Evaluation of Physicochemical, Sensorial and Microbiological Attributes of Fermented Camel Sausages

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ABSTRACT: *Probiotic fermented sausages are safe and healthy meat products. Semi-dry fermented sausages were manufactured from camel meat inoculated with Lactobacillus casei and Lactobacillus paracasei and control. All treatments were analyzed for the physico-chemical characteristics (Protein, Moisture, Fat, Ash, Lactic acid value and pH), microbiological features (total aerobic, total mold and yeast and lactic acid bacteria count) and sensory evaluation (color, flavor, texture and overall acceptability) after 0, 10, 20, 30, 40 and 45 days of refrigerated storage at 4°C. The microbial analysis demonstrated the predominance of lactic acid bacteria in semi-dry fermented sausage during the cold storage which reached (8.07) log CFU/g in samples inoculated with Lactobacillus paracasei at 4°C for 45 days. Chemical analysis of semi-dry fermented sausage showed a significant difference ($p<0.05$) in moisture content which decreases in all samples during the period of cold storage. However, all other parameters such as protein, fat, and ash increased. The dropped in pH value in all samples because of producing lactic acid during the fermentation by lactic acid bacteria. Physicochemical, microbial and sensory characteristicsof fermented sausage inoculated with Lactobacillus paracaseiare found to be better than other ones. Also, we could preserve the product at 4°C for 45 days. The sensory evaluation has appeared superiority in the semi-dry fermented sausage that had Lactobacillus casei and Lactobacillus paracasei compared with control.*

KEYWORDS: *Lactic acid bacteria; Production semi-dry fermented sausage; Quality characteristics.*

INTRODUCTION

The potential of camel meat has received increased attention, although more focus has been paid to the nutritional value of camel meat than to its use in fermented sausages. The demand for camel meat, especially from young animals, appearsto be increasing due to health reasons, as it contains less fat and cholesterol and relatively higher PUFA than other meats red [1]. Compared to beef, camel meat tastes sweeter due to its high glycogen content, and has more protein [2]. Fermentation and drying are the oldest methods to extend food shelf life, including meat preservation. The fermentation of meat products has traditionally depended on indigenous microflora. However, the need for safe products of standard quality and desirable technological properties

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has led to the use of starter cultures for the production of dry-fermented sausages [3]. The wide variety of traditional dry-fermented products found on the market result from different raw materials, formulations and technological conditions [4]. Lactic Acid Bacteria (LAB) are Gram-positive, non-sporulated, anaerobic bacteria, Catalase negative bacteria that produce lactic acid among them *Lactobacillus* is the most important genus in the food industry, due to their contribution to fermented food production or their use as probiotics [5]. The preservative effect exerted byLactic acid bacteria is due to their ability to produce organic and antimicrobial compounds including acetic acids, hydrogen peroxide, bacteriocins [6]. Sausage is known to be the oldest and most continuous formof processed meat. Various types of fermented sausages are manufactured using different spice mixtures, starter cultures and differenttypes of meat [**7**]. Starter cultures are used to ensure food safety and superior quality attributes such as sensorial, nutritional, and technological properties [8]. They also provide rapid lactic acid development from the fermentation of sugars added to the sausage resulting in a decreased pH that delays the growth of most spoilage microorganisms and promotes flavor, the texture of the final product and the fermentation by controlling the microflora of the food [9]. One of the strategies for the development of low-fat fermented sausages was generally based on reducing fat content and/or replacing (to a greater or lesser extent) the animal fat normally present in the product with another fat with characteristics more in line with health recommendations: i.e. smaller proportions of saturated fatty acids (SFAs) and larger proportions of Mono Unsaturated Fatty Acids (MUFA) or polyunsaturated fatty acids [10,11]. Probiotics are live microorganisms that are used to developing the common health conditions of hosts [**12**]and exert their benefits through several mechanisms; they inhibit colonization, cellular adhesion, and invasion by pathogenic organisms. They have direct antimicrobial activity and modulate the host immune response[**13**].For the reason that the potential of camel meat is not fully studied, there are few records about its processing and especially very few papers can be found about fermented camel meat products [4]. There is just one study about sucuk type camel meat sausage [4], however there is no reported study about fermented camel sausage.

