The Effect of Cutting Boards on the Hygienic Quality of Meat

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ABSTRACT

A total of twenty beef meat samples were purchased from meat shops in different localities in Zagazig city for isolation and counting of Enterobacteriacae, Coliform and *Staph aureus* in the examined meats before cutting, after cutting on untreated cutting boards, after cutting on boards treated with acetic acid 1% and after cutting on boards treated with citric acid 1%. Furthermore, the mentioned microorganisms were isolated and counted on the untreated cutting boards, on the boards treated with 1% acetic acid and on the boards treated with 1% citric acid after meat cut. The obtained results revealed that the examined microorganisms were significantly reduced on the boards treated with acetic or citric acids rather than untreated boards and this effect reflected on the bacterial counts of the examined meat. Thus the using of diluted acetic and citric acids on the meat cutting boards is recommended.

INTRODUCTION

We need to eat enough animal protein daily to support growth and maintenance of tissues, and to replace proteins that are broken down by the body *(1)*. Furthermore, red meat is a rich source of well absorbed iron and considerable levels of selenium, potassium, phosphorus and magnesium, also; it rich of vitamins specially B vitamins including vitamin B_{12} *(2)*.

It should be kept in mind that the inner parts of healthy animal tissues are nearly sterile and that is theoretically possible but this objective become impractical when mass production and other economic considerations are realized. So, all foods should be expected to contain certain number of microorganisms of one type or another ideally the numbers of organisms should be low as possible under good conditions and excessively high numbers of microorganisms in fresh foods present cause of alarm *(3)*. In recent years, there has been world wide renew interest in meat hygiene. Outbreaks of food borne illness associated with bacterial agents are reported every year *(4)*. Many of these illnesses are due to growth of pathogens and/ or toxin formation. A list of important recognized pathogens of red meat included enterobactericae, coliforms and *staph aureus* bacteria.

The meat contact surfaces are the main source of the microbiological contamination of red meat. The meat cutting boards are one of the most important sources of these contaminations because these boards are suffered from continues contaminations with blood and meat remnants; thus; these boards are the good media for bacterial growth, and play a role in cross contamination of infection in kitchen *(5)*.

Hence, the present investigation was planned for studying the relationship between the bacterial contamination of cutting boards and those of the meat, and the effect of some organic acids (acetic and citric acids) for improvement of the hygienic state of both examined red meat and cutting boards.

MATERIAL AND METHODS

Collection of the meat samples

A total of 20 beef meat samples were purchased from meat shops in different localities in Zagazig city. The samples (2 kg. for each) were individually packed in aseptic polyethylene bags and maintained in ice box during transport to the laboratory with a minimum of delay.

Experimental Design

- Ten plastic cutting boards (30 X 20 cm.) were used in the current investigation.

- Ten gm from each of the collected meat samples were taken and prepared for the microbiological examination as will be described.
- Exactly 500 gm from each meat samples were taken and cut by sharp knife to thin slices on a clean board (washed by tap water only and dried), then; 10 gm. from meat slices were taken for microbiological examination. After complete the cutting process, a limited area (100 cm^2) from the surface of the board which meat was prepared was swabbed using the recommended method *(6)*.
- Another 500 gm from each meat samples were taken and cut as described previously on a clean board which washed by tap water and dried and then treated by acetic acid 1%. Samples from meat slices and board were taken as described previously.
- Another 500 gm from each meat samples were taken and cut as described on a clean board which washed by tap water and dried and then treated by citric acid 1%. Samples from meat slices and board were taken as described previously.
- After the end of the cutting process, the used cutting board was extremely washed several times by warm water and soap before reusing.

Preparation of meat samples

Ten gm of each meat sample which taken as mentioned above was transferred into a sterile polyethylene bag to which 90 ml of 0.1% sterile buffered peptone water (oxoid CM9) was aseptically added to provide a dilution of 1/10, then the content was blended for not more than 2.5 minutes using blender at high speed not less than 2000 r.p.m. Then the mixture was allowed to stand for 15 minutes at room temperature. The contents of the jar were mixed by shaking before applying the following technique. One ml from the original suspension (10^{-1}) was transferred aseptically with a sterile pipette into a sterile test tube containing 9 ml of sterile peptone water 0.1% (Oxoid CM9) to obtain a dilution of 10^{-2}, from which further 10 fold decimal dilution were prepared up to suitable countable dilution *(7)*.

