Journal of Applied Food Technology

Home page: https://ejournal2.undip.ac.id/index.php/jaft

Influence of Fermentation Time on Total Lactic Acid Bacteria, pH Value, Water Activity, and Organoleptic Properties of Mutton Jerky

Bambang Dwiloka*, Heni Rizqiati, Siti Susanti, Rafli Zulfa Kamil, Sri Mulyani, Farrel Ihza Noer Susanto

Department of Food Technology, Faculty of Animal and Agricultural Sciences, Diponegoro University, Tembalang, Semarang 50275, Indonesia

*Corresponding author (bdl_consulting@yahoo.com)

Abstract

Mutton is a type of meat that is rarely consumed by the public because it has a high saturated fat content. Mutton has good quality and characteristics and can be used as a functional product to improve body health by adding probiotic bacterial cultures. Mutton jerky can be an alternative to functional meat products. Mutton jerky is fermented utilizing a probiotic starter *Lactobacillus plantarum* for 6 hours (T1), 12 hours (T2), 18 hours (T3), and 24 hours (T4). The fermented mutton jerky is then dried in a cabinet for 8 hours and then examine. Total lactic acid bacteria was examined by dilution, pH value by pH meter, water activity by a_w meter, and organoleptic properties by sensory test. The data of total lactic acid bacteria were analyzed descriptively. The data of pH value and water activity is processed with the ANOVA test and the nonparametric test with the Kruskal Wallis method. The result of this research show fermentation time on lowering the pH value and water activity. At the same time, the total lactic acid bacteria experienced a decrease in value which was analyzed descriptively. The conclusion of this research is that the longer the fermentation will cause a decrease in total LAB, pH value, and water activity and affect the panelist's assessment of the organoleptic test. Mutton jerky with the addition of *L. plantarum* bacterial starter, which was fermented for 18 hours, had the best treatment to produce low pH values and water activity.

Article information:
Received: 28 November 2024
Accepted: 17 December 2024
Available online: 20 December 2024

Keywords:
fermentation
functional
Lactobacillus plantarum
mutton

doi: 10.17728/jaft.25148

Introduction

Introduce the topic and rationale for addressing this topic focusing on the reason why this topic is important. Clearly explain exactly what this article will discuss, outline the order in which the author wishes and contribution of the paper. Currently, chicken and beef dominate the needs of the community. Goat meat can be used as an option for people to consume. However, people's demand for mutton can decrease and become a problem in the development of sheep livestock because this livestock meat contains high saturated fat, it can interfere with the health of the body (Riemas et al., 2021). Mutton has a high white fat content in the sinew, the flesh is pink in colour, and the fibre is soft.

Jerky can be used as a diversified food product. Meat processing does not have a significant impact when viewed from its nutritional quality, but this can provide characteristics such as colour, aroma and distinctive taste resulting from each process used (Ribeiro et al., 2021). Processing meat into jerky products aims to increase shelf life. In addition, meat processing can be used as an income source for economic benefits for the community for home industries.

Jerky is a traditional food with the basic ingredients of sliced or ground meat with added spices and then dried. Jerky is a product that has the term "*dry cured meat*" with the characteristics of a food that has low moisture and high protein content (Purnamasari et al., 2013). The process of making beef jerky is carried out through a fermentation process by adding a starter culture, namely *Lactobacillus plantarum*. The starter culture can play a role in reducing the characteristic odour caused by mutton jerky. In addition, the use of this type of lactic acid bacteria is commonly used in meat fermentation processes to prevent deterioration of characteristics and extend shelf life.

Materials and Methods

Starter Production

A pure culture of *L. plantarum* in MRSA media is inoculated in MSRB media, and then incubated at 37°C for 24 hours. The 2% of culture inside the MRSB is then inoculated again in a sterile skim solution before re-incubated for 24 hours in the same temperature, this culture is labelled as the mother culture. The 2% of mother culture would then be inoculated again in a

Table 1. Average value of total lactic acid bacteria, pH value, and water activity in mutton jerky.

Parameters	Treatment			
	T1	T2	T3	T4
Total LAB (log CFU/mL)	7.9×10^7	7.8×10^7	7.7×10^7	7.5×10^7
pH Value	6.270 ± 0.073^b	6.136 ± 0.009^a	6.114 ± 0.114^a	6.144 ± 0.152^a
Water Activity	0.474 ± 0.003^c	0.448 ± 0.006^a	0.447 ± 0.002^a	0.466 ± 0.002^b

sterile skim solution resulting in mid-culture, this 2% of culture is then inoculated again with a sterile skim solution finally resulting in a work culture that will be utilized to ferment mutton.

