city from local Egyptian company.

3) Water:

The water used for meat washing in both microwaved and autoclaved group is sterilized water. Distilled water was used for laboratory tasks.

4) Spices:

The used spices were clove (*Syzygium aromaticum*), nutmeg (*myristica fragrans*), coriander (*Coriandrum sativum*), and black pepper (*Piper guineense*)]. They were purchased from Mansoura local spice shops. Another similar collection of spices was bought from reliable Egyptian company and subjected to HACCP measures in its production.

5) Sodium Nitrite:

The used sodium nitrite is food grade *E250* produced in Germany by *BASF Aktiengesellschaft Company* and imported to Egypt by the importer *AWA Company*. ESS/2005 recommended adding sodium nitrite by 100ppm/1kg meat.

6) Ascorbic Acid:

The used ascorbic acid was bought from *El-Gomhuoria Company for Trading Chemicals and Medical Appliances, Mansoura branch*. It was added by 550ppm/1kg meat (Robach and Sofos, 1982; Sullivan, 2011).

7) Sweeteners:

The used brown sugar was bought from local markets at Mansoura city. Molasses was purchased from El-Dakahlia Company for Sugar Production. The sweeteners are self-determining and there are no specific regulations to add them. They were added in accordance with modified recipe as mentioned below.

8) Rosemary extract:

The rosemary was bought from Mansoura local market and another quantity was bought from reliable supplier. The obtained rosemary leaves were washed with running tape water, dried by air in shade at room temperature for one week. The dried leaves were powdered. After that, 50 ml of ethanol was added to 5 gm of rosemary powder and mixed in a sterile flask. The flask was shaked, centrifuged and filtered (Bibi and Mahnoor, 2014).

9) Nutmeg extract:

The nutmeg was bought from local market of Mansoura city and another quantity was bought from reliable supplier. The ethanolic extract of nutmeg was prepared via the same protocol used for rosemary.

10) Sweet and hot pepper puree:

Sweet (*Capsicum annuum*) and hot pepper (*Capsicum baccatum*) were used in seasoning paste (çemen) applied on pastrami in the form of puree. The puree was prepared according to Sharoba (2009).

11) Garlic:

The fresh garlic (*Allium sativum L*.) cloves were bought from local market of Mansoura city, Dakalia governorate, Egypt. It was smashed and then acidified using 3% citric acid for 24 hrs (Barbara *et al*., 2014).

12) Fenugreek flour:

The fenugreek (*Trigonella foenum graecum*) seeds were obtained from local market at Mansoura city. The seeds were thoroughly washed and dried then the seed were roasted in an open pan at 130 ± 5^{0} C for 7 minutes. Then they crushed in Moulinex Odacio FP7361BM (Pandey and Awasthi, 2015). The resulted fenugreek flour was used in pastrami seasoning paste by 500 g/1 Kg meat according to Aksu *et al*. (2017).

13) Equipment:

Autoclave**,** Incubator, Grinder Moulinex Odacio FP7361BM, Stainless steel trays, Gauze, Needle, strengthen Cotton thread, suitable weight and plastic stretch filament.

Methods

1) ***Pastrami Recipe:***

The quantities used in pastrami recipe was carried out in accordance with Aksu *et al*. (2017) with some modifications.

Quantities of pastrami original recipe by Aksu *et al*. (2017)

Ingredients	Concentration /1000 gm meat
Table salt	50 gm
Sodium nitrite	0.1 gm
Fenugreek Powder	500 gm
Smashed garlic	350 gm
Powdered hot pepper	75 gm
Powdered paprika	75 gm
Water	1000 Ml

Applied modifications on used quantities:

One ounce of curing mixture per one pound of pork meat should be used for dry curing (Ray, 2004). In this experiment, such quantity of dry mixture was applied on used beef meat cuts with the same salt quantity used by Asku *et al*. (2017) with some modifications in recipe by adding spices made for giving flavour and antimicrobial impact. It means that we shall use 62.5 gm of curing mixture for 1 kg meat.

Modified composition of pastrami dry curing mixture according to authors:

Ingredients	Concentration /1000 gm meat
Table Salt	50
Sodium Nitrite	0.1
Ascorbic acid	0.4
Brown Sugar	2
Molasses	2
Coriander	2
Black pepper	2
Clove	2
Nutmeg	2

Modified composition of seasoning paste according to authors:

Ingredients	Concentration /1000 gm meat
Fenugreek flour	500 gm
Smashed garlic	350 gm
Sweet RP (puree)	50 gm
Hot RP (puree)	50 gm
Table salt	20 gm
Powdered clove	10 gm
Powdered coriander	10 gm
Powdered BP	10 gm
Rosemary EE	100 mL
Nutmeg EE	100 mL
Water	800 mL

EE: Ethanolic extract, RP: Red pepper, BP: Black pepper.