The purpose of the present investigation was the production and formulation of semi-dry fermented sausage from camel meat by using two strains of probiotics *(Lactobacillus casei* and *Lactobacillus paracasei*), and to evaluate products' physicochemical, microbiological and sensorial characteristics during the cold storage at 4°C for 45 days.

EXPERIMENTAL SECTION

Materials

Fresh boneless camel meat was obtained from alocal market in Karaj, Iran. Other ingredients such as soy oil, sodium chloride, sodium nitrite, red pepper powder, sugar powder, black pepper powder, polyphosphate, garlic, special spices, ascorbic acid, starch, and flour were obtained from Kadur Factory (Tehran, Iran)are shown in Table 1.

Inoculumpreparation

Two bacterial strains: *Lactobacillus casei (*DSM-20011) *and L. paracasei (*DSM-20006) were obtained from theBioProcess Engineering Laboratory (BPEL), Department of Food Science and Engineering, Faculty of AgriculturalEngineering and Technology, University of Tehran, Iran. These bacteria were reactivated three times in de Man Rogosa and Sharpe (MRS) broth (Merck, Darmstadt, Germany) at 37°C for 24 hours and under aseptic conditions, transferred to (MRS) agar by streaked and incubated at 37°C for 48 hours. The lactic acid bacteria were identified by microscopic morphological checking tests. After purification and enumeration of these Lactic acid bacteria, isolated typical colonies were transferred from MRS agar to MRS broth overnight incubated at 37°C until they achieved turbidity, and the number of cellsabout1×10^8 $_{CFU}$ (Colony Forming Units) mL^{-1}.Then each strain was centrifuged at 4025 ×g, 4°C for 10 minutes, the pellet was washed twicewith 0.85% sterile saline solution water and used for inoculation separately in the product.The purity of cultures was tested periodically and at the starting of each experiment by Gram staining and identifies the strains belonging to the LAB group[14,15].

Sausage manufacture

Three samples from each type of semi-dry fermented sausage were prepared as follows: A control sample

Table 1: Raw material and common ingredients used in semi-dry fermented sausages, formulation.

Ingredients	Quantity (g)
Meat	100
soy oil	15
sodium chloride	2.29
sodium nitrite	0.03
sugar powder	0.37
Garlic	2
poly phosphate	0.86
red pepper powder	0.26
black pepper powder	0.17
ascorbic acid	0.1
Starch	2.6
Flour	8.6
special spice	0.54

produced without starter culture). Two other samples were produced with starter cultures containing one strain from each of the starter culture *Lactobacillus casei* or *Lactobacillus paracasei* respectively. Meat and other ingredientsmentioned above whichwere used in certain percentages per kg batter for theproduction of fermented sausages. The respective starter cultures were added to each sample as a two mL wet inoculums per kg of batter. In control sample, two mL of sterile saline water were added per Kg of batter. A Naturin Cutter (Naturin, Germany) was used for thepreparation of batter; the cutter was sterilized before the preparation of meat mixture for each treatment. The spice mixture and other ingredients including starter culture were added and mixed with minced meat in a cutter for about 20 minutes. The batter had been filled into artificial collagen casings of 20 mm diameter using a filling machine (Naturin, Germany) (Tefal, Prep'Line 1600, France) at 5°C [16]. Produced sausages were fermented at 30°C for 24 hours and then dried at two stages (at 60°C for 4 hours and at 75°C for 20 minutes). These heating steps improve the quality (sensory evaluation) and inhibit bacterial development. They were finally stored in arefrigerator at 4°C according to the method of *Ahmad et al.* [17]. Sampling was performed by randomly choosing from each sausage group after 0, 10, 20, 30, 40 and 45 days in order to analyze physicochemical, microbiological and sensorial properties.

