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Article

Effective of Lemongrass and *Lactobacillus plantarum* in improving some physicochemical and Sensorial characteristics of Buffalo meat salami.

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ABSTRACT

Bacterial starter Lactobacillus plantarum at a concentration of 5% was added to salami, which was manufactured by using buffalo meat and belly fat, both separately and the same kind, at a rate of 75% pure meat, 15% fat, 2% salt, 1% glucose, 2% spices or *C.citratus*. The fermentation process was done at 37°C and relative humidity of 80-85% for 48 hours for all treatments, the salami was stuffed in natural casing, ripening at a temperature ranging between 18-20 °C and a humidity of 75-80% for 8 weeks, The salami product was divided into five groups, depending on the proportion of lemongrass, which was Lg1 Spices 2%, Lg2 *C.citratus* 2%, Lg3 Spices1% + *C.citratus* 1%, Lg4 Spices 0.5% + *C.citratus* 1.5 % Lg5 Spices 1.5 % + *C.citratus* 0.5 %. Buffalo salami was recorded for Thiobarbituric acid (TBA) trials. Lg2 recorded the lowest value for TBA during 2 and 60 days, where it recorded 0.30, 0.65, and mg malonaldehyde kg-1, respectively. The treatment Lg1 recorded the highest value during 2 days 60 days of fermentation and ripening, which recorded 0.36 and 0.98 mg malonaldehyde kg-1, respectively. Moreover, for non-protein nitrogen(NPN) trials, Lg1 recorded the lowest value for NPN during 60 days, which recorded 3.10 %. In the trials, Lg2 recorded the highest value during 60 days of fermentation and ripening, which recorded 3.15. Sensory evaluation for flavor, Tenderness, Juice, Degree of general acceptance, and Texture, whereas trial Lg2 was the highest recorded 8.0,6.6, 7.7, 8.0 (scale point 8.0) and 3.0 (scale point 5.0), respectively.

Keywords: Lemongrass, fermented Buffalo meat Salami, Lb. Plantarum, TBA, NPN, sensory properties.

INTRODUCTION.

Cymbopogon citratus is rich in minerals, vitamins, and macronutrients (carbohydrates, protein, and small amounts of fat). These leaves are also good sources of various bioactive compounds, including alkaloids, terpenoids, flavonoids, phenols, saponins, and tannins that confer *C. citratus* leaves pharmacological properties such as anti-cancer, antihypertensive, anti-mutagenicity, anti-diabetic, antioxidant, anxiolytic, anti-nociceptive and anti-fungi [1]. *Cymbopogon citratus* in traditional medicine is used to treat colds, influenza, cough, diabetes, malaria [2], high blood pressure, high cholesterol, fever, inflammation, dental hygiene, colorectal cancer, toothache and sore throat [3]. Recently, interest has increased considerably in discovering naturally occurring antioxidants in medicinal plants. Antioxidant

potentials of lemongrass extract have been identified, and acknowledged their abilities to reduce (reactive oxygen species) (ROSs). Mechanisms such as inhibition of lipoperoxidation. Phenolic compounds are dietary constituents widely existing in plants and have been considered to have a high antioxidant capacity and free radical scavenging capacity. They have attracted more and more attention for the prevention and reduction of many oxidative stress-related diseases, including cancer[4]. Antioxidants are substances that delay or prevent the oxidation of an oxidizable substrate, and they can either be natural or synthetic. Biological systems produce natural antioxidants; *C. citratus* showed high contents of total phenolic and total flavonoids, as well as high free radical scavenging capacity [5]. In this new era, the search for food ingredients rich in bioactive components is increasing due to the outbreak of COVID-19 caused by the SARS-CoV-2 virus. Food rich in bioactive compounds is advantageous because they boost the immune system, and natural polyphenols have exhibited properties as inhibitors of COVID-19 main protease [6]. The effect of natural spices and oleoresins on the fermentation properties of three commercially available starter cultures of Lactobacillus plantarum has been investigated. In a liquid medium, it was shown that natural spices stimulated the growth of the three bacteria and thus enhanced the cultures to ferment glucose and form more lactic acid [7]. Many research works have recognized the beneficial effects of medicinal plants on health as well as their capacity to prevent many diseases. The use of medicinal plants that are readily available and efficacious would, therefore, be a better and affordable alternative for boosting and enhancing health [8]. LAB causes changes in the flavor texture of meat products and the ability to utilize sugars and other nutrients. They prevent the growth of some pathogenic microorganisms by antimicrobial substance production and contribute to the preservation of foods. Today, LAB strains have been widely used as starter cultures in food production to improve food appearance, smell and taste or to prolong its durability [9]. The vast majority of LABs have the status 'Generally Recognized As Safe' (GRAS), according to the U.S. Food and Drug Administration (FDA). The European Food Safety Authority (EFSA) has also granted the status of "Qualified Presumption of Safety" (QPS) to many LAB species, Lactobacillus plantarum [10]. Lactobacillus plantarum is a facultative heterofermentative lactic acid bacteria (LAB) species that can be isolated from many ecological niches. L. plantarum is a member of the gastrointestinal tract and can be found in the microbiota of almost all fermented foods. L. plantarum has been recommended and used as a probiotic strain due to the health benefits and starter culture in producing distinct fermented food products [11]. Research has clarified and revealed over 140 years the various microorganisms that produce the enzyme Tannase, which are fungi, yeasts, and bacteria. About 21 genera of bacteria were found that were known to produce Tannase, and Lactobacilli was the most dominant genera of bacteria in enzyme production with [13] species, followed by Pediococcus with [4], Serratia with [3], Leuconostoc with two, Pntonea with two, Streptococcus with two types, [12]. Buffalo meat is almost similar to cattle meat; moreover, its meat has many superior characteristics, including higher protein, low fat, and cholesterol content. In the current world scenario, buffalo meat could be a good source of protein and other nutrients, and it can serve a crucial part in achieving the Sustainable Developmental Goal of the United Nations for food security for all. Meat quality has many attributes, including color, tenderness, juiciness, flavor, and palatability [13]. Buffalo meat is one of the healthiest meats among red meat for human consumption; it is low in calories and cholesterol. Buffalo meat is dark red; it is because of less intramuscular fat or more pigmentation. Dark meat possesses good binding properties and is preferred in product manufacture. Buffalo meat can be very well used for the production of sausage[14]. Improving the quality and preservation of foods by microbial fermentation is an ancient strategy that has evolved to produce modern functional fermented

