Probiotics’ Antibacterial Activity on Beef and Camel Minced Meat at Altered Ranges of Temperature

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Abstract—Because of their inhibitory effects, selected probiotic Lactobacilli may be used as antimicrobial against some hazardous microorganisms responsible for spoilage of fresh minced beef (cattle) minced meat and camel minced meat. Lactic acid bacteria were isolated from camel meat. These included 10 isolates; 1 Lactobacillus fermenti, 4 Lactobacillus plantarum, 4 Lactobacillus pulgaricus, 3 Lactobacillus acidophilus and 1 Lactobacillus brevis. The most efficient inhibitory organism was Lactobacillus plantarum which can be used as a propiotic with antibacterial activity. All microbiological analyses were made at the time 0, first day and the second day at altered ranges of temperature [4±2 °C (chilling temperature), 25±2 °C, and 38±2 °C]. Results showed a significant decrease of pH 6.2 to 5.1 within variant types of meat, in addition to reduction of Total bacterial count, Enterococci, Staphylococcus aureus together with the stability of Coliforms and absence of Bacillus cereus and Escherichia coli. Analyses of lactic acid bacteria at the time of slaughtering and progresses till consuming. The combination of low temperature with LAB strains could increase the length of meat shelf life [8].

The aim of this study is to investigate the ability of Lactobacillus species probiotic to induce bacterial inhibition on both beef minced meat (cattle) and camel minced meat at altered ranges of temperatures.

Keywords—Antibacterial, camel meat, inhibition, probiotics.

I. INTRODUCTION

THROUGHOUT 1900 AD, the faith of probiotics appeared when Ellie Metchnikoff contemplated the long life of Bulgarian peasants as a result of taking in fermented milk and milk products. Probiotics are considered a set of microorganisms which passively influence the host’s health. The term “probiotics” is a composite word from Latin and Greek that literally means ‘for life’. Probiotics have many beneficial effects related to preservation of food, especially milk and milk products. Other beneficial effects include saving the stability of flavour, and enhancing the nutritive value of food [1].

Lactic Acid Bacteria (LAB) have been used extensively for manufacturing a wide variety of fermented foods. As the lactic acids produced from these bacteria do not pose any health risks, they are Generally Recognized as Safe (GRAS) organisms. Apart from lactic acids, these bacteria also produce various types of compounds such as organic acids, diacetyl, hydrogen peroxide, and bacteriocins or bactericidal proteins during lactic acid fermentations [2].

Bacteriocins are antimicrobial protein compounds which exert inhibitory activities towards a broad spectrum of pathogenic microorganisms, including food spoilage and foodborne bacteria. They are produced by both Gram-positive and Gram-negative bacteria [3]. In recent times, the bacteriocins from the GRAS LAB have a great scientific role in controlling pathogens in foods. Therefore, LAB are reported as biopreservative agents with great economic importance [4]-[6].

Meat is one of the most desirable types of food; as it contains the highest level of protein, as well as it has high nutritive value. It is one of the perishable types of food because it has high nutrients which are used to support the growth of many micro-organisms.

Meat is subjected to contamination by different microbes due to raw material, grinding of meat where the contamination could spread throughout the entire muscle, post processing handling or different equipment, lack of refrigeration facilities, temperatures above 20 °C, and lack of enough suitable methods of transportation which are used from the point of production till marketing plus improper storage [7]. The process of meat deterioration starts at the time of slaughtering, and progresses till consuming. The combination of low temperature with LAB strains could increase the length of meat shelf life [8].

The aim of this study is to investigate the ability of Lactobacillus species probiotic to induce bacterial inhibition on both beef minced meat (cattle) and camel minced meat at altered ranges of temperatures.

II. MATERIALS AND METHODS

A collection of camel meat samples (ten in number) for isolation of Lactobacilli was performed from different slaughter halls in Assiut, Egypt. Transportation formed by using the refrigerated box (4 °C). Camel and beef (cattle) meat were purchased from Assiut slaughter halls and used as meat test system.