2) ***Pastrami manufacture:***

All steps were implemented according with Aksu *et al*. (2017) and Kaban (2013) as follows:

- **Meat Preparation:** via removal of excessive tendons, fat or connective tissues.
- **Dry Curing**: many cervices and holes were made in meat cuts to assist curing mixture accessing meat depth. The curing mixture was distributed to put on meat surface and penetrate incisions made in meat. Salted meats were kept at 6℃ for 48 hrs.
- **1st Drying**: Cured meats for pastrami were slightly washed and then dried at 15°C for 4 days.
- **1st Pressing**: cured and dried meat cuts were pressed using weight. Pressing was executed at 7-10°C for 17 hrs.
- **2nd Drying**: meat cuts were redried for 3-4 days in 20°C.
- **2nd Pressing**: it was performed at 25°C for 7 hrs.
- **Addition of Seasoning Paste (çemen)**: meat cuts were covered with slurry like seasoning paste (çemen) and kept at 7℃ for 4-5 days.
- **Final Drying**: After the addition of seasoning paste, meat cuts were finally dried at 20°C for 4-5 days.

The whole manufacture process is preferable to be carried out in late September to October and November as the relative humidity must be lower than 75% in drying and pressing chambers also fans must be utilized to improve air movement system in drying and pressing chambers (Asefa *et al*., 2011).

3) ***Manufactured groups of pastrami:***

The raw meat (fresh, frozen, and chilled) was manufactured in two groups as follows:

- **First Group** was prepared under full wholesome conditions. The spices, puree, extract, water, and fenugreek powder were sterilized using microwave P100 (with full power of microwave) for 60 seconds.
- **Second Group** was fabricated under complete sanitary conditions. The spices, puree, extract, water, and fenugreek powder were sterilized using autoclave at 120℃ for 15 min.

Specific Group manufactured (from frozen raw meat) with three treatments of spices:

- *1st* treatment: pastrami production without any spices addition.
- *2nd* treatment: pastrami fabrication using spices which were purchased from local spices shops and subjected to autoclave sterilization (120℃ for 15 min).
- *3rd* treatment: pastrami manufacture using spices which were bought from reliable supplier and underwent to autoclave disinfection (120℃ for 15 min).

4) ***Laboratory tests:***

A) ***Microbiological analysis:***

a. ***Total viable bacterial count (TVBC):***

The *TVBC* assessment was carried out pursuant to Hayes and Forsythe (2013) using nutrient agar plate count.

b. ***E. coli strain count:***

E.coli was determined in accordance with Aksu *et al*. (2008) using MacoConky agar media (pH 7.1 ± 0.2) (Oxoid).

c. ***Yeast and mould count:***

Yeast and mold were identified according to Ozturk (2015) using Dichloran Rose Bengal Chloramphenicol Agar (ISO) and Dichloran 18% (pH 5.6 ± 0.2 at 25℃).

B) Aflatoxin assessment in pastrami final product:

The final pastrami product was tested for presence of aflatoxins using Vicam AflaTest Fluorometer according to Abd-Elghany and Sallam (2015). The used device was VICAM4- 1107-103606.

C) Sensory analysis of pastrami final product:

The Pastrami final product were cut into slices (1.5 cm) used for sensory analysis. Some students of Food and Dairy Science Department were selected and asked to evaluate samples in terms of colour, odour, taste, texture and general acceptability parameters. The evaluation was completed using a hedonic-type scale (1-9 scales: 1: dislike extremely - 9: like extremely) (Ahmet *et al*., 2018).

D) ***Statistical analysis:***

The data collected were presented as mean standard deviation and were analyzed using COSTAT computer software program version 6.0 as one-way analysis of variance (Wright *et al*., 2005).

RESULTS AND DISCUSSION

1. *TVBC* and *E. coli* strains count:

In 1st group, the dry curing mixture is sterilized using microwave P100 for 60 seconds. The data presented in Table (1) and Fig. (1) indicates that there was a significant difference (P<0.05) in total viable count along the production stages of pastrami manufacture made of microwaved sterilized ingredients. The *TVBC* was slightly decreased after addition of dry curing mixture to be (5.51, 5.09, and 5.34 $Log_{10}CFUg_{-1}$) in fresh, frozen, and chilled samples respectively. The *TVBC* was fluctuated during drying and pressing stages due to temperature oscillation. This result is compatible with findings of Brodowska *et al*. (2014). They proposed that the method using electromagnetic waves of microwave is effective against vegetative forms of bacteria and fungi, but the endospore forms of *Bacillus* sp. and *Clostridium* sp. bacteria and mold spores show a high level of resistance. Brodowska *et al*. (2014) also reported that the use of microwaves causes insignificant decline in the microorganism count with synchronized huge losses of EOs and variations of their chemical components.

Table (1). *TVBC* ($Log_{10}CFUg^{-1}$) of pastrami product made of fresh, frozen, and chilled raw meat using microwaved ingredients.

Stage of Production	Fresh sample	Frozen sample	Chilled sample
Raw meat	6.2175^{a}	5.8925^{a}	6.065^{a}
After Dry Curing	5.51^{bcd}	5.09^{bc}	5.3475^{bc}
After 1st Drying	5.715^{bc}	5.35^{abc}	5.58^{bc}
After 1st Pressing	5.185^{d}	4.8525^{c}	5.085^{c}
After 2nd Drying	5.375^{cd}	5.2125^{abc}	$5.45b^{c}$
After 2nd Pressing	5.6675^{bc}	5.6^{ab}	5.5825^{bc}
After Addition of Seasoning Paste	5.855^{b}	5.7875^{ab}	5.73^{ab}
Final Drying	5.5275^{bcd}	5.37^{abc}	5.4525^{bc}
LSD 0.05	**0.2875**	**0.4739**	**0.3448**

Mean values within a column followed with different superscripts are significantly different (P< 0.05).