Jerky Production

Mutton collected from a butcher house owned by Haji Ali from the region of Dukuhturi, Tegal. The femur part of the sheep is then sliced thinly with a thickness of about 5 mm, and then flatten. 50 grams of mutton is then added to 21 gram of mixture seasoning that contains salt, sugar, coconut sugar, pepper, garlic, coriander, and galangal. 3% of the starter is added to the mixture of mutton and seasoning and then this mixture is fermented for as long as the treatment dictates. T1 is fermented for 6 hours, T2 for 12 hours, T3 for 18 hours, T4 for 24 hours.

Total Lactic Acid Bacteria Analysis

Testing for total lactic acid bacteria is based on the research of Joni *et al.* (Joni et al., 2018). Isolates from each sample grown on MRSA media at dilutions of 10^{-1} to 10^{-8} were counted as a whole. The number of colonies obtained from each dilution was then calculated for the total lactic acid bacteria growing by multiplying the number of colonies by one per dilution factor used. The number of colonies used in the calculation of total lactic acid bacteria is between 25-250 colonies and the unit for calculating the number of bacteria is CFU/mL.

pH Value Analysis

Testing the pH value is based on the research of Kosim *et al.* (Kosim et al., 2015). The pH value of the meat was measured using a meat pH meter. The tool is calibrated first using a buffer solution with a pH of 4.01 and 6.86. Jerky with a size of about 6 x 6 cm was folded two times and the pH meter electrode needle was inserted into the jerky beef fold. The pH value of beef jerky will be shown by a number that appears on the tool stably.

Water Activity Analysis

Water activity testing is based on the research of Dijayanti *et al.* (Dijayanti et al., 2021). Water activity (a_w) was measured using an aw meter. The tool will be calibrated first using a saturated NaCl solution. A sample of 5 g is mashed and put into the sample room. The start button is pressed and waited until the water activity value is obtained, which is analyzed by the tool.

Organoleptic Properties Test

Organoleptic testing is based on the research of Dapamawu *et al.* (Dapamawu et al., 2021). Attributes of organoleptic properties, which include colour, aroma, taste, and texture, were assessed using a ranking test.

Data Analysis

The data of lactic acid bacteria total were analyzed descriptively. Water activity and pH value are analyzed using ANOVA (Analysis of Variance) with a significance level of 5% and then continued with Duncan Multiple Range Test. The data incurred from the organoleptic properties test is analyzed using the Kruskal Wallis test with a significance level of 5% and continued with the *Mann-Whitney* method.

Results and Discussion

Total Lactic Acid Bacteria

The results shown on table 1 shows that the different treatments to mutton jerky resulted difference in total lactic acid bacteria of mutton jerky. Total lactic acid bacteria were analyzed descriptively. At the beginning of the fermentation process, which lasted for 6 hours, the number of lactic acid bacteria increased, and the longer the fermentation time in making beef jerky, the population of lactic acid bacteria decreased. Lactic acid bacteria have a large number when accompanied by the availability of nutrients and temperature factors as well as the ongoing fermentation process (Kinteki et al., 2018). Lactic acid bacteria produce a compound called bacteriocins and there are several other types of antimicrobial compounds such as organic acids, diacetyl, hydrogen peroxide, and bacteriocins. The bacteriocin produced by LAB has the ability to increase resistance and obtain a final product with a high level of consistency (Yulvizar et al., 2022). The fermentation process carried out by lactic acid bacteria, in general, will carry out the process of metabolizing lactose into lactic acid.

pH Value

The results shown on table 1 shows that the different treatments to mutton jerky resulted in a real difference in pH value of mutton jerky, with the value of p 0.05. an extended test done with the DMRT method shows that there is a real effect (P<0,05) of diferrent in fermentation during to the increase of pH value. The decrease in pH value was caused by the presence of lactic acid bacteria used, namely *Lactobacillus plantarum*. The fermentation process carried out on food products using lactic acid bacteria will decrease the pH value and increase acidity due to the presence of carbohydrates used to produce lactic acid (Solehah et al., 2022). There are different pH values produced because each has a different fermentation time and a good pH value for beef jerky with a pH range of 5.19-5.90 (Febrina et al., 2019). Changes in the pH value have other factors, such as the water content contained in the product and the WHC (*Water Holding Capacity*) value. Decreasing the pH value will result in protein denaturation, and this denatured protein will decrease the solubility of the protein so that the water holding

Table 2. Average value of hedonic value of mutton jerky

Sensory Atribute	Treatment			
	T1	T2	T3	T4
Colour	2.96±1.274	2.84±1.143	3.56±1.417	3.40±1.500
Aroma	2.24±0.779	2.16±0.624	2.08±0.572	2.24±1.128
Taste	2.92±0.909[a]	2.68±0.900[a]	3.16±0.746[a]	3.68±0.627[b]
Texture	1.92±0.702[a]	2.32±1.069[a]	2.28±0.843[a]	2.88±0.881[b]

capacity decreases. The process of making jerky causes chemical changes due to the cooking of muscle protein into smaller structures so that it can lower the pH and water holding capacity.