Microbiological analysis

After removing the casings from samples, one gramof each sample was diluted aseptically with 9 mL of sterile normal saline-peptone water (0.85%, w/v saline; 0.1%, w/v peptone water). Serial decimal dilutions were prepared from (10^{-1} to 10^{-8}). Nutrient agar (Merck, Darmstadt, Germany), Yeast extract glucose chloramphenicol agar (YGC) (Merck, Darmstadt, Germany) and (MRS) agar (de Man, Rogosa and Sharp agar) (Oxoid ltd., Basing–Stoke, Hampshire, England) were used to count (in triplicate) Total Aerobic Counts (TAC), mould and yeast counts (M &YC) and Lactic Acid Bacteria (LAB) counts, respectively.A colony counter was used for counting colonies grown in the incubated Petri-dishes after incubated at 37°C for 48 hours for (TAC) and (LAB) while (M &YC) incubated at 25°C for (3-5) days[18]. Finally, the viable cell counts were calculatedas $\log_{10}$ value.

Physico-chemical analysis

Moisturedetermination

The moisture content was determined by weighing 5 g of samples and drying in an oven at 105°C until reaching a constant weight[19].

Fat content

Fat content was measured by the Soxhlet method with a solvent extraction system which is based on the method of AOAC [20].

Protein content

Total Protein content was determined according to Kjeldahl method with an automatic Kjeldahl nitrogen analyzer which used to determine the amount of nitrogen (%) and to calculate the ratio of protein by multiplying the amount of nitrogen to the constant factor (6.25) as mentioned in the method of AOAC [21].

Ash content

5 g of each sample was put inside a muffle furnace at 550°C as mentioned in the method of AOAC [22].

pH

The pH value of semi-dry fermented sausage was determined by weighted 10 g of each sample and homogenized in 90 ml of distilled water[23] and measured by pH meter (Crison Instruments S.A., Alella, Spain) by submerging the electrode directly into the samples of sausage.

Lactic acid value

Lactic acid value was determined by filtration samples and then titration with NaOH 0.1 N (1 mL 0.1 N NaOH = 0.0090 g lactic acid) contained phenolphthalein (0.1% in 95% ethanol % w/v) as the indicator [24].

Sensorial analysis

Sensory evaluation (color, texture, flavor and overall acceptability) were carried out for semi-dry fermented sausage inoculated with (*Lactobacillus casei and Lactobacillusparacasei)* and control trained by panelists according to the criteria described by *Carpenter et al.* [25]. Samples were evaluated by 10 panelists in one session. The panelists were recruited from Food Processing Engineering Staff at Tehran University. Semi-dry fermented sausage samples were cut and the samples were coded with random numbers and presented at the same time in a randomized order. The panelists were asked to assess samples stored at 4°C after 0, 10, 20, 30, 40 and 45 days for color, flavor, texture and overall acceptability using a 9-point hedonic scale (1 = dislike extremely, 9 = like extremely). Panelists were instructed to rinse their mouths with water before starting and between sample evaluations according to Al-Ahmad [26]. The ratings of each sensory attribute were converted to numerical scores and the numerical scores were calculated for statistical analyses.

Statistical analysis

SPSS software (version 17.0)was used to determine the effect of the refrigerated storage period andinoculation (addition *Lactobacillus casei* and *L. paracasei)*on the quality characteristics of semi-dry fermented sausage. Each trial was repeatedthree times. The obtained data were analyzed by one-way (ANOVA), and significant differences ($p<0.05$) among the means of samples were compared using Duncan's test.

RESULTS AND DISCUSSIONS

Physicochemicalanalysis

Table 2 shows the results of the physical and chemical analyses of semi-dry fermented sausage samples inoculated with *L. casei* after 0, 10, 20, 30, 40 and 45 day sof cold storage at 4°C. The protein content was significantly ($p<0.05$) increased in all samples until itreached 12.82% at the end of the storage period. The moisturecontent in all samples significantly decreased (range63.8–62.26%) during the storage period. The trend in fat content; it was similar to protein content in significantly($p<0.05$) increased in all samples during storage at 4°C. Fat content ranged between 15.4 and 16.39% for semi-dry fermented sausage during the cold storage period. Ash content was almost significantly ($P<0.05$) increased in all samples during the storage period at 4°C. Ash content ranged between 2.44 and 2.64% during the refrigerated storage period.