Preparation of swabs used on the cutting boards

After a limited area (100 cm^2) of the examined cutting board was swabbed, the swab was first dipped into a screw capped bottle containing 100 ml of 0.1% sterile buffered peptone water (Oxoid CM9) and well rubbed over the appropriate area of the surface to be examined. A second but dry swab was also rubbed over the same area to collect the residual moisture. Both swabs were dropped into the bottle of peptone water and the wooden sticks being stropped off *(6)*.

Enumeration and isolation procedures

Enterobactericae count was conducted *(8)*, Coliform was counted as recommended *(9)*, while; the *staph aureus* count was carried out using surface plating technique *(10)*.

Statistical analysis

The statistical analysis was carried out *(11)*.

RESULTS AND DISCUSSION

Table 1. Statistical analysis results of Enterobactericeae (count/gm) of the examined raw meat samples (n = 20).

Sample	Min.	Max.	Mean ±S.E.
Meat before cutting	1.3×10^2	8.5×10^4	$1.5X10^4 \pm 5.8X10^{3a}$
Meat slices on board without treatment	$1.5X\ 10^2$	$5X10^4$	$1.1X10^4 \pm 3.5X10^{3ab}$
Meat slices on board treated with 1% acetic acid	1×10^2	$3.7\ X10^4$	$2.9X10^3 \pm 1.8X10^{3b}$
Meat slices on board treated with 1% citric acid	1.2×10^2	4.5×10^4	$4.2X10^3 \pm 2.1X10^{3b}$

N.B.: Different litters mean a significant variation between the levels of the examined microorganisms ($p \leq 0.01$).

Table 2. Statistical analysis results of Coliform (count/gm) of the examined raw meat samples (n = 20).

Sample	Min.	Max.	Mean ±S.E.
Meat before cutting	1.3×10^2	2.8×10^4	$3.6X10^3 \pm 1.4X10^{3ab}$
Meat slices on board without treatment	$1.7X\ 10^2$	$3.3X10^4$	$5.6 \times 10^3 \pm 1.8X10^{3a}$
Meat slices on board treated with 1% acetic acid	1.1×10^2	$6.5\ X10^3$	$1.5\ X10^3 \pm 4.6\ X10^{2b}$
Meat slices on board treated with 1% citric acid	1.5×10^2	8.4×10^3	$2X10^3 \pm 6.4X10^{2ab}$

N.B.: Different litters mean a significant variation between the levels of the examined microorganisms ($p \leq 0.01$).

Table 3. Statistical analysis results of *Staph aureus* (count/gm) of the examined raw meat samples (n = 20).

Sample	Min.	Max.	Mean ±S.E.
Meat before cutting	1.8×10^2	6.6×10^5	$4.3X10^4 \pm 3.2X10^{4a}$*
Meat slices on board without treatment	$1.9X\ 10^3$	$2.3X10^5$	$2.8 \times 10^4 \pm 1.2X10^{4\ a}$
Meat slices on board treated with 1% acetic acid	1.3×10^2	$1.6\ X10^4$	$2.7\ X10^3 \pm 9\ X10^{2\ a}$
Meat slices on board treated with 1% citric acid	5.5×10^2	5.7×10^4	$7.1X10^3 \pm 2.7X10^{3\ a}$

*: Non significant variations were detected within the obtained mean bacterial counts.

In the present investigation, the count of Enterobactericae, Coliform, and *Staph aureus* were estimated in the examined red meat before cutting, after cutting on a clean board (without treatment), after cutting on a board treated with acetic acid 1% and after cutting on a board treated with citric acid 1%. Moreover, the mentioned microorganisms were counted

on the surface of the cutting boards after using as described previously.

The obtained results revealed that the mean count of enterobactericae (Table 1) were $1.5X10^4$ $\pm5.8X10^3$, $1.1X10^4$ $\pm3.5X10^3$, $2.9X10^3$ $\pm1.8X10^3$ and $4.2X10^3$ $\pm2.1X10^3$ per gm in the examined red meat before cutting, after cutting on clean (untreated board), after cutting on board treated with acetic acid 1% and after cutting on board treated with citric acid 1%. These finding are similar with those recorded in red meat in Egypt ***(12-14)*** and in Australia ***(15).*** On contrary, higher enterobactericae levels than our findings were reported in red meat in Egypt ***(16).***

Table 2 showed that the mean count of coliform in the examined raw meat before cutting, after cutting on clean (untreated board), after cutting on board treated with acetic acid 1% and after cutting on board treated with citric acid 1% were $3.6X10^3$. $\pm1.4X10^3$, $5.6 X 10^3$ $\pm1.8X10^3$, $1.5 X10^3$ $\pm4.6 X10^2$ and $2X10^3$ $\pm6.4X10^2$ per gm These findings were coincided with those obtained in frozen meat in Luxor city, Egypt ***(14).*** On the other hand, our figures were lower than those previously obtained in Egypt in both canned beef ***(17)*** and in red meat ***(16).*** On contrast, another Egyptian studies ***(12,18)*** and an American study ***(19)*** recorded lower coliform levels than those in the present investigation.