food products [15]. Traditionally, fermented foods have been produced using traditional practices that rely on the exposure and consequent growth of autochthonous/ endogenous microorganisms that modify the composition of foods [16]. In the case of meat products, microbial growth gradually affects the physicochemical, textural, sensory, and functional properties of meat mass, which leads to products with appreciated color, flavor, and aroma that can be stored for long periods [17]. The research aimed to improve some physicochemical and sensory properties of buffalo meat salami fermented with Lactobacillus plantarum and lemongrass.

MATERIALS AND METHODS

Lactobacillus plantarum isolate was used in a study that activated as a pure bacterial culture in the liquid MRS From a local bacterial isolate from Erbil Lebin, northern Iraq, by a master's student, Sarah Ali Obaid (2020) at the College of Agricultural Engineering Sciences University of Baghdad. After inoculating MRS broth with isolated culture, it was incubated anaerobically at 37˚C 24 h, then stored at 4˚C until use [18]. Pure lean meat free from apparent fat was used, obtained from a piece of thigh meat from a carcass (Buffalo) from local markets. An icebox transferred it, and the meat was placed in the refrigerator for 24 hours. The meat was cut into small pieces in cubes with dimensions of 2-3 cm^3 before starting the salami manufacturing process to facilitate the mincing process. It was collected from healthy animals slaughtered in the local butcher's shop and brought to the laboratory. Fat deposited around the bones of the pelvis, kidney and back was used, and it was obtained from a Buffalo carcass from the local markets (The same carcass from which pure meat was taken). The fat was placed in special plastic bags that do not allow air to pass through and kept freezing until use, considering that the bags are closed tightly during the preservation period. Then, cut the fat into small cubes with dimensions of 2-3 cm^3 before making pastrami to facilitate the mincing process. Various spices obtained from local markets in Baghdad were used, as each type of spice was milled individually by the coffee mill. Then, the spice mixture was prepared according to [19], with some changes used in the manufacture of salami as described in Table (1), after which the spice mixture was placed in tightly closed plastic containers until use.

Black pepper 15%	Cinnamon 10%	Kababah 20%		Cardamom 5%	Ginger 10%
	gory roses 5%	Paprika 10%	Poe nut 10%	Garlic 15%	

Table 1. The spice mixture used in the manufacture of salami

NaCl Pure salt crystals processed by Merck, a German company, were used. Glucose pure glucose is processed by the English company Oxoid. Starter bacteria Lb. Plantarum was used after being activated by inoculated in skim milk Triplicates at 37°C and prepared for fermentation [20]. Lemongrass (*C.citratus*) powder leaves of Lemongrass (*C.citratus*) were brought from the Shorja market in Baghdad Iraq. The leaves were washed under running tap water to remove the surface pollutants and cut into small pieces. The plant leaves were dried in the shade at room temperature for 5-7 days. The samples were ground in an electric mill. The powdered samples obtained were kept in an airtight container before use [21]. Casings Natural casings were used to fill the salami. The exact intestines of the calf were obtained, and the next steps were followed in the cleaning and preparation process, as mentioned [19]. Buffalo meat salami manufacture, the following steps were followed in manufacturing the salami under study. The additions were according to Table 2 [22].

	Meat	Fat	Starter	Salt	Sugar	Spices	*C.citratus* powder
	%						
Lg1	75	15	5	2	1	2	---------
Lg2	75	15	5	2	1	-------	2
Lg3	75	15	5	2	1	1	1
Lg4	75	15	5	2	1	0.5	1.5
Lg5	75	15	5	2	1	1.5	0.5

Table 2. Buffalo meat salami composition under trial Lg1 Spices 2%, Lg2 *C. citratus* 2%, Lg3 Spices 1% + *C. citratus* 1%, Lg4 Spices 0.5% + *C. citratus* 1.5 % Lg5 Spices 1.5 % + *C. citratus* 0.5 %.

1. The weights of pure meat and fat of 75% 15%, respectively, were prepared for all experimental treatments: five kg of salami,
2. Mince pure meat and fat using an electric mincing machine for the first time using a disc with a hole diameter of 1.5 mm and the second time using a disc with a hole diameter of 0.8 mm.
3. Glucose and salt were Added in 1%,o.75% chopped mixture, then added 5% of activated starter Lactobacillus plantarum was incubated, mixed well and put in glass bottles at 37°C and a relative humidity of 80- 85% for 48 hours for fermentation
4. Salamis was divided into five treatments depending on table(2). added the spice, c .citratus and rest salt to complete 2% salt for all trials. The chopped salami mixture prepared was stuffed using the natural wrappers and manually. Two main points were taken into account during the packing: homogeneity and regularity to avoid light packing that allows air spaces inside the packages, as well as avoiding heavy packing that hinders the evaporation process during the ripening stage.
5. Wrap the salami using cotton thread coated with wax. The length of the salami was 20 cm, and the diameter was 2.5 cm for all treatments. The salami samples were hung randomly with hooks and placed in a cooler incubator at (22-18)°C and a relative humidity of (75-80) % to complete the technical ripening process that took (60) days.