The results of the physical and chemical analyses of semi-dry fermented sausage inoculated with *L. paracasei* after 0, 10, 20, 30, 40 and 45 days of cold storage at 4°C are presented in Table 3. The protein content was significantly ($p<0.05$) increased in all samples until it reached 14.58% at the end of the storage period, while moisture content decreased in all samples during the storage period, (range 62.63–61.68%). The trend in fat content was similar to protein content which showed asignificant ($p<0.05$) increase in all samples during storag eat 4°C. Fat content was in the range of 16.35-17.13% forsemi-dry fermented sausage during the cold storage period. Ash content was almost significantly ($p<0.05$) increased in all samples during storage at 4°C. Ash content ranged between 2.53and 2.66% during cold storage period (Table 3).

The results of physical and chemical analyses of semi dry fermented sausage samples produced without starter culture (control) after 0, 10, 20, 30, 40 and 45 days of cold storage at 4°C are shown in Table 4. The storage period effected significantly ($p<0.05$) on protein content in all samples until it reached 15.9% at the end of the storage period, while no significant differences were observed in moisture content during cold storage. The moisture content of the samples was in range of 63.85-62.68% during the storage period. There were significant differences in the samples for 45 days at 4°C. Fat content ranged between 15.05 and 16.37% for the controls during the cold storage period. Ash content was in the almost increased in all samples during storage period at 4°C. Ash content range of 2.6-2.72% during the cold storage period (Table 4). The control sample

Table 2: Physico-chemical analysis of semi-dry fermented sausages inoculated with Lactobacillus casei during refrigerated storage at 4°C.

Storage (days)	Protein (% W/W)	Moisture (% W/W)	Fat (% W/W)	Ash (% W/W)	pH -	Lactic acid (% W/W)
0	10.88±0.03^{e}	63.8±0.03^{a}	15.4±0.03^{f}	2.44±0.01^{e}	5.48±0.01^{a}	0.248±0.001^{f}
10	12.33±0.03^{a}	63.08±0.05^{b}	15.57±0.01^{e}	2.49±0.01^{d}	5.42±0.01^{b}	0.54±0.003^{e}
20	12.39±0.01^{c}	63.04±0.21^{b}	15.93±0.03^{d}	2.53±0.02^{c}	5.41±0.04^{b}	0.57±0.003^{d}
30	12.68±0.01^{b}	62.89±0.16^{b}	16.04±0.04^{c}	2.57±0.005^{b}	5.40±0.0 3^{c}	0.59±0.001^{c}
40	12.78±0.02^{a}	62.65±0.17^{c}	16.18±0.01^{b}	2.6±0.02^{b}	5.36±0.01^{c}	0.67±0.001^{b}
45	12.82±0.02^{a}	62.26±0.02^{d}	16.39±0.02^{a}	2.64±ns0.03^{a}	5.21±0.015^{d}	0.702±0.001^{a}

Values are means of three replicates ± standard deviation.

** *Means with different superscript letters in the same column represent significant differences ($p < 0.05$).*

Table 3: Physico-chemical analysis of semi-dry fermented sausages inoculated with Lactobacillus paracasei during refrigerated storage at 4°C.

Storage (days)	Protein (% W/W)	Moisture (% W/W)	Fat (% W/W)	Ash (% W/W)	pH -	Lactic acid (% W/W)
0	13.75±0.01^{e}	62.63±0.04^{a}	16.35±0.01^{f}	2.53±0.03^{d}	5.33±0.01^{a}	0.302±0.001^{f}
10	13.8±0.01^{d}	62.57±0.09^{a}	16.46±0.01^{e}	2.54±0.04^{d}	5.23±0.01^{b}	0.568±0.001^{e}
20	14.07±0.05^{c}	62.29±0.05^{b}	16.5±0.03^{d}	2.56±0.04^{bd}	5.21±0.01^{c}	0.581±0.003^{d}
30	14.15±0.02^{b}	62.14±0.05^{c}	16.7±0.02^{c}	2.57±0.01^{bd}	5.09±0.01^{d}	0.643±0.001^{c}
40	14.56±0.02^{a}	61.73±0.05^{d}	16.75±0.02^{b}	2.61±0.02^{b}	5.07±0.01^{d}	0.679±0.002^{b}
45	14.58±0.01^{a}	61.68±0.08^{d}	17.13±0.01^{a}	2.66±0.01^{a}	4.91±0.02^{c}	0.784±0.001^{a}

* *Values are means of three replications ± standard deviation (SD).*

** *Means with a different superscript letter within column represent significant differences ($p<0.05$).*

Table 4: Physico-chemical analysis of semi-dry fermented sausages (control) during refrigerated storage at 4°C.

