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# Sodium lactate as a potential preservative to green mussel meat

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**Abstract**

The short shelf life of green mussels could limit its consumption and wider distribution to the market and thus, proper storage of this product is necessary. In this study, the effects of different concentrations (1%, 2%, 3%, and 4%) of sodium lactate on the preservation of green mussels during chilled storage of nine days were determined. Changes in pH and weight loss of the mussel meat were recorded every three days. Results showed that the pH values of the treated samples are around the neutral pH (6.7 to 7.1) and are significantly higher than the untreated samples throughout the duration of storage. No significant difference was observed in the weight loss between the control and treatment groups. Thus, the results of the parameters showed that sodium lactate has the potential to be utilized as a preservative agent for meat.

**Introduction. -** Green mussel (*Perna viridis*) is a type of shellfish that is commonly sold in local markets. This bivalve is widely consumed, especially by people living in coastal areas, as a cheap protein source [1]. However, the process of transporting these products from mussel farms to different markets is too laborious due to the small amount of meat produced per kilogram of the green mussels. Consequently, the immediate consumption or proper storage of this product is necessary since it could only be stored for two (2) days at ambient temperature [2]. The process of product deterioration occurs due to the growth of bacteria in the product over time [3]. The development of a processing method is important for extending the shelf life of mussels [4] since this could ensure that the product is still safe for consumption after a period of time.

Various methods on the preservation of green mussel meat, including pre-treatment with organic acids and modified atmosphere packaging, have already been studied. Organic acids are commonly used in food preservation since they have the ability to inhibit the growth of microorganisms, and they also occur naturally in food (i.e. lactic acid from corn and citric acid from oranges) [5]. Preservation occurs when the molecules of these acids dissociate inside bacterial cells due to low pH, resulting in the release of toxic charged anions and protons that inhibit the metabolic reactions of the bacteria [6,7]. Organic salts of these acids, such as sodium acetate, sodium lactate, and sodium citrate, are also used for food preservation.

Sodium lactate is the organic salt of lactic acid that is generally produced from natural lactic acid that is reacted with sodium hydroxide [8], and is reported to be a very prominent flavor enhancer with few negative effects [9]. The addition of this organic salt to meat products delays the development of sour and off-flavors by binding to free radicals in the meat to prevent lipid oxidation [9].

One of the qualities that are analyzed in food preservation is weight loss. This property is an important indicator because it is attributed to the loss of water in the meat [10]. High water retention in food may serve as a nutrient and contribute to the microbial proliferation in the product [4]. Sodium lactate is known for its ability to improve the moisture retention of materials [11]. The addition of sodium lactate to meat products has shown improvement in the cooking yield of the meat due to its humectant properties that contribute to the water-holding capacity of the product [12]. There are three proposed mechanisms by which sodium lactate can have an antimicrobial effect: (1) It has the ability to lower the water activity of the meat and thereby slowing the bacterial growth; (2) Sodium lactate passes through the cell membrane and lowers intracellular pH; and (3) It affects the cellular metabolism by inhibiting $ATP^2$ generation [13]. The lactic acid portion of sodium lactate and the sodium ion has antimicrobial effects, which slows down the normal metabolic process that generates energy in the cell [13].

Additionally, pH values are usually measured as a quality indicator for seafood products. The ideal pH of green mussels ranges from 6.00-6.85 [14].

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According to Miller (2010) [13], sodium lactate addition is associated with increasing the meat pH, increasing the water-holding capacity, and reducing cook losses which results in the increase in the tenderness of meat. Sodium lactate has been proven to be an effective additive in preserving seafood products such as refrigerated sliced salmon [15], and refrigerated rainbow trout [16]. It is also hypothesized that sodium lactate has the ability to preserve green mussel meat. Therefore in this study, sodium lactate was utilized as an additive for the preservation of green mussel meat.

This study aims to determine the effects of different concentrations of sodium lactate on the preservation of green mussel meat during chilled storage. Specifically, this study aims to:

(i) measure the weight loss of the green mussel meat after treatment with different concentrations (1%, 2%, 3%, 4%) of sodium lactate and without treatment for 9 days.