A. Enumeration and Identification of Lactobacilli [9]

15-20 ml sterile De Man Rogosa Sharpe (MRS) agar was poured into sterile petri dishes containing one ml of the diluted test sample. The medium was allowed to solidify on a flat surface for 5-10 minutes and was incubated at 37 °C for 48-72 hrs in CO2 incubator. Colonies with Lactobacilli-like morphology were counted and the number of cfu/g was determined, isolated and purified on MRS agar. Isolates were examined for general characters of Lactobacilli, which are Gram-positive, catalase-negative, non-motile, non-spore forming rods, being able to clot milk, and not able to produce indole.

B. Biochemical Identification

Catalase, oxidase, indole production test, growth at different temperatures like 15, 37 and 45 °C, carbohydrate fermentation for Lactobacilli spp., nitrate reduction test, arginine hydrolysis and growth at 4% NaCl were performed to the isolates.

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C. Antimicrobial Activity of Probiotic Bacteria on Some Pathogens

1. Indicator Organisms Used

Gram-negative bacteria (E. coli (NCTC No. 12023) and B. cereus and St. aureus (NCTC No. 7447) as Gram-positive bacteria were used as indicator bacteria for detection of the antibacterial activity. All strains mentioned above were obtained from High Quality Media unit (HQM) in Animal Health Research Institute in Dokki, Egypt; the pathogens were maintained in Brain Heart Infusion Agar (BHIA) butti-slants in screw-capped tubes kept at 4 °C.

2. Preparation of Test Pathogens [9]

An actively growing test microorganism (indicator) was cultured for 24 hrs at 35 °C in a Tryptone Soya broth (OXOID). The microorganism was dipped with a sterile cotton swab, then spanned various times and pressured thoroughly on the top of the fluid level on the inside of the tube’s wall to discard inocula leftover from the swab.

3. Preparation of Probiotic Strains [9]

The well isolated colony was chosen from MRS agar plate inoculated. A loop was used to touch the growth, which was then transmitted into sterile 5 ml MRS broth in a tube. The broth culture was incubated for 24 hrs at 35 °C.

4. Bacteriocin Activity Assay [10]

Cells were separated by centrifugation for 10 minutes at 5000 rpm. The cell free supernatant pH was amended with sterile 0.2 N NaOH to reach 5.5. The activity of bacteriocin in the supernatant was tested by agar well diffusion assay.

5. Agar Well Diffusions Method

20 ml of molten nutrient agar medium was cooled at 47 °C and seeded with 1% overnight culture of the indicator organism. Seeded agar was poured into sterile petri dish and allowed to solidify at room temperature. Wells of 7 mm diameter were cut in the solidified agar using a sterile metal cork borer and filled with 100 µL of supernatant bacteriocins. The diameter were cut in the solidified agar using a sterile metal allowed to solidify at room temperature. Wells of 7 mm diameter were cut in the solidified agar using a sterile metal cork borer and filled with 100 µL of supernatant bacteriocins. The diameter were cut in the solidified agar using a sterile metal cork borer and filled with 100 µL of supernatant bacteriocins.

The positive LST tubes showing gas production were sub-cultured in Brilliant Green Bile lactose (BGB) broth with inverted Durham's tubes. The inoculated tubes were incubated at 35±0.5 °C for 48±2 hrs. The inoculated LST tubes were incubated at 35±0.5 °C for 24±2 hrs. All the tubes showing the gas were submitted to confirmatory tests for counting total coliform.

f. Confirmed Test for Fecal Coliforms [12]

The positive LST tubes showing gas production were sub-cultured into Escherichia coli broth (EC broth) tubes with inverted Durham's tubes The inoculated EC both tubes were incubated at 45 °C for 48±2 hrs. All positive tubes showing gas production collected in Durham's tubes were recorded.

g. Escherichia Coli Count [12]

Positive EC broth tubes were sub-cultured by streaking on Leviene's-Eosin Methyline Blue (L-EMB) agar plates. The inoculated L-EMB plates were incubated for 24±2 hrs at 35 °C. E. coli appeared in the form of metallic sheen with dark center typically nucleated. Positive EMB plates for E. coli were recorded and the numbers of E. coli/g were calculated from MPN tables for 3 tubes dilutions.
h. Identification of the Suspected E. coli Colonies

i. Microscopic Examination [14]