Storage (days)	Protein (% W/W)	Moisture (% W/W)	Fat (% W/W)	Ash (% W/W)	pH -	Lactic acid (% W/W)
0	15.16±0.02^{f}	63.85±0.02^{a}	15.05±0.1^{e}	2.6±0.03^{c}	5.56±0.01^{a}	0.207±0.002^{f}
10	15.26±0.01^{e}	63.78±0.03^{a}	15.43±0.03^{d}	2.63±0.02^{cd}	5.5±0.01^{b}	0.222±0.002^{e}
20	15.39±0.02^{d}	63.47±0.02^{b}	15.73±0.03^{c}	2.65±0.02^{bc}	5.48±0.02^{c}	0.540±0.002^{d}
30	15.53±0.02^{c}	63±0.1^{c}	15.97±0.03^{b}	2.68±0.01^{ab}	5.44±0.02^{d}	0.574±0.002^{c}
40	15.58±0.02^{b}	62.86±0.01^{d}	15.99±0.01^{b}	2.7±0.03^{a}	5.36±0.010^{e}	0.602±0.001^{b}
45	15.9±0.02^{a}	62.68±0.01^{e}	16.37±0.02^{a}	2.72±0.02a	5.34±0.01^{e}	0.624±0.001^{a}

* *Values are means of three replications ± standard deviation (SD).*

** *Means with a different superscript letter within column represent significant differences ($p<0.05$).*

had higher protein content compared to the samples inoculated with *L. casei* and *L. paracasei*.

This increasing in the protein of semi-dry fermented sausages can be due to the proteolytic activities of enzymes produced by microorganisms during fermentation and ripening which can cause an increase in the bioavailability of amino acids [27]. Our results are in coinciding with those of *Asmare* and *Admassu* [28] who reported increase of protein content in all dry fermented sausages; this may be because of the decrease in water content and high concentration of nutrients during processing [28]. Our findings are in agreement according to *Ahmad et al*. [17] demonstrated that lowering down of moisture content of semi-dry fermented sausage.

The moisture content was significantly ($P<0.05$) decreased in all dry fermented sausages [28] *Asmare* and *Admassu* [28] showed that fat content was also significantly ($p<0.05$) increased in all dry fermented sausage. Our findings of ash are almost as consistency with results that reported by *Hemat et al.* [29], there was also a significant ($p< 0.05$) increase in mineral components for the final dry fermented sausage. Usually, 2.0–4.0% NaCl is added to the sausage batter[30] and these values increase in final products due to drying process[30]. Salt (sodium chloride, NaCl) is one of the major ingredients in dry fermented sausages;it plays anessential role in assuring the microbiological stabilityand it also has an importantinfluence on the final tasteand texture [31].

pH and Lactic acid values

pH and lactic acid values for the samples inoculated with *L. paracasei* during storage at 4°C are shown in Table 3. The pH of all samples decreased significantly ($p<0.05$) during the cold storage period. Fewer declines in pH valuein all samplesof semi-dry fermented sausages inoculated with *L. paracasei*until itreached (4.91) at the end of the storage period (Table 3). The production of lactic acid during fermentation by lactic acid bacteria led to decreasing pH values. Theamount of lactic acidincreased significantly ($p<0.05$) in all samples of semi-dry fermented sausages during the storage at 4°C. The control sample had alowervalue of lactic acid 0.624% (Table 4) compared to those inoculated with *L. casei* and *L. paracasei* which had 0.702% and 0.784% respectively.

LAB utilize the carbohydrate portion of the meat to produce acid and thus lower the PH, improving the texture of the products, providing stability against the proliferation of food pathogens and producing some aromatic compounds [32]. Moreover, LAB inhibits the growth of spoilage and pathogen microorganisms through the production of lactic acid andantimicrobial compound [33], LAB produce anumber of other antimicrobial and organoleptic compounds, e.g.acetic acid, ethanol, acetoin, carbon dioxide and pyruvic acid [32].

The current study is in agreement with the results of *Ahmad et al.* [17] demonstrated that refrigerated storage significantly ($p<0.05$) decreased pH of semi-dry fermented sausage.