(ii) determine the change in pH of the green mussel meat after treatment with different concentrations (1%, 2%, 3%, 4%) of sodium lactate and without treatment for 9 days

**Methods. -** The methods for the conduct of this study were designed to be doable at home. Two parameters were analyzed, namely the change in pH and weight loss. Each member of the work unit prepared a set-up of the experiment. However, the same materials were utilized for the conduct of the experiment. The experiment performed was the same for both set-ups. Green mussels were obtained from a mussel farm in Dangula-an, Anilao, Iloilo. Aqueous solutions of sodium lactate with different concentrations (1%, 2%, 3%, 4%) were prepared for the treatment of the shucked mussel meat.

The study was conducted for 9 days, and analyses of weight loss and pH were performed every 3 days during the duration of the study. Samples were stored in a storage condition of 3 ± 1°C [4].

*Sample collection.* Samples of green mussels were collected in Dangula-an, Anilao, Iloilo. An icebox filled with seawater was used to store the mussels. The samples were then transported back to Iloilo City, with the duration of the travel being approximately one hour from the collection site.

*Sample preparation.* Upon arrival, the mussels were shucked, washed with distilled water, and drained. Mussels having a foul odor or open shells were removed. A total of 2 kg of mussel meat was obtained. The mussels were divided into five (5) groups: (a) 1% sodium lactate, (b) 2% sodium lactate, (c) 3% sodium lactate, (d) 4% sodium lactate, and (e) negative control, which are the samples without treatment. Sodium lactate (USP grade) was purchased online through the website of Dalkem Corporation. The formula $C_1V_1 = C_2V_2$ was used to calculate the different concentrations of sodium lactate. The concentrations 1%, 2%, 3%, and 4% were obtained by diluting 60% sodium lactate solution with distilled water. The solutions were stored in clean, plastic bottles. The calculations were as follows:

Calculation for 1%:

$$C_1V_1 = C_2V_2$$
$$60\% \cdot V_1 = 1\% \cdot 1000\,mL\ water$$
$$V_1 = 16.67\,mL$$

Calculation for 2%:

$$C_1V_1 = C_2V_2$$
$$60\% \cdot V_1 = 2\% \cdot 1000\,mL\ water$$
$$V_1 = 33.33\,mL$$

Calculation for 3%:

$$C_1V_1 = C_2V_2$$
$$60\% \cdot V_1 = 3\% \cdot 1000\,mL\ water$$
$$V_1 = 50.00\,mL$$

Calculation for 4%:

$$C_1V_1 = C_2V_2$$
$$60\% \cdot V_1 = 4\% \cdot 1000\,mL\ water$$
$$V_1 = 66.67\,mL$$

For the sample storage, 20 plastic resealable bags were utilized. A different bag for each treatment was used for every sampling interval. The ratio of the weight of the mussels to the solution is 1:2. Each pack of samples contains 100 g of green mussel meat. The samples were treated with 200 ml sodium lactate solution. The solutions were then poured into the resealable plastic bags according to the labels. The samples were stored inside the refrigerator for nine (9) days with a storage condition of 3 ± 1°C [4]. A thermometer was utilized in order to monitor the temperature inside the refrigerator.

*pH determination.* The pH of the control and treated samples was measured using a pen-type pH meter (Milwaukee, PH600AQ Digital pH Pen). This device was calibrated by measuring the pH of distilled water in every sampling interval before analysis. The pH of each group was determined by following the standard method of measuring the pH of solid-liquid mixtures. The samples were drained using a strainer to separate the mussel meat from the solution. The liquid solution was transferred to a beaker, and then its pH value was measured. Then, the mussels were blended into a homogenous paste and the pH measurement was taken. After that, the liquid solution and paste were combined, and pH was measured. The measurements were done in triplicates.