As well as, there was a significant difference (P<0.05) in *TVBC* after addition of seasoning paste to be (5.855, 5.7875, and 5.73 $Log_{10}CFUg^{-1}$) in

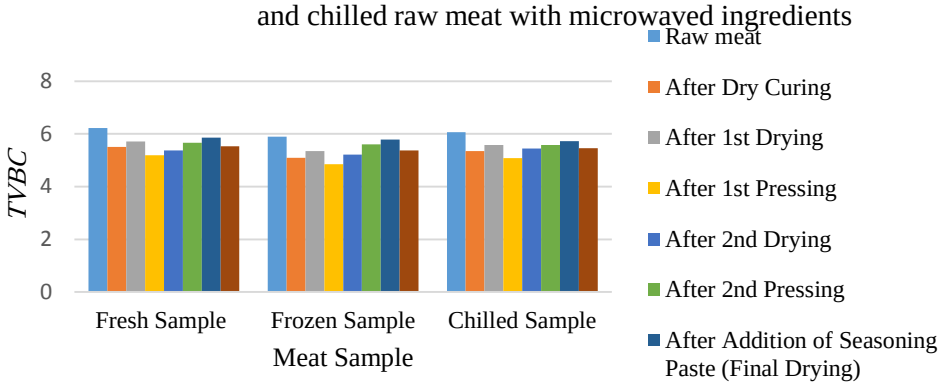


Figure (1). Variation of *TVBC (*$Log_{10}CFUg^{-1}$*)* along pastrami production steps in samples made of fresh, frozen, and chilled raw meat with microwaved ingredients

fresh, frozen, and chilled samples respectively which confirm the ineffectiveness of microwave utilization in spices and components decontamination. After final drying, there was a significant difference ($P<0.05$) in *TVBC* to be (5.5275, 5.37, 5.4525 and 5.73 $Log_{10}CFUg^{-1}$) in fresh, frozen, and chilled samples respectively. Hence, the *TVBC* was above the permissible limit in final product as it must not be more than 10^4 *Cell/gm* in ESS (2005).

In *E. coli* strains, Table (2) and Fig. (2) showed that there was a significant difference ($P<0.05$) in *E. coli* count in the manufactured samples as the *E. coli* count ($Log_{10}CFUg^{-1}$) was slightly decreased in each sample after addition of dry curing mixture to be (1.8125, 1.1575, and 1.375 $Log_{10}CFUg^{-1}$) in fresh, frozen, and chilled samples respectively. During the drying and pressing stages, the *E. coli* count was fluctuated according to temperature applied in each stage. The higher the temperature the greater the *E. coli* count. These findings are matched with what reported by Canumir *et al*. (2002). They reported that microwave treatment could reduce *E. coli* population by 2-4 log due to effect of heat. Hence, microwave is not sufficient to eliminate *E. coli* completely from spices especially if they had high count.

Therefore, insufficient decontaminated spices, *E. coli* count located originally in meat, and processing temperature participated in presence of *E. coli* along the stages of curing, drying, and pressing. These results are also partially compatible with what found by Ingham *et al*. (2006) that the Dry-curing and drying are potentially so essential pathogen-reduction steps because drying was implemented under different temperatures along with

Table (2). *E. coli* strains count ($Log_{10}CFUg^{-1}$) of pastrami product made of fresh, frozen, and chilled raw meat using microwaved ingredients.

Stage of Production	Fresh sample	Frozen sample	Chilled sample
Raw meat	1.8925^{a}	1.56^{a}	1.7675^{a}
After Dry Curing	1.8125^{a}	1.1575^{ab}	1.375^{ab}
After 1st Drying	1.79^{a}	0.775^{ab}	1.225^{ab}
After 1st Pressing	1.1975^{ab}	0.6875^{ab}	0.4975^{bc}
After 2nd Drying	0.4975^{bc}	0.5725^{ab}	0.5375^{bc}
After 2nd Pressing	0.4975^{bc}	0.6^{ab}	0.625^{bc}
After Addition of Seasoning Paste	ND	ND	ND
Final Drying	ND	ND	ND
LSD 0.05	**0.5817**	**0.7486**	**0.6729**

Mean values within a column followed with different superscripts are significantly different (P< 0.05), ND: not detected.