Films were prepared from the pure culture of suspected colonies then, stained with Gram’s stain and examined microscopically.

j. Biochemical Reactions

k. Sugar Fermentation Reaction [15]

Pure cultures of the isolated organisms were inoculated into peptone water containing 0.5-1% of the following sterile filtered sugars (xylose, lactose, glucose, mannitol, arabinose, raffinose, dulcitol and sorbitol), as well as, inverted Durham’s tubes. Tubes were incubated at 37 °C and reactions were noticed daily for up to 7 days. The appearance of yellow color indicated sugar fermentation.

l. Triple Sugar Iron (TSI) Agar Reaction [16]

A pure culture of suspected colonies was picked up and inoculated into TSI agar by stabbing the butt of the tube and streaking the surface of the slant. The tubes were incubated at 37 °C for 18-24 hrs. The results were documented as acid production (yellow butt and/or slant), alkaline production (red slant), gas production (bubbles and/or cracks in the medium or the medium pushed up in the tube) and H2S production (black discoloration).

m. Urease Test [15]

The ability of the microorganism to hydrolyze urea was detected by heavy streaking the surface of Christensen’s urea agar slant with a pure culture of the tested organism. The inoculated slants were incubated at 35 °C for 18-24 hrs up to 3 days or more. A positive reaction was indicated by red discoloration of the medium, while negative tubes retained the original yellow colour.

n. Indole Production Test [15]

Tryptone water tubes were inoculated with a pure culture of the tested organism. Inoculated tubes were incubated at 35 °C for 18-24 hrs, and then drops of Kovac’s reagent were added down the inner wall of the tubes. Development of a bright fuchsin red colour appeared at the interface of the reagent and the broth within seconds after adding the reagent indicated a positive test.

o. Methyl Red Test [15]

MR-VP broth was inoculated with a pure culture of the tested organism, and then incubated at 35 °C for 48-96 hrs. After incubation, (0.5 ml) 5 drops of the methyl red reagent were added directly to the broth. Development of stable red color of the medium indicated a positive test. Negative tubes were yellow in color.

p. Voges-Proskauer Test [15]

Tubes of MR-VP broth were inoculated with a pure culture of the tested organism. Inoculated tubes were incubated for 24 hrs at 35 °C. At the end of the incubation period, one ml of the broth was transferred to a clean test tube and 0.6 ml of 5% α-naphthol, followed by 0.2 ml of 40% KOH addition. The tube was shaken gently and allowed to be undisturbed for 10-15 min. Positive results were indicated by the development of a red color within 15 min or more after addition of the reagents. The test should not be read after standing for over 1 hr.

q. Citrate Utilization Test [15]

The slant surface of Simmons citrate agar tubes was tightly streaked with a pure culture of the test organism. The bottom was also inoculated by stabbing. The inoculated tubes were incubated at 37 °C for up to 48 hrs. Blue discoloration of the medium indicated positive results, while negative tubes had a green colour with no growth.

r. Enumeration of Enterococci Count [17]

One-tenth (0.1 ml) of the prepared dilutions of each sample was dispensed into the dry surface of KF streptococcal agar plates (duplicate plates were used), and evenly distributed until complete absorption using plating technique. The inoculated plates were incubated at 35±1 °C for 48±2 hrs. All red and pink colonies were counted and recorded as Enterococci.

s. Enumeration of Staphylococcus aureus Count [18]

Over a dry surface of Baird-Parker agar plates (duplicate plates were used), 0.1 ml from each of the prepared dilutions of samples under investigation was transferred and evenly spread using surface plating technique. Inoculated Baird-Parker agar plates were incubated at 37 °C for 24 hrs. Suspected colonies showing black, shiny with narrow white margins and surrounded by clear zones extending into the opaque medium were counted. The plates were then re-incubated for additional 24 hrs before being counted for further growth. A significant number of the suspected colonies were submitted to confirmatory tests.

t. Enumeration of Bacillus spp.

From the already prepared serial dilution, 0.1 ml was transferred to Mannitol egg yolk polymyxin agar (MYP) according to [19].