*Weight loss.* For the weight loss determination, the samples were weighed before and after storage. An analytical balance (Shimadzu, BL3200H) was utilized to determine the weight of the samples. This analysis was done in triplicates for every sampling interval. Percentage of weight loss was determined using the formula [17]:

$$Weight\ loss\ (\%) = \frac{initial\ weight - final\ weight}{initial\ weight} \times 100$$

*Data Analysis.* The data gathered was analyzed using One-way ANOVA, and post-hoc analysis was evaluated using Duncan's multiple range test. Differences between the means of the control and treated samples were examined with the level of significance set at $\alpha < 0.05$. This analysis was performed through the SPSS software.

*Safety Procedure.* The use of safety equipment such as laboratory gowns, gloves, and surgical masks was observed at every sampling interval. Different types of waste were segregated into different bins, and liquid wastes were collected in empty plastic bottles.

**Results and Discussion.** - The study aimed to determine the effects of different concentrations of sodium lactate on the preservation of green mussel meat. To this end, the pH change and weight loss of treated and untreated samples were monitored for 9 days.

*Weight loss analysis.* Weight loss is attributed to the loss of water in meat products [4]. High water retention is linked to the deterioration of meat since it might serve as a nutrient, which contributes to the microbial proliferation in food products [18]. However, the ability of a product to retain water is also integral to its quality in terms of juiciness and tenderness [19].

All samples showed a decrease in weight at the end of the storage. Results of the statistical analysis showed no significant difference in the weight loss between the control and treatment groups (Figure 1). This indicates that adding sodium lactate has no significant effect on the water retention of the mussel meat. The ability of myofibrillar proteins and myofibrils to entrap water is directly affected by pH and ionic strength [20]. This may explain the absence of significant difference in the weight loss between the treated and untreated samples since the pH values recorded are near neutral.

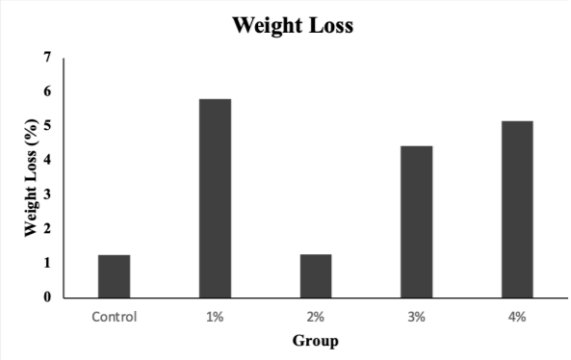


**Figure 1.** Percent weight loss of treated (1%, 2%, 3%, or 4% sodium lactate) and untreated samples after treatment (n=3). No significant difference observed between the treated samples and control.

In the second set-up, the analysis also showed no significant difference between the weight of the control and the treated samples. The mussels had high water retention since the weight loss percentage was low. Sodium lactate exhibits high water holding capacity which may explain the low weight loss of the samples [21].

*Changes in pH.* One of the physical qualities that are frequently analyzed for food quality control is pH value [4]. This factor is examined along with the Total Volatile Basic Nitrogen (TVB-N), Trimethylamine Nitrogen (TMA-N), and Thiobarbituric acid reactive substances (TBARS) for seafood quality assessment [22]. It indicates the degradation of muscle components and post-mortem change of glycogen to lactic acid during long storage [23].

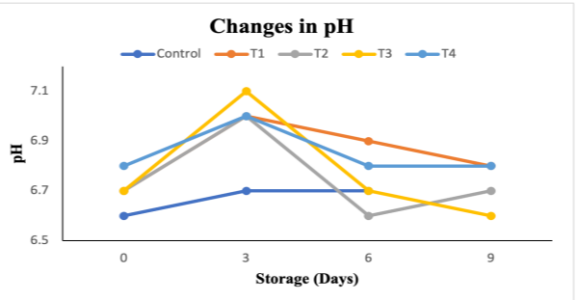


**Figure 2.** The trend of change in pH of the homogenized mussel meat observed per treatment throughout the nine-day period (n=3).