Table 3 detected that the mean values of the *staph aureus* were $4.3X10^4$ $\pm3.2X10^4$, $2.8 X 10^4$ $\pm1.2X10^4$, $2.7 X10^3$ $\pm9 X10^2$ and $7.1X10^3$ $\pm2.7X10^3$ per gm in the examined raw meat before cutting, after cutting on clean (untreated board), after cutting on board treated with acetic acid 1% and after cutting on board treated with citric acid 1% respectively. These results are consistent with those reported by Egyptian investigators on canned beef ***(17)*** and red meat ***(13),*** while; some Egyptian studies estimated *Staph aureus* in levels below than our figures ***(16,20)*** in raw meat and meat products respectively. Furthermore; another local study could not be detected this bacteria in the examined red meat ***(18).***

Regarding the effects of the cutting board treatments with acetic and citric acids (1% for each) on the examined bacterial counts of the meat, the statistical analysis showed that the count of enterobactericae in meat before cutting were significantly higher than those cut on the boards treated with either acetic or citric acids 1%, while; there were no significant variance between enterobactericae counts in the examined meat cut on untreated boards with those in the other three types of the examined meats. On the other aspect, the coliform count in the meat samples cut on boards treated with acetic acid 1% was significantly lower than those cut on untreated boards, meanwhile; no significant difference between coliform count in meat cut on boards treated with citric acid 1% and those in another three kinds the of examined meat. On the other hand, the statistical analysis showed no significant variance between *staph aureus* counts in the different examined meat samples in the current study.

Table 4. Statistical analysis results of Enterobacteraceae (count/cm^2) on the examined cutting boards (n = 20).

Sample	Min.	Max.	Mean ±S.E.
Cutting boards without treatment	$2.2 X 10^2$	$5.5 X 10^4$	$5.6X10^3$ $\pm2.7X10^{3a}$
Cutting boards treated with 1% acetic acid	1.1X 10	$5.5X10^2$	$1 X10^2$ $\pm0.3X10^{2b}$
Cutting boards treated with 1% citric acid	1 X 10	$6.5 X10^2$	$2.4X10^2$ $\pm0.5X10^{2b}$

N.B.: Different litters mean a significant variation between the levels of the examined microorganisms ($p \leq 0.01$).

Table 5. Statistical analysis results of Coliform (count/cm^2) on the examined cutting boards (n = 20).

Sample	Min.	Max.	Mean ±S.E.
Cutting boards without treatment	2.3 X 10^2	8.2 X 10^4	1.5X10^4 ±6.1X10^{3a}
Cutting boards treated with 1% acetic acid	1.1X 10	8.8 X10^2	3.2 X10^2 ±7.9X10^b
Cutting boards treated with 1% citric acid	2.6 X 10	8.6 X10^3	1.1X10^3 ±5.2X10^{2b}

N.B.: Different litters mean a significant variation between the levels of the examined microorganisms ($p \leq 0.01$).

Table 6. Statistical analysis results of *Staph aureus* (count/cm^2)on the examined cutting boards (n = 20).

Sample	Min.	Max.	Mean ±S.E.
Cutting boards without treatment	0.0	6.4 X 10^3	1.6X10^3 ±4.9X10^{2a}
Cutting boards treated with 1% acetic acid	0.0	5.5 X10^2	1.5 X10^2 ±0.5X10^{2b}
Cutting boards treated with 1% citric acid	0.0	1.2 X10^3	3.8X10^2 ±1X10^{2b}

N.B.: Different litters mean a significant variation between the levels of the examined microorganisms ($p \leq 0.01$).