III. RESULTS

Ten isolates obtained from camel minced meat according to their morphological characteristics and biochemical properties which collectively showed that these are common features of Lactic acid bacteria [9].

Isolates R1 were identified as L. fermenti, R2 -R4 -R7 -R10 as L. plantarum, R 3 as L. pulgaricus, R5, R8, R9 L. acidophilus and R6 as L. brevis.

The varied ranges of inhibition zones are observed against the pathogenic strains of bacteria. The diameter of each zone was measured in millimeters (inhibition diameter, mm) (Table I). All the diameters of inhibition zones against St. aureus ranged from 16 mm to 23 mm as well as B. cereus while E. coli from 18 mm to 22 mm (Table I). (Fig. 1).

Results about the in vivo assay revealed a pH drop from 6.2 to 5.1 in inoculated cattle minced meat while inoculated camel
minced meat showed the decrease of pH from 6.3 to 5.1 at altered ranges of temperature, within two days of the incubation (Tables II, III). In the non-treated samples, the pH reached 7.3 units in the same periods. This means the spoilage of meat with the appearance of off odour, changing in colour and texture. The pH decrease in the inoculated assay to 5.1 was due to lactic acid formation by LAB; as there is no off odour, changing in colour and texture.

The microbial profiles plotted to show TBC decreased 3log units at chilling temperature in cattle minced meat (Fig. 2), where camel minced meat showed 2.5 log units (Fig. 5). The initial TBC of the mixture was around 4x10^7 cfu/g which decreased to 3x10^5 cfu/g at the second day of inoculation. Low decrease pattern at the same temperature observed for Enterococci. Enterococci reduced 0.6log units and 1log units in cattle minced meat and camel minced meat respectively on the first day (Figs. 2, 5).

Minimum inhibitory activity of *L. plantarum* cleared at high temperatures whether 25±2 °C or 38 ±2 °C against TBC as it failed to prevent its level from increasing (9.5log cfu/g to 11.5 log cfu/g), (9.5log cfu/g to 11.3log cfu/g), (9.5log cfu/g to 11.2log cfu/g) and (9.5log cfu/g to11.7logcfu/g) in both cattle and camel minced meat, respectively on the first day. Nearly the same levels appeared on the second day (Figs. 3, 4, 6, 7) in spite of acidic pH (5.2) at inoculated samples (Tables II, III).

### Table I

<table>
<thead>
<tr>
<th>Sample</th>
<th>Species</th>
<th>Zone diameter (mm) of inhibition</th>
<th><em>St. aureus</em></th>
<th><em>B. cereus</em></th>
<th><em>E. coli</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td><em>L. fermenti</em></td>
<td>21</td>
<td>20</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td><em>L. plantarum</em></td>
<td>20</td>
<td>23</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td><em>L. pulgaricus</em></td>
<td>21</td>
<td>18</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>R4</td>
<td><em>L. plantarum</em></td>
<td>20</td>
<td>16</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>R5</td>
<td><em>L. acidophilus</em></td>
<td>18</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>R6</td>
<td><em>L. brevis</em></td>
<td>16</td>
<td>22</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>R7</td>
<td><em>L. plantarum</em></td>
<td>21</td>
<td>22</td>
<td>22</td>
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</tr>
<tr>
<td>R8</td>
<td><em>L. acidophilus</em></td>
<td>20</td>
<td>21</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>R9</td>
<td><em>L. acidophilus</em></td>
<td>19</td>
<td>22</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>R10</td>
<td><em>L. plantarum</em></td>
<td>23</td>
<td>21</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

The second day showed better results as reduction reached 1 log unit for cattle minced meat, but 1.3 log unit for camel minced meat. *Bacillus* species had high initial count 1x10^7 cfu/g. In spite they are psychrotrophic microorganisms; it diminished at the chilling temperature to 3x10^5 cfu/g from 9x10^7 cfu/g.

Some microorganisms can cause deterioration in fresh meat not only *Enterococci* but also *St. aureus* and coliforms. In this article, there was absence of *St. aureus* at the inoculated and control samples, otherwise the coliforms showed stability for more than 1100 cfu/g on two types of meat all degrees of all degrees of temperature at the same duration of two days.