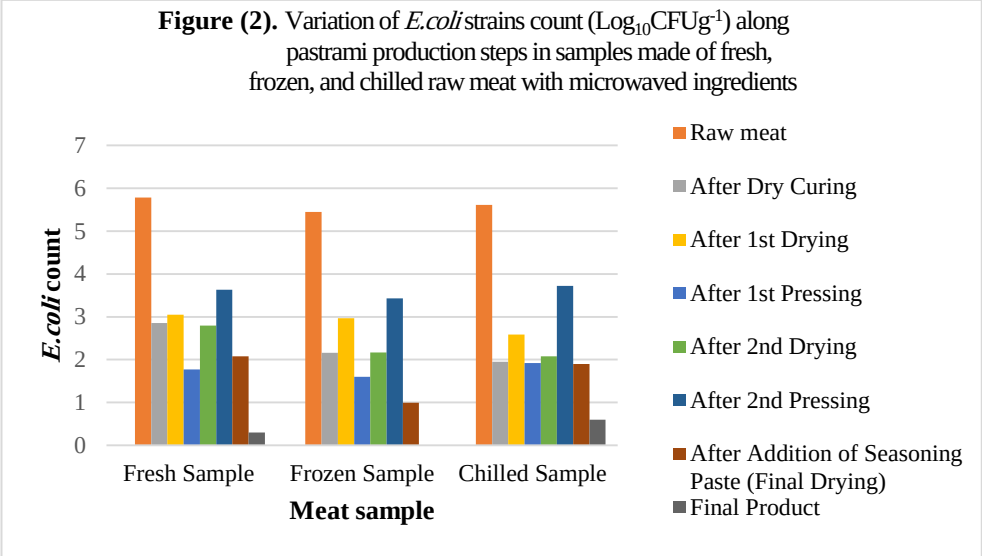


Figure (2). Variation of *E.coli* strains count ($Log_{10}CFUg^{-1}$) along pastrami production steps in samples made of fresh, frozen, and chilled raw meat with microwaved ingredients

insufficient decontaminated spices, which led to formulate an impact on the microbial count and *E.coli*. After addition of microwaved seasoning paste and applying final drying, there was a significant difference (P<0.05) in *E.coli* count as it was markedly decreased and disappeared in frozen sample. This may be attributed to preserving effect of seasoning paste as confirmed by (Yetim *et al*., 2006). The *E.coli* count is compatible with ESS (2005) as pastrami final product must be free from *E.coli* strains.

In 2nd group, The manufacture process is executed under complete sterilized conditions with spices and all other ingredients sterilization using autoclave at 120℃ for 15 minutes. The data presented in Table (3) and Fig. (3) indicates that there was a significant difference ($P<0.05$) in total viable count along the production stages of pastrami manufacture made of autoclave sterilized ingredients. The *TVBC* was significantly decreased after addition of autoclaved sterilized dry curing mixture then rinsed using sterilized water to be (2.855, 2.1575, and 1.95 $Log_{10}CFUg^{-1}$) in fresh, frozen, and chilled samples respectively. The addition of dry curing mixture containing Nacl and sodium nitrite as well as spices led to notable decrease in TVBC. This result is compatible with what reported by King *et al*. (2014). They reported that the Nacl can solubilize proteins, emulsify fats, control harmful bacteria causing spoilage besides the antimicrobial effect of spices which was proven by many scientists.

There was a significant difference ($P<0.05$) in total viable count after applying the drying and pressing stages. This was due to change in temperature in each stage. The higher the temperature the greater the *TVBC*. The notable difference was occurred after carrying out the second stage of pressing at 25℃ for 7 hrs as the *TVBC* was elevated due to temperature increse. This is partially compatible with what found by Ingham *et al*. (2006) that the Dry-curing and drying are potentially so essential pathogen-reduction steps because drying and pressing were implemented under different temperatures that led to formulate an impact on the microbial count. This assures that the drying and pressing temperature control must be taken into account as an essential prophylactic procedure to obtain safe pastrami.

After applying the sterilized seasoning paste using autoclave at low temperature 7℃ for 4-5 days, *TVBC* was decreased to be (2.075, 0.9975, 1.9 $Log_{10}CFUg^{-1}$) for fresh, frozen, and chilled samples respectively. After final drying at 20℃ for 4-5 days, the microbial count was declined to be (0.3, not detected, and 0.6 $Log_{10}CFUg^{-1}$) for fresh, frozen, and chilled samples respectively. This result is matched with what assured by Yetim *et al*. (2006). They found that the paste prepared from ground fenugreek, garlic and red hot pepper, which tested for inhibitory effect on *E.coli*, *S. aureus* and *Y. enterocolitica*, showed varying inhibitory effect against all tested bacteria. In addition, the complete seasoning paste are effective against microbes when compared with only one component. This assures the exactitude and correctness of spices, plant extract, and hot and sweet pepper puree in the presented modified recipe of seasoning paste.

Table (3). *TVBC* ($Log_{10}CFUg^{-1}$) of pastrami product made of fresh, frozen, and chilled raw meat using autoclaved ingredients.

Stage of Production	Fresh sample	Frozen sample	Chilled sample
Raw meat	5.7825^{a}	5.45^{a}	5.61^{a}
After Dry Curing	2.855^{bc}	2.1575^{bc}	1.95^{bc}
After 1st Drying	3.0475^{bc}	2.97^{b}	2.5825^{bc}
After 1st Pressing	1.775^{c}	1.6^{bcd}	1.9225^{bc}
After 2nd Drying	$2.795b^{c}$	$2.17b^{c}$	2.0775^{bc}
After 2nd Pressing	3.6325^{b}	3.4275^{b}	3.72^{b}
After Addition of Seasoning Paste	2.075^{c}	0.9975^{cd}	$1.9b^{c}$
Final Drying	0.3d	ND	0.6^{c}
LSD 0.05	**0.9631**	**1.3817**	**1.4520**

Mean values within a column followed with different superscripts are significantly different (P< 0.05), ND: not detected.