Microbiology Analysis

Lactic acid bacteria

Significantly increased ($p<0.05$) in the numbers of Lactic acid bacteria during theperiod of storage at 4°C in all fermented samples and became the predominant flora in the final products and they reached 7.92, 8.07 and 6.67 log CFU/g for *L. casei*, *L. paracasei* and control respectively at the end of storage due to the inoculation with *L. casei and L. paracasei* (Fig. 1).

Lactic acid bacteria were able to resist the drying process and to maintain its growth during refrigerated storage stages. Increasing in LAB numbers which could be due to the environment of meat is suitable for the growth of LAB and a good adaptation of these bacteria tofermentation conditions [34].These results are in correspond with those of *Ferreira et al.* [35] in fermented sausages in which displayed a rapid increase in LAB count was observed. The number of LAB decreased at the end of refrigerated storage due to the exhaustion of the sugar and the low temperature conditions [36] and also may be attributable to the decrease inmoisture and increase in acidity of sausage during refrigerated storage [34].

Total aerobic count

Total Aerobic counts of semi-dry fermented sausage were significantly increased ($p<0.05$) in allsamples during the storage period at 4˚C (Fig. 2). Control sample had lower number 6.63 log CFU/g compared to thos einoculated with *L. casei*and *L. Paracasei* which had number 7.23 and 6.80 log CFU/g respectivelyat the end of refrigerated storage period. *Bacha et al.* [37] were observed similar loads of Total Aerobic Count (TAC) on other sausages. These increasing in (TAC) numbers can be due to the initial ingredients and the properties of used meat [38]. Microbial growth during storage is one of the main factors affecting the quality of meat products, leading to spoilage and hence economic losses [39]. Sausage may be contaminated after heat processing and during other processes such as slicing, packaging and peeling [40].

Yeast and mold count

The numbers of yeast and molds count were lower than LAB and TAC of semi-dry fermented sausages and were significantly ($p<0.05$) decreased inall samples during the period of storageat 4°C (Fig. 3). Control sample had higher

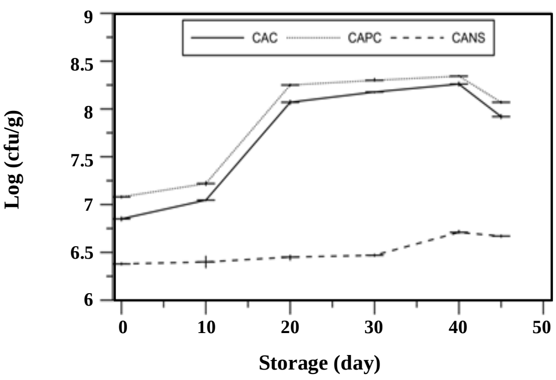

Fig. 1: Growth of lactic acid bacteria (log CFU/g) in semi-dry fermented sausages inoculated with Lactobacillus casei (CAC), Lactobacillus paracasei (CAPC) and control (CANS) during refrigerated storage at 4°C.

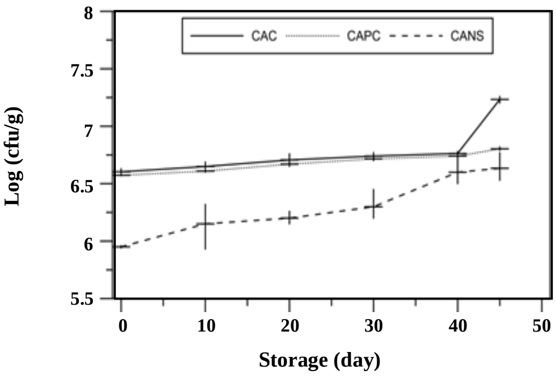

Fig. 2: Growth of Total Aerobic Count (log CFU/g) in semi-dry fermented sausages inoculated with (Lactobacillus casei, Lactobacillus paracasei) and control during refrigerated storage at 4°C.