The same screen appeared for the presence of *E. coli* in cattle minced meat as it decreased from 11 cfu/g to less than 3 cfu/g in cattle minced meat. The highest number in camel minced meat was about 36 cfu/g. The inoculated samples showed the least reduction in the number of *E. coli* at all ranges of temperature.

### Table II

<table>
<thead>
<tr>
<th>pH</th>
<th>Chilling temp (control)</th>
<th>Chilling temp</th>
<th>25 °C temp (control)</th>
<th>25 °C temp</th>
<th>38 °C temp (control)</th>
<th>38 °C temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero day</td>
<td>6.2</td>
<td>6.2</td>
<td>6.2</td>
<td>6.2</td>
<td>6.2</td>
<td>6.2</td>
</tr>
<tr>
<td>First day</td>
<td>5.3</td>
<td>5.2</td>
<td>5.3</td>
<td>5.3</td>
<td>5.2</td>
<td>5.2</td>
</tr>
<tr>
<td>Second day</td>
<td>6.4</td>
<td>6.2</td>
<td>7.1</td>
<td>6.3</td>
<td>7.3</td>
<td>6.1</td>
</tr>
</tbody>
</table>
TABLE III

PH VALUES OF INOCULATED AND NON-INOCULATED WITH L. PLANTARUM (10⁶) IN CAMEL MINCED MEAT SAMPLES AT DIFFERENT RANGES OF TEMPERATURE

<table>
<thead>
<tr>
<th>pH</th>
<th>Chilling temp (control)</th>
<th>Chilling temp 25 °C (control)</th>
<th>25 °C temp</th>
<th>25 °C temp</th>
<th>38 °C temp (control)</th>
<th>38 °C temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero day</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
</tr>
<tr>
<td>First day</td>
<td>5.6</td>
<td>5.5</td>
<td>6.7</td>
<td>5.3</td>
<td>6.7</td>
<td>5.2</td>
</tr>
<tr>
<td>Second day</td>
<td>6.6</td>
<td>6.5</td>
<td>7</td>
<td>6.6</td>
<td>7</td>
<td>5.1</td>
</tr>
</tbody>
</table>

For all that, at these ambient temperatures Enterococci on the first day and second day (6.5log cfu/g, 6.1log cfu/g) showed an immediate bactericidal effect of L. plantarum in comparison with 9.4log cfu/g and 9.3log cfu/g at 25±2 °C and later 38±2 °C in camel minced meat (Figs. 6, 7). Besides, there was corresponding decrease in cattle minced meat (2.9log units cfu/g) on the first day only, within the same temperatures (Figs. 3, 4). This effect is totally eliminated at non inoculated samples during different ranges of temperature at the different time.

The influence of L. plantarum as antibacterial
microorganism also appeared towards B. cereus in cattle minced meat and camel minced meat. The high decline level revealed at the former (4.4log units cfu/g) at 25±2 °C (Fig. 3), in addition to 6.7log cfu/g was the number of B. cereus at 38±2 °C on the second day. The latter vanished (2.7log units) cfu/g at 25±2 °C (Fig. 6), while it decreased to 3.2 log units cfu/g (38 ±2°C) (Fig. 7); all of these results appeared on the first day. On the second day in the inoculated cattle minced meat samples the B. cereus counts were 6x10^6 cfu/g which are less than the counts at zero time (1x10^7 cfu/g). B. cereus was nearly 4x10^6cfu/g 38±2 °C.

IV. DISCUSSION

LAB originally isolated from meat and meat products are probably the best candidates for improving the microbiological safety of these foods because they are well adapted to the conditions in meat and should be more competitive than LAB from other sources [20]. LAB isolated from meat and meat products are able to compete with target culture when they are incubated together as they are most originally adapted to the condition of the meat. This characteristic media used to improve the microbiological safety of these types of foods, therefore this article looked for inhibitory activities of the ten isolates from fresh meat against Gram positive and Gram negative bacteria.