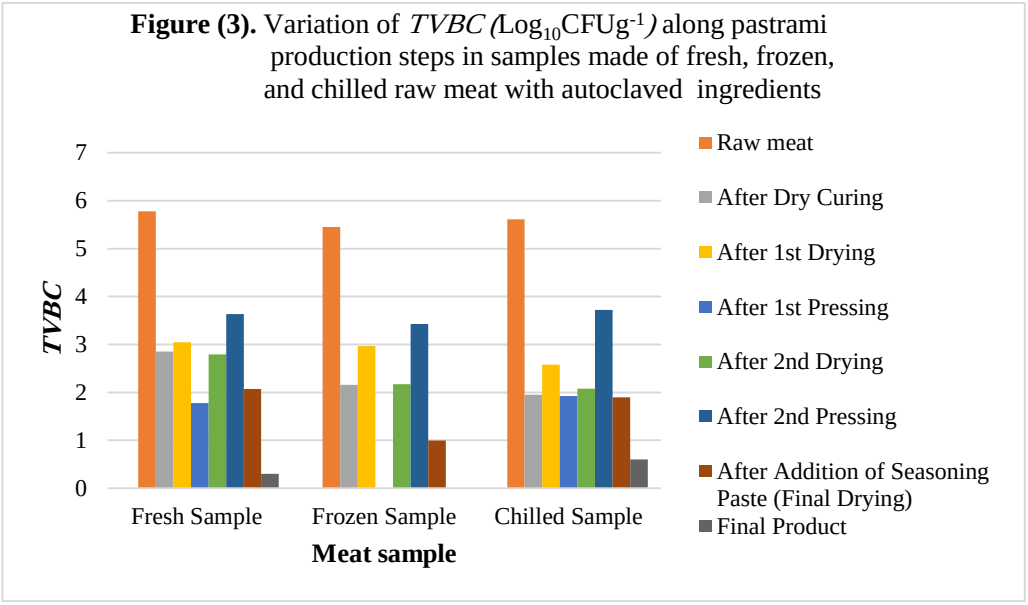


Figure (3). Variation of *TVBC (*$Log_{10}CFUg^{-1}$*)* along pastrami production steps in samples made of fresh, frozen, and chilled raw meat with autoclaved ingredients

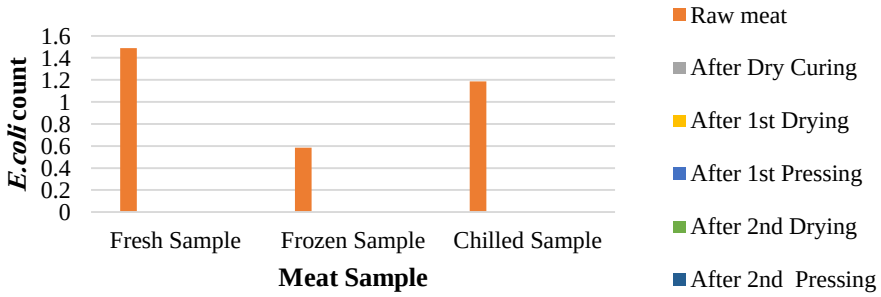
The data presented in Table (4) and Fig. (4) showed the *E. coli* strain count which is being undetectable after addition of dry curing mixture and during drying and pressing stages as it was confirmed with what reviewed by (Kaban, 2013) that the *enterobacteriaceae* do not stay alive during pastrami processing. The *E. coli* count is compatible with ESS (2005) as pastrami final product must be free from *E. coli* strains.

Table (4). *E.coli* strains count ($Log_{10}CFUg^{-1}$) of pastrami product made of fresh, frozen, and chilled raw meat using autoclaved ingredients.

Stage of Production	Fresh sample	Frozen sample	Chilled sample
Raw meat	1.4875^{a}	0.585^{a}	1.185^{a}
After Dry Curing	ND	ND	ND
After 1st Drying	ND	ND	ND
After 1st Pressing	ND	ND	ND
After 2nd Drying	ND	ND	ND
After 2nd Pressing	ND	ND	ND
After Addition of Seasoning Paste	ND	ND	ND
Final Drying	ND	ND	ND
LSD 0.05	**0.2548**	**0.3606**	**0.2143**

Mean values within a column followed with different superscripts are significantly different (P< 0.05), ND: not detected.

Figure (4). Variation of *E.coli* strains count ($Log_{10}CFUg^{-1}$) along pastrami production steps in samples made of fresh, frozen, and chilled raw meat with autoclaved ingredients



2. Yeast and mold count:

Yeast and mould count was calculated in final product in both microwaved and autoclaved groups. Data presented in Table (5) showed that there was a significant difference (P<0.05) in yeast count in autoclaved and microwaved manufactured pastrami groups. The yeast count of fresh final product was 1.4575 and 0.15 $Log_{10}CFUg^{-1}$ in microwaved and autoclaved groups respectively. The yeast count of frozen final product was 1.5125 $Log_{10}CFUg^{-1}$ in microwaved final product and not detected in autoclaved final product. The yeast count of chilled final product was 1.785 $Log_{10}CFUg^{-1}$ in microwaved final product and not detected in autoclaved final product. The best final product is autoclaved one as microwave

Table (5).. Yeast and mould count ($Log_{10}CFUg^{-1}$) of pastrami final product made of fresh, frozen, and chilled raw meat with microwaved and autoclaved ingredients

Final Product	Fresh sample		Frozen sample		Chilled sample	
	Y	M	Y	M	Y	M
Pastrami FP with microwaved ingredients	1.4575[a]	ND	1.5125[a]	ND	1.785[a]	ND
Pastrami FP with autoclaved ingredients	0.15[b]	ND	ND	ND	ND	ND
LSD 0.05	**0.4486**	**-**	**0.3684**	**-**	**0.3957**	**-**

Mean values within a column followed with different superscripts are significantly different (P< 0.05), ND: Not detected, FP: Final product, Y: Yeast, M: Mould.

decontamination is less effective as previously discussed. Both microwaved and autoclaved final products are free from mould. This result is generally compatible with what reviewed by Kaban, (2013) that it was determined that yeast and mould counts are decreased during coating and final drying as it was reported that garlic which comprise 35% of seasoning paste has anti-moulding effect.

