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Original Article

The Differences in Meat Storage Using a Vacuum, Freezer, and a Combination of Vacuum and Freezer against Spoilage Bacteria

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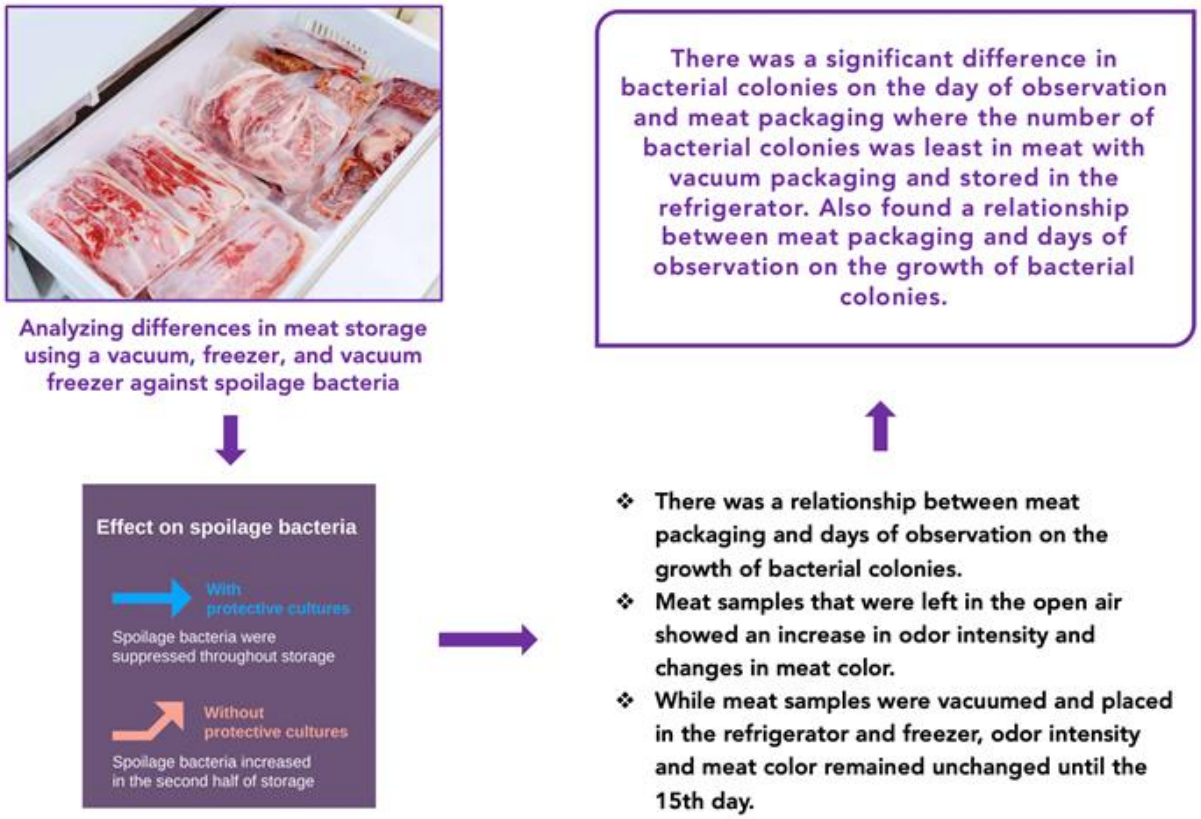
ABSTRACT