The isolation of different species of LAB formed from camel meat. L. plantarum showed a high frequency of inhibition in the media to St. aureus, B. cereus and E. coli where the inhibition zone diameter reached to 23 mm. This corresponds to [21] and agreed with [22]; where the LAB strains, which were isolated from Burkina Faso fermented milk, had showed nearly similar inhibition zone diameters against the same used indicator bacteria (E. coli and St. aureus).

The inhibition variety of bacteria by Lactobacillus bacteria was due to a combination of many factors produced LAB e.g. production of lactic acid reduced pH of meat and also inhibitory substances which are responsible for the most antimicrobial activity [23]. The pH decreased drastically during the first day in cattle minced meat; less than 6 units in the treated and untreated sample, while the range of ultimate pH values of camel meat ranged between 5.7units and 6units [24]. Similarly, pork meat samples inoculated with either St. carnosus or L. alimentarius showed a pH reduction from 6.4 to 5.5 within 24 hrs when stored at 20 °C [25].

A drop in pH may be due to lactic acid production by L. plantarum. [7]. The shelf life of meat products could be extended; by the inoculation of L. plantarum under refrigeration after dipping in sugar cane molasses can be extended to 5 °C by inhibiting psychotrophic and mesophilic microorganisms [21].

Lactobacillus bacteria were used as biopreservative at the refrigeration temperature and sub-tropical temperature [26]. The fermentation performed in these studies at 20 °C stopped the growth of the pathogens and spoilage of microorganisms [26]. Recently, using a combination of Lactobacillus bacteria and changing temperature can be considered as an integral part of hurdle technology.

Our results are confirmed by [27], where the bacteriocin activity of L. plantarum was very stable at 4 °C. A significant reduction by L. innocua was observed with a combination of low pH 5.5 and nisin at 20 °C [28].

Highest antibacterial activities against E. coli, St. aureus were suggested by species of L. corusetorus, L. plantarum, L. casei, and L. fermentum [29].

Nearly similar results revealed in this study to those reported by [7]; L. dibreuki was isolated from camel meat for preservation at pH (4.0-4.2) and it led to the drastic reduction in SPC (Standard plate count), Coliforms, Enterococci and Staphylococci, within 3 days at 22 °C [7].

Lactic acid is the supernant of L. fermentum. The effect of 30% of lactic acid was clear on orange juice since it decreased the viable count of microorganisms by 3log units in comparison with control at 4 °C for 21 days. This effect was increased, with increasing the concentration of the preservatives, while there was no effect at 25 and 37 °C at all storage periods [30].

The stability to the number of coliforms was coinciding, with the using of the different strains of LAB, as biopreservative bacteria; which preserve the whole fish, meat, or minced meat products. The total plate count estimated for three days and the count of coliforms reduced, but it was not inhibited [31].

Our evidence is supported by [32]; where pH control samples in their study increased to 7.54 on the third day; due to the growth of meat-borne spoilage and pathogenic bacteria. The antibacterial effect of plantarcin is produced by L. plantarum against B. cereus, E. coli and St. aureus.

In [31], L. plantarum count reached to 8.0log/g, but the complete inhibition of the bacteria was not achieved. It was referred that this case might be due to the presence of dominant Gram-negative lipolytic bacteria; such as Flavobacterium and Pseudomonas species. L. plantarum 15H isolated from traditional dairies microbiota, showed the most efficient antagonistic pathogens [33].

The influence of LAB strains of variation of inhibition related to many different aspects as generating lactic acid which declines pH of meat, in addition of the inhibitors like bacteriocins and hydrogen peroxide, which are liable for most antimicrobial activity [34].

V. CONCLUSION

The vision of the new generations is the fulfillment of the healthiest livelihood; from here probiotics are widely used; due to the increasing of the consumer demands; for the natural products and the application of a natural inhibitory substances, as a food preservative. Probiotics adds to the extension of shelf life and the improvement of the food quality; by using microbes or their metabolites. The results presented in this article provide a clearer idea on the potential of antimicrobial Lactobacillus strains selected; which represents a way.
forward, for the production of antimicrobial substances, that are used in the fermentation and biopreservation of the food. This study showed that probiotics strains could be used for the inhibition of the microorganisms; which is responsible for the deterioration and the spoilage of meat. In the course of time, probiotics can be taken into an account for biopreservation.

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