It is observed that all groups have yielded a pH value that is near neutral. The pH values of the mussel meat for the last day of storage were lower compared to the initial pH values. Figure 2 shows the trend of the pH change per group throughout the storage period. Based on the initial pH values of the treated and untreated samples, an increase in the pH of the treated samples could be observed on the third day of storage. After this, the pH value of the samples eventually decreased in the succeeding days except for treatment 4, where an increase in pH was observed on the final day of storage. Slight changes in the pH value upon addition of sodium lactate were also observed in other studies on meat products such as ground beef [24], cig kofte [25], poultry sausage [26], and sliced salmon [14]. Sallam and Samejima [24] indicated that sodium lactate has the ability to stabilize the pH of most meat products during storage. The recorded pH of the treated samples in this study verified an almost constant pH since all treatment groups have maintained pH values that are near neutral (6.7-7.1) throughout the duration of storage. The results of this analysis contradict the data reported in the study conducted by Eckert et al. [27], and Tan and Shelef [28], where it was stated that sodium lactate had no significant effects on the initial pH of ground meat products.

After the 9-day period, One-way ANOVA showed that the green mussels treated with sodium lactate have pH values significantly higher than the control group which indicates that there is a significant difference between the groups of samples. However, no significant difference was found to exist between the treatment groups, which implies that these four (4) treatments are not significantly different in terms of their effect on the pH of green mussel meat during chilled storage. This further indicates that 1% sodium lactate is enough to significantly increase the pH value of green mussels during storage. Having a pH value near neutral indicates that the green mussels are still safe for consumption. A decline in pH values could be due to factors such as post-mortem changes, muscle component degradation, and the fermentative conversion of glycogen [18,29]. It could also be attributed to increasing microbial count, which could be considered as the deterioration stage of the product [30]. A pH value of 5.9 for mussels is an indicator of deterioration according to Hardey [31].

However, no significant difference has been found between the control and treated groups during

the second set-up. The result may have been affected due to an error in data gathering during the first sampling interval. The pH was not correctly measured because the mussels were not blended and there was no separate measurement for the liquid part. Throughout the storage, the pH of the control has declined. This was also observed in the study conducted by Arcales and Nacional (2019) [21] that showed that the control samples had a near-neutral pH value at the start of the study and had decreased during storage.

The results of the analysis conducted on the weight loss and pH in the untreated and treated samples showed that the effect of adding sodium lactate is only evident on the change in pH and not on the percent (%) weight loss. An increase in the pH value of the samples was only observed on the third day of sampling. Based on these data alone, it could be inferred that the addition of 1% sodium lactate is already sufficient in increasing the pH level of green mussel meat that makes it suitable for consumption after longer storage. Although the pH value of the control group is significantly lower, it still falls in the range of suitable pH values for green mussels. Therefore, the data collected in this study only shows that sodium lactate has the potential to be used as a preservative agent as evidenced by its ability to increase the pH value of green mussel meat. Further analysis on the microbial proliferation and chemical reactions taking place in green mussel meat treated with sodium lactate shall be made to further determine the effectiveness of sodium lactate as a preservative for green mussels.

*Limitations.* A power outage occurred during the storage which lasted for 10-15 minutes (during the first set-up) and 30 minutes (during the second set-up). This circumstance may have affected the storage condition of the samples. Slight differences in the draining time of the samples may have affected the recorded weight of the samples in every sampling interval.

**Conclusion.** - The results obtained from each parameter showed that there is a significant difference in the pH between the treated and untreated samples. However, no significant difference was observed in the weight loss of the control and treatment groups. These results indicate that sodium lactate has the potential to be used as a preservative to green mussel meat. However, further analysis on the microbial proliferation and chemical reaction taking place in the mussel meat must be performed to determine the effectiveness of sodium lactate as a preservative and to further prove this claim.