3. Aflatoxin estimation:

Another group of pastrami was manufactured under complete sanitation using frozen meat imported from Brazil and divided into three treatments tested for presence of aflatoxins. The data presented in Table (6) illustrated that there was a significant difference (P<0.05) in aflatoxin level between the submitted three treatments.

The first treatment that produced without any spices showed low level of aflatoxins (8.5 ppb) which indicates that the raw meat imported from brazil itself contains a certain level of aflatoxin. The second treatment, which manufactured using unbridled spices bought from spice shops and decontaminated using autoclave at 120℃ for 15 min showed high unacceptable limit of aflatoxin (41ppb) more than the acceptable limit which established by FDA (2000) to be 20ppb. Hence, it was found that the spices in second treatment participated in aflatoxin increase in pastrami final product by 32.5ppb. This result indicates that the unbridled spices that purchased from ordinary spice shops contains aflatoxin that did not destructed by autoclaving. This is agreeable to what illustrated by Wannasawat and Vichai (2018). They illustrated that the aflatoxins need treatment by ultra-super steam 300-400℃ for 10 to 80 seconds to be significantly decreased. The third treatment bought from hypermarket (spices were subjected to HACCP system application) and autoclaved. The

Table (6). Aflatoxin Estimation (*ppb*) in pastrami final product made of three treatments of spices.

Pastrami final product	**Aflatoxins**	**Aflatoxin Increase due to spices addition**
Treatment without any spices	8.5^{c}	-
Treatment using ordinary spices from spice shops	41^{a}	32.5
Treatment using spices subjected to HACCP	15.75^{b}	7.25
LSD 0.05	**3.004**	-

Mean values within a column followed with different superscripts are significantly different (P< 0.05).

sample showed low level of aflatoxins (15.75ppb) that is acceptable by permissible limits. The spices in third treatment participated in aflatoxin increase in pastrami final product by 7.25ppb.

This is generally agreeable with what found by Refai *et al*. (2003) as they found that aflatoxins were detected in spices paste used in Egyptian pastrami within high levels ranged from 9.6 to 120 µgm/kg. This assures the importance of tracking the source of utilized ingredients especially spices entered the industrial process to guarantee safe final product of pastrami.

4. ***Sensory evaluation*:**

The final product of autoclaved group was inspected for colour, taste, odour, texture, and overall acceptability through hedonic scale (1-9 scales: 1: dislike extremely - 9: like extremely). The data presented in **Table (7)** revealed that there was no significant difference (P<0.05) for taste, odour, and overall acceptability in all pastrami samples made of fresh, frozen, and chilled raw meat. Data revealed that there was a significant difference (P<0.05) in colour and texture between three final products. The lowest one was frozen sample (7.9 for texture and 7.3 for colour). This result is attributed to drip loss during thawing process and agreeable to what found by Zhao *et al*. (1998). They reported that the colour of beef meat were affected by method of thawing and it is preferable to use high hydrostatic pressure at 210 MPa (which takes about 25-30 min) to avoid high drip loss and meat discoloration. This method is a preferable method of meat thawing than conventional thawing (atmospheric pressure at 3°C) according to Zhao *et al*. (1998).

Table (7). Sensory Evaluation of pastrami final product made of fresh, frozen, and chilled raw meat with autoclaved ingredients.

Sample	Taste	Odor	Texture	Color	Overall acceptability
Fresh	8.2[a]	8.4[a]	8.7[a]	9[a]	8.5[a]
Frozen	8.2[a]	7.9[a]	7.9[b]	7.3[b]	7.8[a]
Chilled	8.6[a]	8.2[a]	8.8[a]	8.3[a]	8.4[a]
LSD 0.05	**0.6974**	**0.7259**	**0.5749**	**0.7936**	**0.6243**

Mean values within a column followed with different superscripts are significantly different (P< 0.05).

It was revealed that autoclave sterilization is more efficient than microwave. This impact was so clear in pastrami final product from microbiological aspect. Moreover, spices was a hazardous source of aflatoxins and this was oblivious when pastrami final product tested for aflatoxins also meat contained a certain level of aflatoxin, which participated in final product aflatoxin content elevation. The pastrami final product in all samples was acceptable in terms of taste, odour, and overall acceptability. The pastrami final product made of frozen raw meat had lower evaluation in terms of colour and texture. This paper concluded that it is importance to decontaminate spices in meat industry as well as spices source tracking to get spices from reliable suppliers and of high quality subjected to quality programs. Figure (4) showed the flow chart of Egyptian pastrami production as well as detection of hazard type and necessity of applying prerequisite program including sanitation and personal hygiene in each step to control hazards.