Background: Fresh meat is easily damaged by chemical, enzymatic, and bacterial reactions. Bacterial growth can be inhibited by preservation. In addition to cooling, packaging using vacuum plastic bags/vacuum is a method of preservation.
Aim(s) (including purpose setting): To analyze the differences in meat storage using a vacuum, freezer, and a combination of vacuum and freezer against spoilage bacteria.
Material and methods: Experimental research with "Post Test Only Control Group Design" and quantitative methods. Samples of beef outer scrub muscle (Longissimus dorsi) were obtained from Surabaya Slaughterhouse (Slaughterhouse). The Independent variables are temperature and packaging, and the dependent variable is physical changes in meat and the discovery of spoilage microorganisms.
Result: There are differences in storing meat using vacuum, freezer, and a combination of vacuum and freezer against spoilage bacteria. Meat samples that were left in the open air showed an increase in odor intensity and changes in meat color. While meat samples were vacuumed and placed in the refrigerator and freezer, odor intensity and meat color remained unchanged until the 15th day. Changes in the texture of meat occurred in samples in open air since the 5th day of the study, while samples in a vacuum and placed in a refrigerator and freezer did not change in texture until the 15th day of the study. Conclusion: There was a significant difference in bacterial colonies on the day of observation and meat packaging where the number of bacterial colonies was least in meat with vacuum packaging and stored in the refrigerator. Likewise, there was a relationship between meat packaging and days of observation on the growth of bacterial colonies.

GRAPHICAL ABSTRACT



Introduction

Fresh meat is easily damaged as a result of chemical and enzymatic reactions and the activity of microorganisms, especially bacteria. A common way to keep meat fresh is by its refrigerating and freezing. However, various ways of application are combined or not combined with refrigeration and freezing in the hope that the shelf life of fresh meat will be longer [1, 2]. The long shelf life of fresh meat is necessary, especially for long trips, for example, on a long cruise, you certainly need food that is suitable for consumption over a long period of time. Shipping will be able to reach its destination successfully, on time, safely, and securely if all existing infrastructure and supporting components are properly fulfilled. One support that is very vital and related to welfare and health is the quality and quantity of food ingredients.

Cows are livestock whose main product is meat or milk [2]. The availability of beef needs to be supported by proper storage techniques. Beef is a product favored by the public and is a very good source of animal protein. As a food ingredient with high nutritional value, beef is a fertile medium for the growth of bacteria and fungi, so proper attention must be paid to handling meat [1, 3]. Meat and its processed products are perishable foods because they are very susceptible to contamination by spoilage microorganisms and pathogenic microorganisms. Meat and its processed products contain good nutrition for humans. These nutrients are also an excellent growth medium for microbes. Meat and its processed products are easily subject to microbiological damage because of their high nutritional and water content, and they contain lots of vitamins and minerals. Microbiological damage to meat is mainly caused by the growth of spoilage bacteria. Some physical signs of damage to meat include discoloration, odor (smelling rancid or smelling bad), the formation of mucus, and a sour taste [4].

Fresh meat contains bacteria originating from equipment, processing, workers, and water [5]. Succeeded in isolating several bacteria was found in fresh beef namely, *Pseudomonas*, *Lactobacillus*, *and Brochothrix thermosphacta*. These bacteria have the potential to cause spoilage because of their activity in degrading protein because meat has a high protein content [6]. Protein is used by bacteria for metabolism. Factors that cause the growth of these microorganisms can be inhibited by preservation or preservation. Preservation can protect the meat from damage or decay due to microorganisms. The pickling process should be carried out safely without reducing the quality of the meat. Preservation aims to extend the shelf life of meat before consumption. There are three methods of preservation, namely physical, biological, and chemical. Physical preservation by withering (draining blood for 12-24 hours after slaughter), heating, and cooling. Biological preservation uses microbes that produce antibacterial substances, while chemical preservation is divided into the preservation of natural active ingredients and chemicals (sodium nitrite salt, sodium acetate, etc.). The most widely used preservation method for meat is by controlling the storage temperature (cooling and freezing). Refrigeration and freezing can inhibit and limit enzymatic reactions, and chemical and physical damage to beef. Cooling is a process when the temperature of the material is lowered from -1 ºC to 8 °C, while freezing is a process when the temperature of the material is lowered below its freezing point and water undergoes a phase change to become ice crystals. Raw food ingredients support the growth of pathogenic microorganisms and spoilage microorganisms so the temperature has an important role in inhibiting the growth of these microorganisms. The growth of *Pseudomonas*, which is a spoilage bacterium in beef, occurs in storage at 1-7 °C for 1-12 days [7]. One effort that can be made to preserve meat is to store it in the freezer in the refrigerator. However, public awareness of storing meat in the freezer is still low [8]. Most people, especially traders, still store meat at refrigerator temperature. In addition to cooling, packaging is a method of preservation or preservation. Furthermore, the packaging used for storage is very influential on the quality of beef. Processing and storage factors that can be controlled by packers include light, concentration, oxygen, moisture content, heat transfer, contamination, and microorganisms [9]. Plastic packaging is widely used with the consideration that this material is easy to shape as desired, is not corrosive (easily corroded), and does not require special handling. In the world of trade, it is known that there are special plastics for packaging food (food grade) and plastic for packaging non-food materials (non-food grade). Therefore, if you are going to choose plastic for packaging ingredients and food products, especially meat, you should choose food grade. Packaging using vacuum plastic bags is an effort to prevent bacterial contamination, extend the storage life of meat, and is an opportunity for a more effective aging process. Some things that need to be considered in the process of packaging meat with a vacuum include cleanliness and sanitation, temperature during the cooling and storage process. Meat that is dark in color or with a high level of acidity (pH) should not be packed in a vacuum bag. By controlling cleanliness, packaging, meat temperature, and storage room temperature, the shelf life of meat can be extended from one week to several weeks. Based on existing phenomena, it is very important to keep meat fresh, especially on long journeys that require food that can be consumed in a short time. Accordingly, the author wants to know more about the differences in meat storage using a vacuum, freezer, and a combination of vacuum and freezer against spoilage bacteria.