**Recommendations.** - A study analyzing the bacterial load and chemical reactions taking place in green mussel meat after subjecting to sodium lactate preservation must be conducted to determine the quality of green mussel meat after the addition of the organic salt. Other recommendations include the setting of a specific duration for the draining time and provision of a backup power source in case of power outages. The addition of parameters to be analyzed such as TVB-N and TMA-N determination and sensorial evaluation is also recommended. Another recommendation is the addition of a positive control group such as using other organic substances such as sodium acetate, lactic acid, and sodium citrate, which already have established concentrations for green mussel meat preservation, in order to have a comparison for the efficacy of the organic salt that is utilized in the study.

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**References**

[1] Azanza MP, Azanza R. Ventura S. 2005. Heat Shocking of Philippine Green Mussels, *Perna viridis*. Int. J. of Food Sci. and Tech. 40: 689-694.

[2] Batista I, Mendes R. 2012. Processing molluscs, shellfish and cephalopods. In: Second International Congress on Seafood Technology on Sustainable, Innovative and Healthy Seafood. p. 85–107.

[3] Masniyom P, Benjama O. 2007. Effect of lactic, acetic and citric acids on quality changes of refrigerated green mussel, *Perna viridis* (Linnaeus, 1758). Sci. Technol. 29(4): 1123–1134.

[4] Arcales JAA, Nacional LM. 2018. Effect of Lactic and Citric Acid Pretreatment on Quality Changes of Green Mussel (*Perna viridis*) During Chilled Storage. Curr. Res. Nutr. Food Sci.ch in Nutrition and Food Science Journal. 6(3): 862–872. doi:10.12944/crnfsj.6.3.29.

[5] Nakai SA, Siebert KJ. 2003. Validation of bacterial growth inhibition models based on molecular properties of organic acids. Int. J. Food Microbiol. 86(3): 249–255. doi:10.1016/s0168-1605(02)00551-2.

[6] Booth IR, Gould RG. 1989. The preservation of foods by low pH. In: Mechanisms of action of food preservation procedures. London, United Kingdom: Elsevier Applied Science, Elsevier Science Publishers Ltd. p. 119–160.

[7] Russell J. 1992. Another explanation for the toxicity of fermentation acids at low pH: anion accumulation versus uncoupling. J. Appl. Bacteriol. 73(5): 363–370. doi:10.1111/j.1365-2672.1992.tb04990.x.

[8] Houtsma, P. C. 1996. The antimicrobial activity of Sodium Lactate. Department of Food Science of the Agricultural University in Wageningen and at the Department of Microbiology of the University of Groningen in Haren.

[9] Organic Materials Review Institute. 2015. Lactic Acid, Sodium Lactate, and Potassium Lactate Handling/Processing. Available from: https://www.ams.usda.gov/sites/default/files/media/Lactic%20Acid%20TR%202015.pdf.

[10] Hadawey A, Tassou SA, Chaer I, Sundararajan R. 2017. Unwrapped food product display shelf-life assessment. Energy Procedia. 123: 62–69.

[11] Onoda H., Haruki M. 2015. Effect of mechanical treatment on the powder properties of zinc phosphate white pigments. J. Adv. Ceram. 4(4): 312–317. doi:10.1007/s40145-015-0167-8.

[12] McClure, B.N. 2009. The Effect of Lactate on Nitrite in a Cured Meat System. Graduate Thesis, Iowa State University.

[13] Miller, R. 2010. Functionality of Non-Meat Ingredients Used In Enhanced Pork. Extension.Org. https://bit.ly/3smGT6h.

[14] pH values of foods and food products. Arrow Scientific. [accessed 2020 Oct 12]. http://www.arrowscientific.com.au/index.php?option=com_content&view=article&id=61%3Aph-values-of-foods-and-food-products.

[15] Sallam KI. 2007. Antimicrobial and antioxidant effects of sodium acetate, sodium lactate, and sodium citrate in refrigerated sliced salmon. Food Control. 18(5): 566–575. doi:10.1016/j.foodcont.2006.02.002.

[16] Haghparast S., Kashiri H., Shabanpour B., Pahlavani M.H. 2009. Antioxidant properties of sodium acetate, sodium citrate and sodium lactate on lipid oxidation in rainbow trout (Onchorhynchus mykiss) sticks during refrigerated storage (4°C). Iran. J. Fish. Sci. 9(1) 73-86.