CONCLUSION

It was clear that the ingredients addition in meat processing is an prominent source of contamination that heavily affect the final product. Therefore, it is recommended to select high quality ingredients with following-up personal hygiene and complete sanitary conditions. It is so important to track origins of materials and ingredients used during production process especially spices. This helps us controlling the microbial load and aflatoxin contents. To get antibacterial, antioxidant, and antifungal benefits from spices, spices must be subjected to HACCP measures in their production and recommended to be autoclaved at 120 for 15 minutes. Hence, spices addition is considered an essential CCP in pastrami manufacture. In pastrami manufacture as above mentioned, the higher the temperature during drying and pressing stages, the greater the bacterial count. Therefore, it is advisable to adjust temperature lower than 20°C to

avoid bacterial count raising. In addition, it is advisable to add spices, plant extracts, and hot and sweet pepper puree in our modified recipe of seasoning paste to assist in *TVBC* lowering during pastrami production.

Finally, It was revealed that the commitment to apply decontamination process for all ingredients, components, tools, and equipment as well as the guarantee to stratify staff aseptic terms and tracking the sources of used materials in manufacturing process are so essential matters to obtain high quality pastrami. This will lead us to follow-up the CCPs along the production course. Figure (5) showed the flow chart of dry-cured Egyptian pastrami.

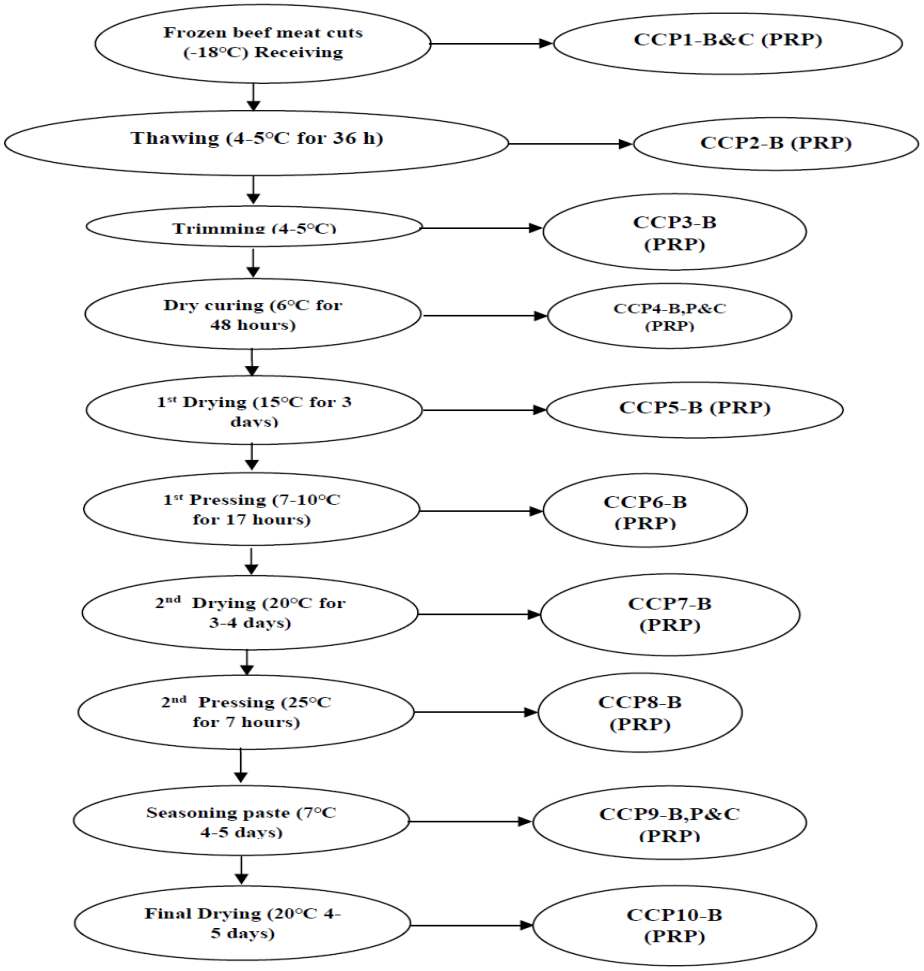


Figure (4). Flow Chart of Dry Cured Egyptian Pastrami
B: biological hazard, P: physical hazard, C: chemical hazard, PRP: prerequisite program

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تأثير التعقيم باستخدام المايكرويف والأوتوكلاف على جودة البسطرمة وتتبُّع نقاط التحكُّم الحرجة

رحاب محمد الموجي[١] – عبدالجواد محمد الشوَّاف[١] – عطيه محمد المخزنجي[١] – سمير عبدالغني عبدالله[٢]

١. قسم علوم الأغذية والألبان – كلية التكنولوجيا والتنمية – جامعة الزقازيق – جمهورية مصر العربية.

٢. قسم الرقابة على الأغذية – كلية الطب البيطري – جامعة المنصورة - جمهورية مصر العربية.