Concerning the bacterial counts on the examined cutting boards, Table 4 showed that the mean counts of enterobactericae were 5.6X10^3 ±2.7X10^3, 1 X10^2 ±0.3X10^2 and 2.4X10^2 ±0.5X10^2 per cm^2 on untreated cutting boards, treated cutting boards with acetic acid 1% and on cutting boards treated with citric acid 1% respectively. The enterobactericae counts on untreated boards were nearly similar to those obtained on plates in an Egyptian study *(13),* while; another local study reported an enterobactericae count similar to our estimations in treated boards with acids *(21).*

Table 5 detected that the mean count of coliform in untreated cutting boards, treated cutting boards with acetic acid 1% and cutting boards treated with citric acid 1% were 1.5X10^4 ±6.1X10^3, 3.2 X10^2 ±7.9X10^2, 1.1X10^3 ±5.2X10^2 per cm^2 respectively. Local study estimated coliform levels within the range obtained in the current investigation *(13).* On the other aspect, our estimations were obviously lower than those previously obtained (6.6 X10^6) *(22),* on contrast; coliform were found in very lower levels compared with our figures in another study *(23).*

Table 6 revealed that the mean *Staph aureus* counts on the examined untreated cutting boards, treated cutting boards with acetic acid 1% and on cutting boards treated with citric acid 1% were 1.6X10^3 ±4.9X10^2, 1.5 X10^2 ±0.5X10^2 and 3.8X10^2 ±1X10^2 per cm^2. A previously Egyptian investigation recorded *Staph aureus* levels within our findings *(13).* Meanwhile, this microorganism could not be detected on the examined plates in another two Egyptian studies *(21,23).*

The statistical analysis exhibited a significant reduction of the examined microorganisms (enterobactericae, coliform and *Staph aureus*) on the cutting boards treated with either acetic acid 1% or citric acid 1% compared with those untreated. In spite of there were no significant variance in the bacterial counts between the boards treated with acetic acid and the others treated with citric acid (Tables, 4,5,6,) we can noticed that

the effect of acetic acid as disinfectant against the examined microorganisms is higher than those of citric acid, this results coincided with an another investigation *(24).*

From aforementioned data we can concluded that the treatment of the cutting boards with 1% organic acids (acetic or citric acids) has an important role for decreasing the counts of the examined microorganisms, this effect of the organic acids reflected on the bacterial counts in the red meat cut on the treated boards but in relatively lower effect rather than the boards as expected. Therefore, the treatment of the meat cutting boards in kitchens of houses or restaurants with diluting acetic or citric acids is highly recommended.

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الملخص العربي

تأثير ألواح التقطيع علي الحالة الصحية للحوم

مها محمد سمير- وائل محمد صلاح الدين- تيقين حسن إسماعيل

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أجريت هذه الدراسة لإستبيان العلاقة بين الحالة الصحية لألواح تقطيع اللحوم و بين الحالة الصحية للحوم المقطعة علي تلك الألواح و كذلك مدي تأثير بعض الأحماض العضوية علي الحالة الصحية لتلك الألواح و بالتالي علي الحالة الصحية للحوم . تم تجميع عدد ٢٠ من عينات اللحم البقري من أسواق مدينة الزقازيق و تم فحص عينات اللحوم قبل التقطيع لإجراء العزل و العد الكلي للميكروبات المعوية، الميكروبات القولونية و ميكروبات العنقود الذهبي، وكذلك تم فحص عينات اللحوم بعد تقطيعها علي ألواح غير معالجة بالأحماض العضوية، و بعد تقطيعها علي ألواح معالجة بحمض الخليك ١% و حمض الستريك ١%. و كذلك تم فحص ألواح التقطيع بعد استخدامها بدون علاج بالأحماض العضوية و بعد العلاج بالأحماض العضوية و ذلك لنفس أنواع البكتيريا المذكورة سالفا.

و قد دلت الدراسة عن و جود نقص معنوي في العدد الكلي لجميع أنواع الميكروبات محل الدراسة التي تم عدها علي ألواح التقطيع بعد علاجها سواء بحمض الخليك أو الستريك (بتركيز ١% لكل منهما) مقارنة بأعدادها علي الألواح الغير معالجة بتلك الأحماض، كما أنعكس استخدام الأحماض العضوية في تطهير الألواح علي تقليل العدد الكلي للميكروبات محل الدراسة في اللحوم المقطعة عليها مقارنة بأعدادها في اللحوم المقطعة علي ألواح غير معالجة. و علي هذا نوصي باستخدام حمضى الخليك و الستريك في معالجة ألواح تقطيع اللحوم و ذلك لتحسين الحالة الصحية لتلك اللحوم.