[17] [FAO] Food and Agriculture Organization of the United Nations. Proximate Analyses. Nutrition of Fish and Crustaceans a Laboratory Manual. [accessed 2020 Jan 31]. http://www.fao.org/3/AB479E/AB479E03.htm#ch3.1.

[18] Sengor G., Kalafatoglu H. and Gun H. 2004. The Determination of Microbial Flora, Water Activity and Chemical Analyses in Smoked, Canned Mussel (*Mytilus galloprovincialis, L.*). Turkish J. Vet. Anim. Sci. 28: 793–797.

[19] Brewer M.S. 2014. Chemical And Physical Characteristics Of Meat | Water-Holding Capacity. Encyclopedia of Meat Sciences (Second Edition). pp. 274–282. https://doi.org/10.1016/B978-0-12-384731-7.00247-6.

[20] Goncalves A., Ribeiro J. 2008. Do Phosphate Improve the Seafood Quality: Reality and Legislation. Pan-Am. J. Aquat. Sci. 3(3): 237–247.

[21] Arcales JAA, Nacional LM. 2019. Quality Changes of Chilled Green Mussel (*Perna viridis*) Pre-Treated with Organic Acids and Sodium Tripolyphosphate. Curr. Res. Nutr. Food Sci.ch in Nutrition and Food Science Journal. 7(3):894–904. doi:10.12944/crnfsj.7.3.28.

[22] Terzi G., Gucukoglu A., Cadirci O., Kevenk T., Alisarli M. 2012. Effects of chitosan and lactic acid immersion on the mussel's quality changes during the refrigerated storage. Kafkas Univ Vet Fak Derg. pp. 1–8.

[23] Songsaeng S., Sophanodora P., Kaewsrithong J., Oshima T. 2010. Quality changes in oyster (*Crassotreabelcheri*) during frozen storage as affected by freezing and antioxidant. Food Chem. 123: 286–290.

[24] Sallam KI., Samejima K. 2004. Microbiological and chemical quality of ground beef treated with sodium lactate and sodium chloride during refrigerated storage. LWT. 37(8): 865–871. doi: 10.1016/j.lwt.2004.04.003.

[25] Bingol, E. B., Colak, H., Cetin, O., & Hampikyan, H. 2012. Effects of Sodium Lactate on the Shelf Life and Sensory Characteristics of Cig Kofte - A Turkish Traditional Raw Meatball. J. Food Process. Preserv. 38(3): 1024–1036.

[26] Radziejewska RC., Pikul J. 2003. Sodium Lactate Addition on the Quality and Shelf Life of Refrigerated Sliced Poultry Sausage Packaged in Air or Nitrogen Atmosphere. J. Food Prot.. 67(3): 601–606.

[27] Eckert L.A., Maca J.V., Miller R.K. Acuff G.R. 1997. Sensory, microbial and chemical characteristics of fresh aerobically stored ground beef containing sodium lactate and sodium propionate. J. Food Sci. 62: 429–433.

[28] Tan W., Shelef L.A. 2002. Effects of sodium chloride and lactates on chemical and microbiological changes refrigerated and frozen fresh ground pork. Meat Sci. 62: 27–32.

[29] Cao R., Xue C., Liu Q. 2009. Changes in Microbial Flora of Pacific Oyster (*Crassotrea gigas*) During Refrigerated Storage and its Shelf-life Extension by Chitosan. Int. J. Food Microbiol. 131: 272–276.

[30] Lima M., Melo M., Monteiro A. 2013. Evaluation of the Processing of *Perna perna* mussels: The Influence of Water Quality Involved in the Cooling Operations in the Physico-Chemical and Microbiological Characteristic of the Product. J. Sci. Food Agric. 93: 3322–3329.

[31] Hardey D. 1991. Handling, Processing and Marketing Scallop Farming. Fishing News Books, Osney Meat, Oxford, pp. 168–180.