سعت هذه الدراسة إلى تحديد تأثير إزالة التلوث من المكونات الداخلة في تصنيع مُنتَج البسطرمة باستخدام المايكرويف والأوتوكلاف وتأثير هذا الأمر على المُنتَج النهائي للبسطرمة من الناحية الميكروبيولوجية ومحتوى المُنتَج النهائي من الأفلاتوكسينات الأمر الذي يقودنا في نهاية المطاف إلى تتبع نقاط التحكُّم الحرجة على طول العمليَّة التصنيعيَّة. ركَّز البحث على مُنتج البسطرمة كمُنتَج شهير يستخدم على نطاق واسع في مصر. صُنِّع مُنتَج البسطرمة (من اللحم الطازج والمُجمَّد والمُبرَّد) بإجراء بعض التعديل على وصفة التصنيع الأصلية والتعقيم للمكوِّنَات باستخدام المايكرويف لمدة ٦٠ ثانية والأوتوكلاف عند ١٢٠ درجة مئوية لمدة ١٥ دقيقة، وقد كانت العينات المُعقَّمة باستخدام الأوتوكلاف أفضل من الناحية الميكروبيولوجية مع ملاحظة انخفاض العدد الميكروبي بعد إضافة خليط التمليح وتذبذُبه في مراحل التجفيف والضغط ثم يعود العدد إلى الانخفاض بعد إضافة معجون التوابل وخطوة التجفيف النهائي، ويرجع ذلك كله إلى الاختلاف في درجات الحرارة والرطوبة بين الخطوات التصنيعية. صُنِّعت ثلاثة عينات أخرى من البسطرمة باستخدام لحم مُجمد مستورد من البرازيل بثلاث معاملات من التوابل. كان مُعدَّل الأفلاتوكسينات في المعاملة الأولى 8.5ppb وهذا يعني أن اللحم ذاته يحتوي على نسبة من الأفلاتوكسينات، أما المُعاملة

الثانية فكانت تحتوي على نسبة عالية جدًا (41ppb) مما يعني أن إضافة التوابل المُشتراه من السوق المحلي لمدينة المنصورة من محلات العطارة والتي تم تعقيمها بالأوتوكلاف ساهم بزيادة نسبة الأفلاتوكسينات في البسطرمة بمقدار 32.5ppb وهي نسبة كبيرة (أعلى من النسب المسموح بها وهي 20ppb) وهو ما يؤكد عدم فاعلية التعقيم بالأوتوكلاف في القضاء على الأفلاتوكسينات. أما المُعاملة الثالثة فقد كان محتواها من الأفلاتوكسينات (15.75ppb) أي أن إضافة التوابل عالية الجودة والتي خضعت لبرنامج الهاسب في إنتاجها ساهم في زيادة محتوى المُنتج النهائي من الأفلاتوكسينات بمقدار 7.25ppb والنسبة عمومًا في المُنتَج النهائي متوافقة مع النسب المسموح بها عالميًا وهي 20ppb. أُجريت الاختبارات الحسية على مُنتَج البسطرمة النهائي (المُصنَّع من اللحم الطازج والمُجمَّد والمُبرَّد) المعقمة مكوناته بالأوتوكلاف وأوضحت النتيجة أن العينات جميعها مقبولة إلى حد كبير من حيث المذاق والرائحة والقبول العام إلا أن العينات المصنوعة من اللحم المُجمَّد كانت أقل تقييمًا من حيث اللون والملمس ويُعزى هذا التدني في التقييم إلى زيادة كمية السائل المتقطِّر من اللحم نتيجة عملية فك التجميد. ويتضح أنه من الضروري للغاية تتبع مصادر المكونات والمواد المستخدمة أثناء عملية الإنتاج وبخاصة التوابل فينبغي أن تكون عالية الجودة ومن مورِّد على درجة عالية من الموثوقيَّة وخضعت لبرنامج الهاسب أثناء إنتاجها ونقلها وتوزيعها لضمان عدم نقل التلوث إلى المُنتجات المُصنَّعة ولجني الفوائد من خصائصها المُضادة للبكتريا والفطريات والأكسدة. لذا فإضافة التوابل تعتبر نقطة تحكُّم حرجة خلال إنتاج البسطرمة، كما تمثِّل درجة الحرارة والرطوبة خلال كل مرحلة من مراحل التصنيع من نقاط التحكُّم الحرجة لأنها أدت إلى تذبذُب العدد البكتيري لذا يُنصَح بضبط درجات الحرارة خصوصًا خلال مراحل التجفيف والضغط بحيث لا تتجاوز ٢٠ درجة مئويَّة. كما يوصي بتجنب إطالة مدة فك تجميد اللحم المُجمَّد لتجنب زيادة الفقد في كمية السائل المتقطِّر من اللحم نتيجة عملية فك التجميد الأمر الذي أدى إلى تدني تقييم البسطرمة من حيث اللون والملمس.

التوصية : يوصى عمومًا باتباع التعديل الذي أُجري على وصفة التصنيع من حيث إضافة التوابل عالية الجودة، والمُستخلصات الإيثانولية النباتية لإكليل الجبل وجوزة الطيب، وهريسة الفلفل الحار والحلو الأمر الذي يساعد كثيرًا في خفض العد البكتيري أثناء مراحل التصنيع وإعطاء مُنتَج نهائي على درجة عالية من الناحية الميكروبيولوجيَّة.

الكلمات المساعدة: البسطرمة – التوابل – التعقيم بالأتوكلاف – المعاملة بالميكروييف – الخصائص الحسية – الحمل الميكروبي.