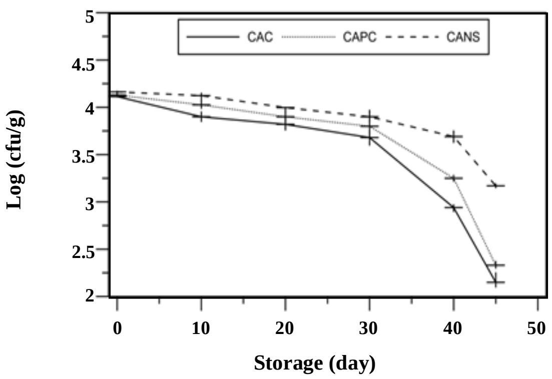

Fig. 3: Yeast and Molds Count (log CFU/g) in semi-dry fermented sausages inoculated with (Lactobacillus casei, Lactobacillus paracasei) and control during refrigerated storage at 4°C.

number 3.17 log CFU/g compared to others inoculated with *Lactobacillus casei* and *Lactobacillus paracasei* which hadnumberranged between 2.15 and 2.33 log CFU/g respectively after 45 days of refrigerated storage. *Al-Ahmad et al.* [34] demonstrated to decrease the number of yeast and molds in the treatment content LAB compared to control in smoked, fermented semi-dry sausages. This decline in the number of yeast and moldsin the sausage inoculated with LAB compared with control can be due to the competition between lactic acid bacteriaand yeasts& molds [34].

Sensory Evaluation

The addition of starter culture that has improved the sensorial properties of samples inoculated with starter culture compared to control. Thereare many factors affecting thesen sory characteristics of meatproducts such as them eatsusedasrawmaterials (genetictype, feed, age, sex, and rearing system), microorganisms selected as microbials tarters for the fermentation and type of processing technologies (cooking, drying, ripening, smoking, etc.) [41]. The sensorial analysis included thee valuation of color, flavor, texture and overall acceptability.

Color

Lactic acid bacteria result in increasing the lactic acid and promote the color of the product and reduced enzyme rancidity of fat and improving the sensory evaluation of the final product [42]. During stor ageat 4˚C, thes corevalues of color decreased significantly (p<0.05) in all samples. The control sample had lower score 6.10 compared to those inoculated with *L. casei* and *L. paracasei* which obtained 6.13 and 6.66 respectively, at the end of refrigerated storage period (Figs. 4, 5 and 6).

The decreasing in color scores during storage may be due to the lipid oxidation and subsequently oxidized compounds reacting with amino acids during non-enzymatic browning of the product [41]. Our results are in agreement with those of *AIhmad* and *AmeIr* [41] reported during refrigerated storage the score values of color significantly (p<0.05) decreased in semi dried fermented sausages.

Flavor

During refrigerated storage, a t4°C, the score values of flavor decreased significantly (p<0.05) in all samples. Control sample had lower score 5.51 compared to those in oculated with *L. casei* and *L. paracasei* which scores

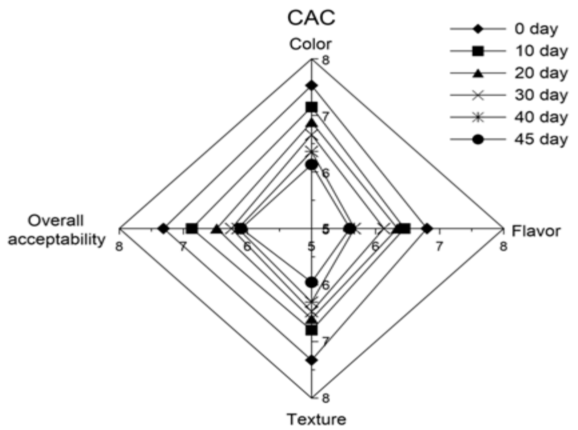

***Fig. 4:** Sensory evaluation of semi-dry fermented sausages inoculated with Lactobacillus casei during refrigerated storage at 4°C*.