Salami maturation method: the technical method set out in [23] was followed in maturing the salami under study in order to suit the circumstances of the current experiment, as follows:

- Fermentation duration: the salami was placed in glass bottles and then in the incubator at 37 °C and relative humidity of 85-93% for 48 hours.
- Maturation Duration After the end of the fermentation period, the salami was transferred from the glass bottles to the natural animal casings by manual methods and then placed in the incubator at (25-18) °C and a relative humidity of 75-85% for 58 days, that is, until the end of the ripening period of 60 days.

Thiobarbituric acid (TBA)

The number of thiobarbituric acid was estimated according to the method mentioned [24]., weighing 10 g of salami model and falling for 2 minutes in 47.5 ml distilled water and adding 3 ml hydrochloric acid solution to reduce the hydrogen number to 1.5 and complete the volume to 100 cm3 distilled water. 2 ml paraffin oil and 1 g dry stone was added in the distillation flask. (A boiling stone is placed to prevent the bubble.) Heat the flask, collect 50 ml of the distillation within 10 minutes of starting the boiling, and take 5 ml of the distillation with 5 ml of the thiobarbituric acid solution in a glass test tube with a plug. (Melting 0.2883 g of TBA in 100 ml of snow acetic acid 90% concentration) The tube nozzle is

blocked and slightly crowded and placed in a boiling water bath for 35 minutes. The blank sample model is prepared by pulling 5 ml of distilled water into a test tube and adding 5 ml of TBA solution, after which the test tubes are cooled with water for 10 minutes. The suction is read on a 538 nm wave, and the number of thiobarbituric acids is calculated according to the following equation: TBA value (mg Malone aldehyde/kg meat) = A538 x 7.8.

Non protein nitrogen (NPN)

The method mentioned by [25] was used for the determination of non-protein nitrogen (NPN) by crushing 10 g of salami in a ceramic mortar with a sufficient amount of potassium chloride 0.5 N (KCl) solution and mixing well and then transferring the mixture to a volumetric flask with a capacity of 100 ml The volume was completed with the same solution up to the mark and the shaking was done from time to time within 30 minutes. A centrifugal process was conducted for 15 minutes at a speed of 850 x g, then 50 ml of the filtrate was taken and 10 ml of a 30% TCA (trichloroacetic acid) solution was added to it, then the mixture was mixed well using a mixer After 15 minutes of mixing, centrifugation was carried out for 15 minutes at a speed of 850 x g, after which the clear solution was taken and used to determine the non-protein nitrogen by Kjeldahl method. Fry salami: I followed the method mentioned by [26] for frying salami samples intended for sensory examinations. The salami was cut into small circular pieces with a thickness of 1.5 cm and placed in 99% pure corn oil at a temperature of 120 °C (boiling) for two minutes. After frying, the pieces were placed on paper Short-time type Watman N.1 filtration to remove oil in pastrami models. Sensory evaluation of the Buffalo salami, which included the taste, was conducted 45 days after maturation and by experts in food in general and food manufacturing in particular, with 14 residents. Taste Sensory evaluation Flavor, softness, juice, texture and general acceptance, and estimating the taste sensory of the product after frying it, followed the method mentioned by [26]. Evaluation Scores for Taste Sensory Traits (Flavor, degree 8 Very strong-- Completely absent degree 1), *Softness(degree 8 very good-degree 1 very good toughness) Juicy (degree 8 very good –degree 1 very dry), texture (degree 5 very rough-degree 1 very soft), Degree of general acceptance (degree 8 very acceptable—degree 1 Totally rejected).

Statistical Analysis:

The Statistical Analysis System- [27] program was used to detect the effect of different factors on study parameters. The least significant difference –the LSD test (Analysis of Variation-ANOVA), was used to compare the means in this study significantly.

RESULTS AND DISCUSSION

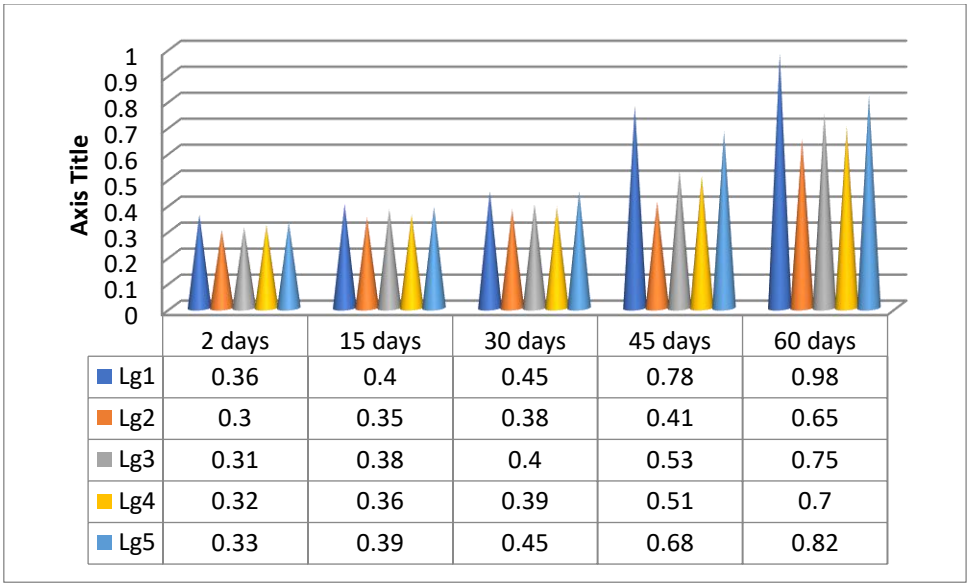
Physico-chemical Results of Buffalo Salami.