Material and Methods

This research is an experimental study, with the design "Post Test Only Control Group Design" which aims to find out whether there are differences in storing meat in freezing, vacuum and freezing and vacuum packaging in the presence of bacteria in the decomposition process. This research uses primary data and quantitative methods, namely a process of finding knowledge that uses data in the form of numbers as a tool to analyze information about what you want to know. The population is beef while the

sample is beef obtained from the people's market center, namely stalls selling animal meat from slaughterhouses (RPH), and then brought using a thermos.

Charan *et al.* (2015) [4] argued that the sample size is calculated using the Resource Equation Modeling method [10], where it is not possible to make assumptions about the size, effect, and description of the standard deviation because there are no previous findings.

- E = total amount of meat − total number of treatment groups
- 18 = (n × 6) – 6
- n = 4
- The total sample is 4×6 = 24

The sampling technique was samples or specimens of the beef outer muscle (Longissimus dorsi) obtained from Surabaya RPH (Slaughterhouse) with a weight of 250 grams each. Then it will be stored at room temperature, in the freezer, and partly packaged first in plastic packaging and vacuumed, and then stored in the freezer. This research was designed using a completely randomized design (CRD) with a 5×3 factorial pattern, namely with 6 types of storage and packaging (left open at room temperature, stored in the refrigerator, freezer, packed in plastic that has been vacuumed and left at room temperature, packed in plastic which has been vacuumed and put in the freezer) and 3 kinds of treatment storage time, namely 5 days (fresh meat as control), 10 days and 15 day, and then it was seen that there was a decomposition process based on a physical examination and examination for the presence of spoilage bacteria which was carried out at the Microbiology Laboratory, Faculty of Medicine, Hang Tuah University, Surabaya.

In this study, the independent variables were temperature and packaging while the dependent variable was the process of spoilage as seen from the physical changes in the meat and the discovery of spoilage microorganisms.

Table 1: Bacterial colony normality test on observation day

Sample Code	Number of Coloniesx 10^8 *CFU*/mL*			
	a	B	c	d
H 5.1	851	785	890	980
H 5.2	485	515	484	539
H 5.3	252	240	251	279
H 5.4	407	345	374	387
H 5.5	160	131	213	387
H 5.6	70	73	75	38
H 5.1	851	785	890	980
Kolmogorov-Smirnov Test: *p*: .200*				
H 10.1	629	699	725	547
H 10.2	814	960	986	1,132
H 10.3	310	400	390	480
H 10.4	238	262	213	178
H 10.5	137	124	165	150
H 10.6	4	6	18	5
Kolmogorov-Smirnov Test: *p*: .200*				
H 15.1	237	515	540	158
H 15.2	1.280	1.274	1,187	1.324
H 15.3	190	170	150	320
H 15.4	132	174	145	94
H 15.5	60	73	81	55
H 15.6	6	4	6	7
H 15.1	237	515	540	158
Kolmogorov-Smirnov Test: *p*: .074*				