Water Activity

The results shown on table 1 shows that the different treatments to mutton jerky resulted in a real difference in water activity of mutton jerky, with the value of p 0.05. an extended test done with the DMRT method shows that there is a real effect (P<0,05) on the increase of water activity of P1, P2, P3, and P4. The resulting data shows that the value of water activity has decreased due to the decreased pH value due to lactic acid produced by lactic acid bacteria. The water content is very influential on food ingredients because it relates to the shelf life of these foods (Olejnik et al., 2021). The process of making beef jerky needs control regarding water activity and water content because the two are interrelated. If the free water content of the material is higher than the air, the air will absorb water in the material and if the air moisture content is higher, the water in the air will be absorbed by the material until an equilibrium is reached (Delviani et al., 2021). Foodstuffs that contain water activity will affect resistance to microbial attack. Microbes can experience growth and damage the structure of foodstuffs so that they will affect their characteristics. The good water activity value for jerky quality is below 0.85 so the food is safe for consumption.

Organoleptic Properties

a. Colour

In general, beef jerky has a brownish colour which is caused by the Maillard reaction. The Maillard reaction is caused by the carbonyl group of the reducing sugar reacting non-enzymatically with the amino group of meat protein and amino acids to produce a brown colour (Febrianingsih et al., 2016). In addition, the addition of spices used to make beef jerky affect the browning of products such as brown sugar. Brown sugar is a type of seasoning used to improve the colour of food products consumed.

b. Taste

The average value of the taste parameter is low, with a taste that is not sweet and rather sweet. The heating process makes the sweet taste less because sucrose is converted into reducing sugar which has a role in the browning reaction (Anwar et al., 2022). In addition, the heating process affects the melting of fat in the meat so that the fat components are reduced to production of volatiles such as hydrocarbons and aldehydes which affect the flavour. Things that can affect the formation of taste can be formed from the factors of the use of seasonings and temperature.

c. Aroma

Humans can recognize that food is delicious through the sense of smell so that it can determine the acceptability of a food. The process of making jerky can cause an aroma that comes from the mixture of spices into the jerky during fermentation (Purdiyanto, 2016). Drying for the manufacture of jerky causes some of the compounds in jerky to evaporate so that aroma can be formed. The aroma can arise due to the browning reaction on the spices by the influence of heating.

d. Texture

The use of spices used to make jerky can improve the texture of the resulting jerky. Granulated sugar is one of the spices that can improve the texture of beef jerky. The resulting texture may be affected by less water content, so the resulting texture becomes rough and wrinkled. The water content has a role in the texture characteristics of the beef jerky produced (Frans et al., 2016). In addition, the texture of the product is affected by the proportion of drying used and the intramuscular fat content in the meat.

Determination of The Best Treatment Based on Total LAB, pH Values, Water Activity, and Organoleptic Properties

The best total lactic acid bacteria is given for a high percentage in treatment P1. The high content of LAB has the quality of food products that are good for health. Good food products contain at least 1×10^7 CFU/g lactic acid bacteria until the end of their shelf life (Usman et al., 2019). The best pH value is the one with a low value in the P3 treatment. The best water activity parameter was given to the treatment with the lowest value, namely the P3 treatment. The best quality jerky meat is jerky that has a low water activity value because it can control the microbial growth of the product. Based on the determination of the best treatment, it can be concluded that the best treatment for mutton jerky is the P3 treatment (18 hours of fermentation). Meanwhile, produce mutton jerky based on the panellist preference assessment, namely the P4 treatment (24 hours of fermentation).

Conclusions

Based on the research that has been done, it can be concluded that the longer the fermentation will cause a decrease in total LAB, pH value, and water activity and affect the panellist assessment of the organoleptic properties test. Treatment with a long fermentation time of 18 hours was the best treatment to produce low pH values and water activity. Meanwhile, the best organoleptic properties were mutton jerky which was fermented for 24 hours.

Acknowledgements
The authors would like to acknowledge the Diponegoro University for the support in completing this research.

References

Anwar, C., Irmayanti, I., Ambartiasari, G. 2022. Pengaruh lama pengeringan terhadap rendemen, kadar air, dan organoleptik dendeng sayat daging ayam. Jurnal Peternakan Sriwijaya 10(2): 29–38. DOI:10.36706/jps.10.2.2021.15730.