Thiobarbituric acid (TBA)

The thiobarbituric acid (TBA) number is a standard used to estimate the oxidation of fat in meat products when maturing and stoking, as the flavored flavor appears when the value of TBA in meat products has exceeded 2.0 mg Malone Aldehyde/kg model [28]. The oxidative stability TBA values (mg malonaldehyde /kg meat) of buffalo salami meat during the fermentation and maturation in Figure (1), which increased from 0.24 mg MDA/kg meat in buffalo salami mixture to (0.36, 0.30, 0.31, 0.32, 0.33) mg MDA/ kg meat for Lg1, Lg2, Lg3, Lg4, Lg5, trials respectively, after fermentation. Statistical analysis was carried out, and the results of treatments (Lg1, Lg3, Lg4, Lg5) were significant, while treatment (Lg2) was not significant after 60 days of fermentation and ripening. TBA values were increased during the 60-day ripening period. The results showed a higher percentage of TBA by increasing the period of ripening in the treatments without *C.citratus*,

which requested 0.98 mg MDA/kg meat for trial Lg1 Compared to treatment(Lg2, Lg3, Lg4, Lg5) which was recorded (0.65, 0.75, 0.70, 0.82) mg MDA/kg meat respectively. Adding *C.citratus* improved extended storage life by preventing fat oxidation during ripening periods. There was a consistent increase in TBA number values till 60 days, TBA number values were very low as far as deterioration level/rancidity level was concerned. The samples were edible even on the 60 days of ripening because lemongrass is a medicinal plant and a source of terpenes like citral that has shown antioxidant effect avoiding lipid peroxidation in food matrices [29]. The significant decrease in the value of TBA in the addition treatments is because it contains phenolic and flavonoid compounds that play an intense role as antioxidants by cleaning free radicals and converting them into stable products and ending oxidative reactions [30]. The reason for low values of thiobarbituric acid number in treatments inoculated with the starter bacteria of typical buffalo salami was due to the role of the starter in lowering pH through the production of lactic acid and thus inhibiting the activity of lipolytic enzymes, [31]. *C. citratus* possesses powerful antioxidants that reduce fat oxidation. *C. citratus* showed high contents of total phenolic and total flavonoids, as well as high free radical scavenging capacity with potential as an antioxidant [32, 5]. [33] found that when using different types of garlic with different concentrations in the manufacture of fermented sausages, the control treatment kept the thiobarbituric acid values within the permissible limits after 21 days of ripening. It refers to the role of garlic used in the sausage mixture, which has antioxidant and antimicrobial properties.

Natural antioxidants are frequently used in food products to prevent the oxidation of fat and oil in foods [34] Antioxidant activities of herbs, spices, vegetables and other extracts are similar to that of the synthetic additives [35]. herbal fresh sausages had higher antioxidant activities than the sausages adding BHT due to herbs, which contained several compounds such as polyphenolics, flavonoids, lignans, and terpenoids [36]. The results showed an increase in the values of thiobarbituric acid number with an increase in the ripening period in the treatments inoculated with the starter bacteria of buffalo salami. However, they remained within the desired standard limits in the semi-dry sausages that should not exceed 2.0 mg Malone Aldehyde/kg model. Confirms that treatments inoculated with the starter bacteria, buffalo salami meat retain the desired characteristics of the product [28]. [37], which uses Milano-type salami inoculated with Lb. Plantarum, 42 days fermentation and ripening, requested (0.43 to 1.32) mg MDA/kg meat. TBA (mg/100g) values of beef burgers supplemented by Cymbopogon citratus 2% during the frozen storage period, which recorded (0.34) two months, [38. 39] increased significantly to 0.33 mg MDA/kg, while samples with 0.50% *C.citratus* after, over the 42 days in fresh sausage.

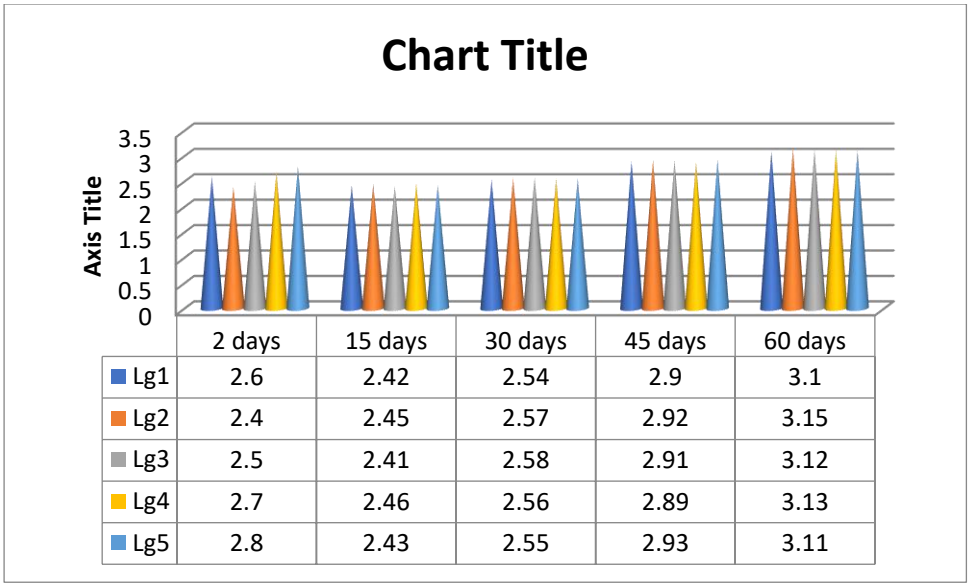


	2 days	15 days	30 days	45 days	60 days
Lg1	0.36	0.4	0.45	0.78	0.98
Lg2	0.3	0.35	0.38	0.41	0.65
Lg3	0.31	0.38	0.4	0.53	0.75
Lg4	0.32	0.36	0.39	0.51	0.7
Lg5	0.33	0.39	0.45	0.68	0.82

Figure 1. TBA values of fermented Buffalo meat salami inoculated with Lb.plantarum and enhanced by C.citratus extract. Lg1 (Spices 2%), Lg2 (*C. citratus* 2%), Lg3(Spices 1% + *C. citratus* 1%), Lg4(Spices 0.5 % + *C. citratus* 1.5 %) Lg5 (Spices 1.5 % + *C. citratus* 0.5 %)

Non-protein nitrogen (NPN).