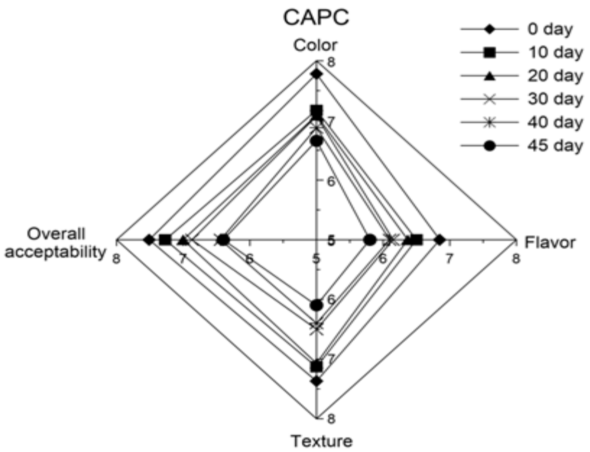

***Fig. 5:** Sensory evaluation of semi-dry fermented sausages inoculated with Lactobacillus paracasei during refrigerated storage at 4°C.*

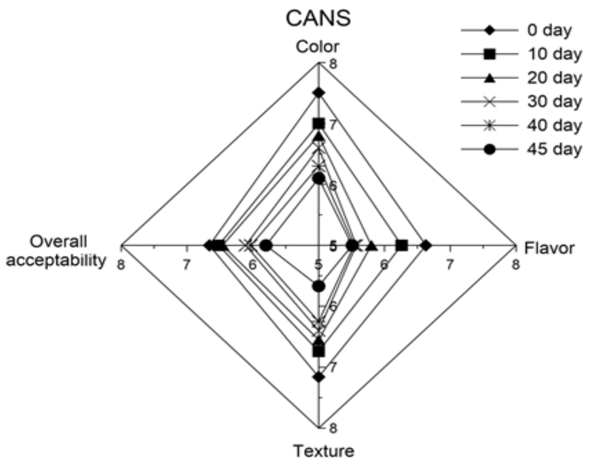

***Fig. 6:** Sensory evaluation of semi-dry fermented sausages control (CANS) during refrigerated storage at 4°C.*

5.60 and 5.80 respectively, at the end of refrigerated storage (Figs. 4, 5 and 6). The characteristic flavor of fermented sausages mainly originates from the breakdown of carbohydrates, lipids, and proteins through the action of microbial and endogenous meat enzymes [36]. The development of flavor is also influenced by several variables such as product formulation (especially spices), processing conditions, and starter culture [41]. These results are similar to those obtained by *Ahmad* and *Amer* [41] in which indicated a decrease of flavor during refrigerated storage**.**

Texture

Textureisa power ful element of the quality and acceptability of foods. It is perceived from sensory impressions of the physical properties of the material, its nature, composition, and behavior on de form at ion received from senses of touch, sight, and hearing [36]. During refrigerated storage at 4°C, thescorevalues of textured ecreasedsignificantly ($p<0.05$) in all samples (Figs. 4, 5 and 6). Control sample had lowerscore5.67 compared to those in oculated with *L. casei* and *L. paracasei* which had scored 5.95 and6.10respectively at the end of refrigerated storage. The significant decrease in texture during storage may be due to changes in the disulphide bonds and contents of amino acid [41]. According to study of *Ahmad* and *Amer* [41] increasing levels of fat constantly improved the score values of texture was significantly ($p<0.05$) decreased during refrigerated storage at 2°C indicated that the score of texture for semi-dry fermented sausages incorporated with 20% and 25% fat.

Overall acceptability

During refrigerated storage at 4°C, the scorevalues of over all acceptability decreased significantly ($p<0.05$) in all samples (Figs. 4,5 and 6). Control sample had lower scores 5.80 compared to those inoculated with *Lactobacilluscasei* and *Lactobacillus paracasei* which scores 6.10and6.40respectivelyat the end of refrigerated storage. The best overall acceptability score was found for semi-dry fermented sausage inoculated with *Lactobacillus paracasei***.**

CONCLUSIONS

The use of *Lactobacillus casei and L. paracasei* improved the quality and nutritional value of food by producing probiotic functional food. Concludedthat the fermentation process with *Lactobacillus casei* and *L. paracasei* of the semi-dry fermented sausage processed from camel meatleading to lower the moisture content and PH and dominated by lactic acid bacteria on the microflora in fermented sausage, and it helped improve the sensory qualities in fermented sausage and kept them within 45 days of refrigerated storage at 4°C. The best sensory evaluation in the color, flavor, texture and overall acceptability scores was obtained in the samples of semi-dry fermented sausage inoculated with *Lactobacillus paracasei*.

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