Dapamawu, R., Malelak, G.E.M., Kale, P.R. 2021. Pengaruh pemberian ekstrak tepung rosela (*Hibiscus sabdarifa*) terhadap sifat fisik dan kimia dendeng daging babi. Jurnal Nukleus Peternakan 8(1): 33–39.

Delviani, Y., Lestari, S., Lestari, S.D., Ridhowati, S. 2021. Kajian mutu dan daya simpan dendeng udang putih (*Penaeus merguensis*) selama pengemasan dan penyimpanan suhu ruang. Agrointek 15(2): 608–616. DOI:10.21107/agrointek.v15i2.9690.

Dijayanti, S.R., Rosyidi, D., Evanuarini, H. 2021. Moisture, fat and fatty acid profile of beef dendeng in Malang City. Jurnal Ilmu dan Teknologi Hasil Ternak 16(1): 32–41. DOI:10.21776/ub.jitek.2021.016.01.4.

Febrianingsih, F., Hafid, H., Indi, A. 2016. Kualitas organoleptik dendeng sapi yang diberi gula merah dengan level berbeda. Jurnal Ilmu dan Teknologi Peternakan 3(2): 10–15.

Febrina, B.P., Tuti Suryati, T., Arief, I.I. 2019. Karakteristik dendeng lambok khas sumatera barat dengan metode pengolahan dan lama penyimpanan yang berbeda. Jurnal Ilmu dan Teknologi Peternakan Tropis 6(1): 92. DOI:10.33772/jitro.v6i1.5451.

Frans, S.K., Detha, A.I.R., Tangkonda, E. 2016. Pengaruh pemberian konsentrasi gula lontar pada dendeng ikan tembang (*Sardinella fimbriata*) terhadap lama simpan berdasarkan kadar air, nilai organoleptik dan total cemaran mikroba. Jurnal Kajian Veteriner 4(2): 28–39.

Joni, L.S., Erina, Abrar, M. 2018. Total bakteri asam laktat (BAL) pada feses rusa sambar (*Cervus unicolor*) di taman rusa aceh besar. Jurnal Ilmiah Mahasiswa Veteriner 2(1): 77–85.

Kinteki, G.A., Rizqiati, H., Hintono, A. 2018. Pengaruh lama fermentasi kefir susu kambing terhadap mutu hedonik, total bakteri asam laktat (BAL), total khamir, dan pH. Jurnal Teknologi pangan 3(1): 42–50.

Kosim, A., Suryati, T., Gunawan, A. 2015. Sifat fisik dan aktivitas antioksidan dendeng daging sapi dengan penambahan stroberi (*Fragaria ananassa*) sebagai bahan curing. Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan 3(3): 189–196.

Olejnik, T.P., Mysakowski, T., Tomtas, P., Mostowski, R. 2021. Optimization of the beef drying process in a heat pump chamber dryer. Energies 14(16):. DOI:10.3390/en14164927.

Purdiyanto, J. 2016. Evaluasi kualitas dendeng yang beredar di pasaran kabupaten pemekasan dengan metoda uji sensoris. Maduranch 1(1): 17–22.

Purnamasari, E., Munawarah, D.S., Zam, D.S.I. 2013. Mutu kimia dendeng semi basah daging ayam yang direndam jus daun sirih (*Piper betle* l.) dengan konsentrasi dan lama perendaman berbeda. Jurnal Peternakan Vol Februari 10(1): 917.

Ribeiro, J.S., Silva, L.K.R., Silva, M. V da. 2021. Natural antioxidants used in meat products. Meat Science 148 181–188. DOI:10.1007/978-3-030-45299-5_10-2.

Riemas, G.A., Hernaman, I., Ramdani, D., Nurhadi, B. 2021. Dampak pemberian mikroenkapsulasi minyak ikan dalam pakan terhadap kolesterol darah dan performa pada domba. Jurnal Agripet 21(1): 5–11. DOI:10.17969/agripet.v21i1.16627.

Solehah, M., Riyanti, R., Wanniatie, V., Septinova, D. 2022. Pengaruh pemberian *lactobacillus acidophilus* terhadap pH dan daya ikat air daging broiler. Jurnal Riset dan Inovasi Peternakan 6(2): 151–157.

Usman, N.A., Suradi, K., Gumilar, J. 2019. Pengaruh konsentrasi bakteri asam laktat *Lactobacillus plantarum* dan *Lactobacillus casei* terhadap mutu mikrobiologi dan kimia mayonnaise probiotik. Jurnal Ilmu Ternak Universitas Padjadjaran 18(2): 79–85. DOI:10.24198/jit.v18i2.19771.

Yulvizar, C., Hanum, M., Iskandar, E., Ismail, Y.S. 2022. Isolasi dan skrining bakteri asam laktat dari daging kerbau Aceh. Jurnal Bioleuser 6(3): 5–8.