The amount of non-protein nitrogenous substances is an indicator of proteolysis. The increase in non-protein nitrogen is due to the activity of proteolytic enzymes produced by the protein-destroying bacteria 40. Non-protein nitrogen values in buffalo salami during the fermentation were (2.6, 2.4, 2.5, 2.7, and 2.8)for trials (Lg1, Lg2, Lg3, Lg4, and Lg5), respectively. During ripening, there was an increase in NPN contents of fermented buffalo salami (Fig 2). At the end of ripening periods, results were recorded (3.10, 3.15, 3.12, 3.13 and 3.11) % for trials (Lg1, Lg2, Lg3, Lg4 and Lg5), respectively. Statistical analysis was carried out, and the results of treatments (Lg1, Lg2, Lg3, Lg4, Lg5) were significant after 60 days of fermentation and ripening. Increasing NPN values may be due to the activity of proteolytic enzymes produced by starter bacteria that break down protein, and this was consistent with what was found by [41], that the percentage of non-protein nitrogen increases in treatments inoculated with starter bacteria in fermented sausage models compared to a control treatment after 21 days of ripening. [42] indicated that the proteolysis of fermented sausage products is one of the main biological reactions that are catalyzed either by endogenous enzymes present in the meat tissue or by enzymes of microbial origin (starter bacteria), which break down meat proteins into multiple peptides. These reactions are catalyzed by muscle enzymes such as cathepsins and calpains. Protein breakdown during dry sausage ripening yields polypeptides, then the polypeptides are broken down into simple peptides mediated by peptidases enzymes, and then free amino acids. Low molecular weight peptides and free amino acids are the main components representing Non-Protein Nitrogen (NPN), which are directly or indirectly responsible for the volatile or non-volatile flavor in dry and semi-dry sausage products [43]. Results were consistent with [40] in buffalo pastrami, which recorded 2.96 % NPN after 21 days, using Lb.plantarum. [44], Which recorded 3.25 % NPN after 28 days, used mold strains on proteolysis in dry fermented sausages. [45] NPN increased during the first 28 days from 4.52% to 9.06%, which used a Spanish dry-cured pork sausage. Many factors affect the chemical and physical features of meat, such as species, genus, size, physiological status, sexual maturation and nutrition of animal [46].



	2 days	15 days	30 days	45 days	60 days
Lg1	2.6	2.42	2.54	2.9	3.1
Lg2	2.4	2.45	2.57	2.92	3.15
Lg3	2.5	2.41	2.58	2.91	3.12
Lg4	2.7	2.46	2.56	2.89	3.13
Lg5	2.8	2.43	2.55	2.93	3.11

Figure 2. Non-protein nitrogen(NPN) for the values of fermented Buffalo meat salami inoculated with Lb.plantarum and enhanced by C.citratus extract. Lg1 (Spices 2%), Lg2 (*C. citratus* 2%), Lg3(Spices 1% + *C. citratus* 1%), Lg4 (Spices 0.5 % + *C. citratus* 1.5 %) Lg5 (Spices 1.5 % + *C. citratus* 0.5 %)

Sensory evaluation for salami.

Flavor

The flavor values of buffalo meat salami during the ripening periods are shown on a scale from 1 (completely nonexistent) to 8 (very strong). Results flavor values were registered (7.3, 8.0, 7.7, 7.9, and 7.6) for trials (Lg1, Lg2, Lg3, Lg4, and Lg5), respectively, in figure (3). Statistical analysis was carried out, and the results of all treatments (Lg1, Lg2, Lg3, Lg4, Lg5) were insignificant. It was noted that the highest value in the flavor was found in trials Lg2 was reached (8.0), with a content of 2% C.citrarus. The result may be related to the citral phytochemical component, which has a strong lemon-like odor that can be pleasant to the consumer, [47]. Starter bacteria were used for the production of lactic acid. However, these are also responsible for producing organic acids, gas, flavor, aroma, and texture development in food and dairy products [48]. The lowest flavor scores were evaluated in trials Lg1 after 60 days of ripening, which was *C.citratus* free. The chicken burger formulated with lemongrass at 2% had higher levels of antioxidant activity than other treatments [49]. The enzymes in the meat tissues play an important role in flavor, 50, examined the importance of meat enzymes on the ripening and flavor development of meat products. They opined that meat enzymes also play a major role in producing flavor compounds. Results were consistent with [51] in fresh sausage with 1% Cymbopogon citratus extract, which recorded the value of flavor acceptance 6.98 (Scale of points 1- 9) for 42 days. Bulgarian-type dry-cured sausage, antioxidants, and ground spices for improving the quality of dry sausage, which recorded a value of flavor acceptance of 7.50 (Scale of points 1- 9) for 44 days, [23]. [52] confirmed that fermented sausages inoculated with Lb.plantarum, Lb.pentosus, Lb.curvatus, or a mixture of the three species and added to them with Staph. carnosus bacteria increased some flavors but did not affect the total flavor, which achieved the highest grades after ripening. 28 days, the degree reached (7), although some flavors obtained lower values. [53] found that the flavor of sausage is closely related to the compounds 3-methyl-butanal and 3-methyl-butanoic acid derived from the amino acid leucine. [54] indicated that sausage inoculated with starter bacteria releases some amino and fatty acids that improve some of the sensory properties of the product compared to the control treatment. [55] mentioned that the development of flavor in fermented cooked meat occurs as a result of the increase in the release of the amino

acids glutamic, aspartic and lysine by the activity of the initiator bacteria, while the development of the light sour flavor is due to the release of glutamic and aspartic acids. In contrast, the development of sweet flavor occurs due to the release of the two acids Alanine and glycine. Buffalo meat has excellent palatability attributes (e.g., more tender, flavorful and juicy) [56, 57].

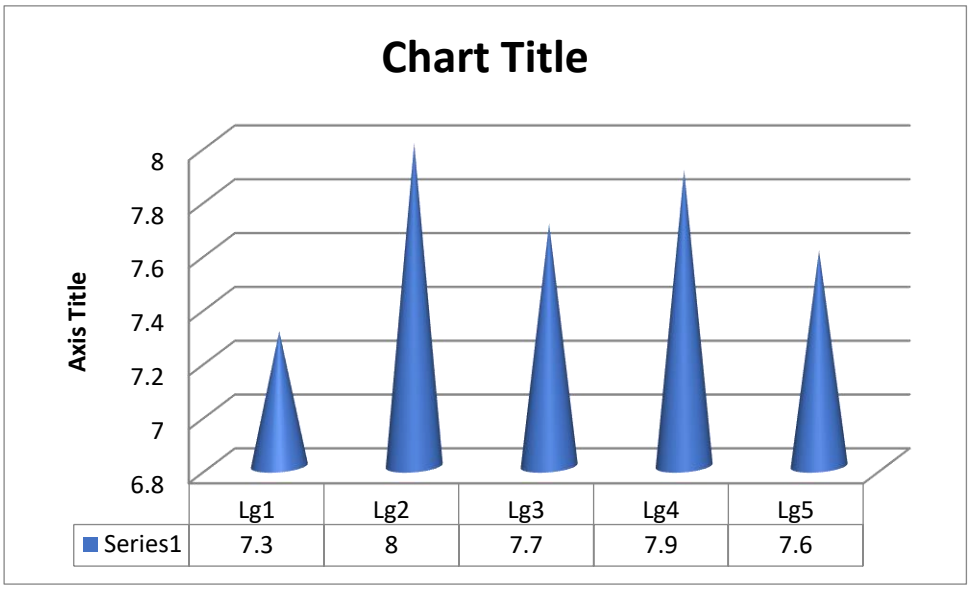


Figure 3. Sensory Evaluation of Buffalo Salami Flavor inoculated with *Lb.plantarum* and enhanced by *C.citratus* extract. Lg1 (Spices 2%), Lg2 (*C. citratus* 2%), Lg3(Spices 1% + *C. citratus* 1%), Lg4(Spices 0.5 % + *C. citratus* 1.5 %) Lg5 (Spices 1.5 % + *C. citratus* 0.5 %)

Tenderness.

Tenderness of meat is rated as the most important quality attribute by the average consumer and appears to be sought at the expense of flavor or color [58]. assessing the tenderness of the eighth week of the buffalo salami during the ripening period in scale points from 1 (very good toughness) to 8 (very good tenderness) in Figure (4), the highest score value observed for treatment Lg2 which reached 6.6, while the lowest score value for tenderness was recorded for trial Lg 1, it reached 5. Statistical analysis was carried out, and the results of all treatments (Lg1, Lg2, Lg3, Lg4, Lg5) were significant. Adding *C. citratus* improves the tenderness of the salami, and these results are similar to what Hussein found when adding *C. citratus* to improve the tenderness. lemongrass,(2%) provides best effectiveness. The antioxidant activity of lemongrass is overwhelming due to phenolic compounds which could retard lipid oxidation, consequent mark-downing of oxidative rancidity and deterioration, delaying off-flavor development and upturning consumer acceptance [49]. Water holding capacity (WHC) is one of the most important properties, including the eating quality, tenderness, juiciness, thawing drip and cooking loss of meat and meat products, [38]. This is due to the fact that *C.citratus* improves juiciness by increasing the water holding capacity (WHC) and reducing the loss of exudate liquid, which leads to an increase in the moisture content inside the salami, [59]. The results were in agreement with what was found by [60] about the difference in tenderness values in different types of meat, ranging between 4.6-7.2 n of starters. Results were consistent with [40] in buffalo pastrami, which recorded the value of tenderness 7.31 (7.5 was good) at 21 days in cultures of starter Lb. Plantarum. The treatments inoculated with the starter bacteria for all treatments retained the desired characteristics of the product, and the reason for this is due to the control of the ripening conditions in terms of temperature and relative humidity and the

occurrence of homogeneity between the center and the outer surface of the product and a decrease in moisture loss [19]. Buffalo meat has excellent palatability attributes (e.g. more tender, flavorful and juicy) [56, 57]. [61] stated that the ripening process maintains better tenderness than the freezing process, as the Tenderness value reached 3.57 in the ripening process compared to 2.75 in the freezing process out of 5.

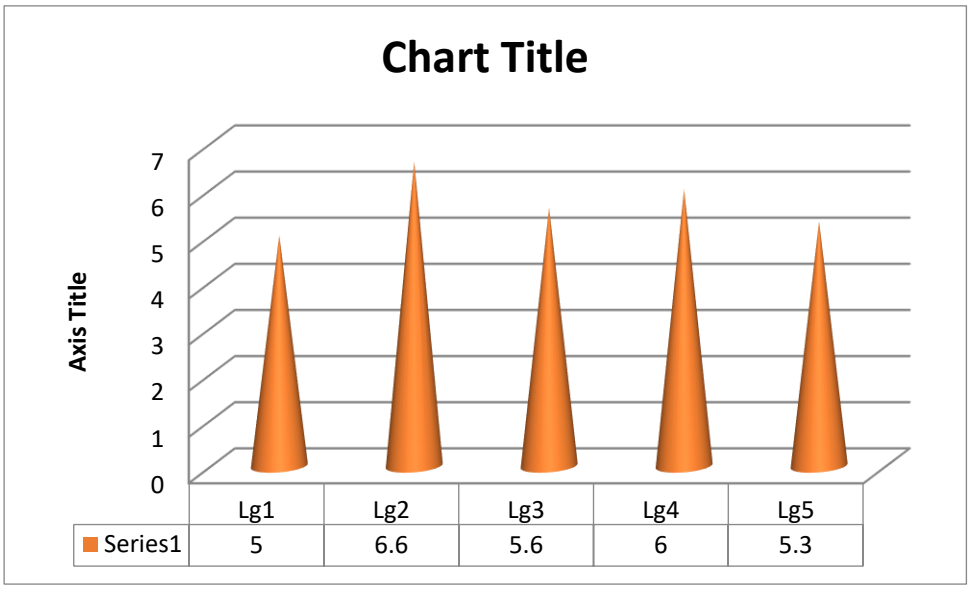


Figure 4. Sensory Evaluate of Tenderness Buffalo meat salami inoculated with Lb.plantarum and enhanced by *C.citratus* extract. Lg1(Spices 2%), Lg2 (*C. citratus* 2%), Lg3(Spices 1% + *C. citratus* 1%), Lg4(Spices 0.5 % + *C. citratus* 1.5 %) Lg5 (Spices 1.5 % + *C. citratus* 0.5 %)

Juicy

The juicy values of buffalo salami during the ripening periods are shown in Scale points from 1 (too dry) to 8 (very good). The highest score value observed for treatment Lg2 reached 7.7 in Figure (5). Statistical analysis was carried out, and the results of all treatments (Lg1, Lg2, Lg3, Lg4, Lg5) were insignificant. Juiciness is defined as the amount of water liberated from the product in the mouth after chewing, and the juiciness values in fermented sausages are usually relatively high [62]. The reason is that trial Lg2 contained 2% *C.citratus*, while the lowest score value for juicy was recorded at 7.0 for trial Lg1. This is because *C. citratus* improves juiciness by increasing the water holding capacity (WHC) and reducing the loss of exudate liquid, which leads to an increase in the moisture content inside the salami, [58]. It is noticed from the results a decrease in the percentage of juice with an increase in the ripening period and the concentration of the starter used and the percentage of *C.citratus* in the treatments inoculated with the starter bacteria of the buffalo salami, but it remained within the desired standard limits in the dry sausage, and this confirms that all the treatments retained the desired characteristics of the product, and the reason for this is due to the control of the ripening conditions In terms of temperature, relative humidity, homogeneity between the center and the outer surface of the product, and low moisture loss [19]. Buffalo meat has excellent palatability attributes (e.g., more tender, flavorful and juicy) [56, 57].

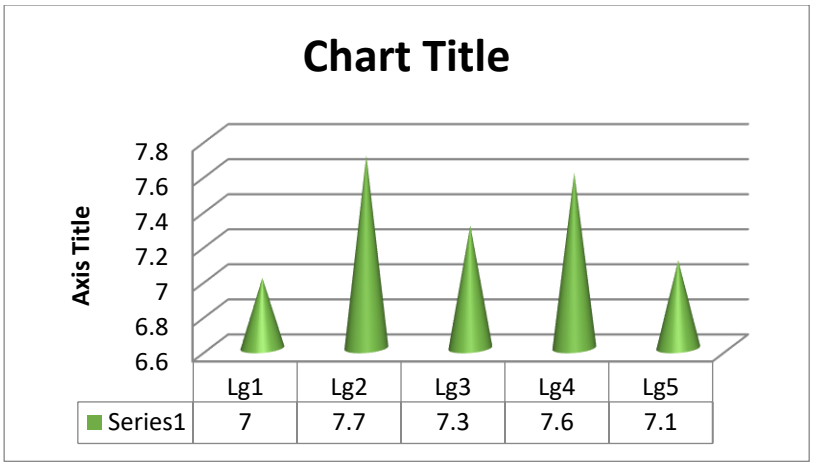


Figure 5. Sensory Evaluate of juicy Buffalo Salami inoculated with Lb.plantarum and enhanced by C.citratus extract.Lg1(Spices 2%), Lg2 (*C. citratus* 2%), Lg3(Spices 1% + *C. citratus* 1%), Lg4(Spices 0.5 % + *C. citratus* 1.5 %) Lg5 (Spices 1.5 % + *C. citratus* 0.5 %)

Texture

The texture values of buffalo meat salami during the ripening periods ranged from 1 (very soft) to 5(too rough). The highest score for texture was found in trial Lg2, which reached 3.0, while the lowest score was recorded for trial Lg 1, which was 2.0 in Figure (6). Statistical analysis was carried out, and the results of all treatments (Lg1, Lg2, Lg3, Lg4, Lg5) were significant. His result may be related to the citral phytochemical component, which has a strong lemon-like odor that can be pleasant to the consumer, [47]. The results agree with what [63] found that the tissue value of pastrami made from buffalo meat and inoculated with the starter bacteria was 7.9 compared to the control treatment, which reached 7.0 out of (10.0). These results were similar to what he found, [51], which activity 1% Cymbopogon citratus extract for application as a natural antioxidant in fresh sausage for 42 days, which recorded texture 6.73. [64] sausage wraps using chitosan films incorporating lemongrass oil after 45 days, which recorded 5.30 (scale 9 points).

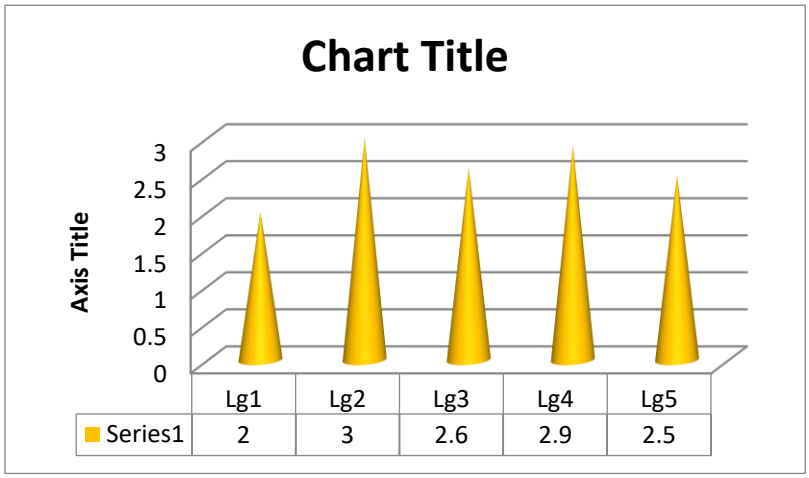


Figure 6. Sensory Evaluate of Texture Buffalo Salami inoculated with Lb.plantarum and enhanced by C.citratus extract. Lg1(Spices 2%), Lg2 (*C. citratus* 2%), Lg3(Spices 1% + *C. citratus* 1%), Lg4(Spices 0.5 % + *C. citratus* 1.5 %) Lg5 (Spices 1.5 % + *C. citratus* 0.5 %)

General acceptance.

The effect of different treatments on general acceptance on a scale from 1 (rejected) to 8 (very acceptable) in the eighth week of the maturation period of buffalo salami fermented with the bacterium Lactobacillus plantarum was observed.

The highest value was observed in trial Lg2, which reached 8.0, followed by trial 4, which registered 7.9, while the lowest score was recorded at 7.0 in trial Lg1 in Figure (7). Statistical analysis was carried out, and the results of all treatments (Lg1, Lg2, Lg3, Lg4, Lg5) were significant. *C.citratus* improved the taste sensory qualities of the manufactured salami, which included tenderness, juice, flavor and texture. Also, lactic acid bacteria play a role in the degree of general acceptance by producing acid; acidification is a desirable technological characteristic. Moreover, lactic acid, as well as other weak acids, has positive effects on the flavor because, when combined with ethanol and other products, it strengthens the perception of aroma [65]. His result may be related to the presence of the citral phytochemical component, which has a strong lemon-like odor that can be pleasant to the consumer, [47]. Results were consistent with [51] in fresh sausage with 1% Cymbopogon citratus extract, which recorded a value of general acceptance of 6.87 (7.5 was good) for 42 days. These results were similar to what he found: 23 spice freon extracts towards ground spices and antioxidants for improving the quality of Bulgarian-type dry-cured sausage, which recorded the value of flavore acceptance 6.[83] (Scale of points1- 9) for 44 days.

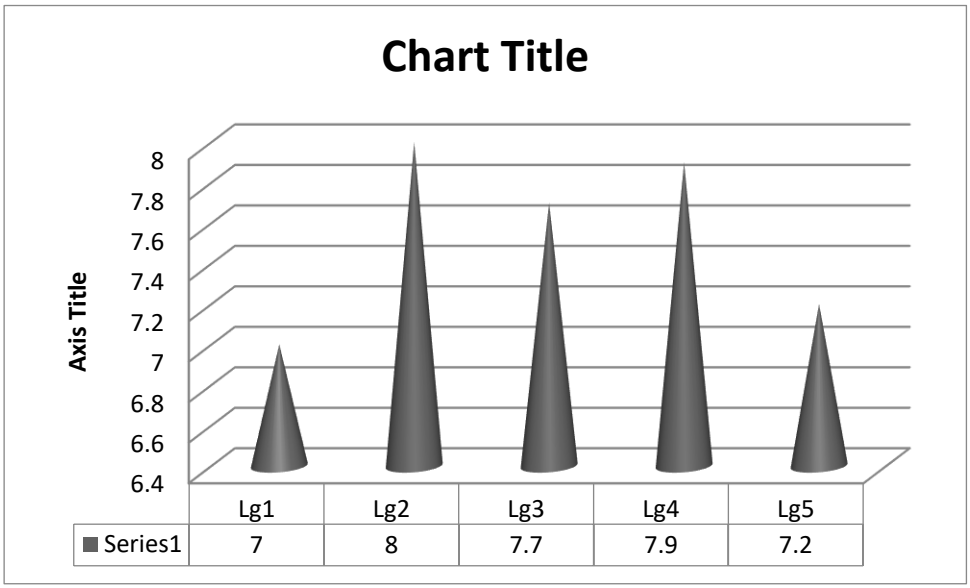


Figure 7. Sensory Evaluate of general acceptance Buffalo Salami inoculated with Lb.plantarum and enhanced by C.citratus extract. Lg1(Spices 2%), Lg2 (*C. citratus* 2%), Lg3(Spices 1% + *C. citratus* 1%), Lg4(Spices 0.5 % + *C. citratus* 1.5 %) Lg5 (Spices 1.5 % + *C. citratus* 0.5 %)

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