Table 2: Bacterial colony normality test on meat packaging

Tests of Normality							
Meat Packaging		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	Df	Sig.
Bacterial Colony	Open Air	0.189	12	0.200*	0.938	12	0.468
	Refrigerator	0.273	12	0.014	0.797	12	0.009
	Freezer	0.127	12	0.200*	0.940	12	0.503
	Vacuum	0.203	11	0.200*	0.894	11	0.155
	Vacuum + Refrigerator	0.265	13	0.013	0.805	13	0.008
	Vacuum + Freezer	0.283	12	0.009	0.748	12	0.006

Table 3: Meat odor normality test

Normality Test				
	Meat Texture	Shapiro-Wilk		
		Statistic	df	Sig.
Meat Samples	Day 5	0.866	6	0.212
	Day 10	0.814	6	0.078
	Day 15	0.907	6	0.415

Results and Discussion

Comparison of bacterial colonies based on research groups

From the bacterial colony normality test in the table below, it was found that the research data were normally distributed in meat samples with different packaging on days 5, 10, and 15 with a p-value> 0.05 (Table 1 and 2).

Comparison of meat odor based on research groups

From the meat odor normality test at the table below, it was found that the research data were normally distributed on meat samples on days 5, 10, and 15 with a p-value >0.05 (Table 3 and 4). From the results of the odor test research in the table above, it was found that meat that was vacuum packed and placed in the refrigerator and freezer had a better test than meat products that were not packaged and placed in the open air or placed in the freezer and refrigerator.

Comparison of meat color by research group

From the meat color normality test at the table below, it was found that the research data were normally distributed on meat samples on days 5, 10, and 15 with a p-value >0.05 (Table 5 and 6). From the results of the meat color test research in the table above, it was found that meat that was vacuum packed and placed in the refrigerator and freezer had a better test than meat products that were not packaged and placed in the open air or placed in the freezer and refrigerator.

Comparison of meat texture based on research groups

From the meat texture normality test at the table below, it was found that the research data were normally distributed on meat samples on days 5, 10, and 15 with a p-value >0.05 (Table 7 and 8). From the results of the texture test research in the table above, it was found that meat that was vacuum packed and placed in the refrigerator and freezer had a better test than meat products that were not packaged and placed in the open air or placed in the freezer and refrigerator.

Comparison of bacterial colonies based on research groups

From the bacterial colony normality test, it was found that the research data were normally distributed in meat samples with different packaging on days 5, 10, and 15 with a p-value >0.05. The test was continued using the two-way ANOVA test, with the results showing that there were significant differences in bacterial colonies on the day of observation and meat packaging with a p-value <0.05.

Table 4: Meat odor descriptive analysis of packaging

	Odor		
Meat Samples in Days	5	10	15
Open Air	3	4	4
Refrigerator	2	2	3
Freezer	2	2	2
Vacuum + Open Air	2	2	3
Vacuum + Refrigerator	1	1	1
Vacuum + Freezer	1	1	1

Table 5: Meat color normality test

Normality Test				
	Meat Color	Shapiro-Wilk		
		Statistic	df	Sig.
Meat Samples	Day 5	0.683	6	0.006
	Day 10	0.775	6	0.035
	Day 15	0.775	6	0.035

Table 6: Meat color descriptive analysis of packaging

	Color		
Meat Samples in Days	5	10	15
Open Air	2	3	3
Refrigerator	2	3	3
Freezer	1	1	1
Vacuum + Open Air	2	2	2
Vacuum + Refrigerator	1	1	1
Vacuum + Freezer	1	1	1

There was also a relationship between meat packaging and the day of observation on the growth of bacterial colonies with a $p<0.05$ value. This is in accordance with research conducted by Hernando [11]. Which concluded that the factors that influence the growth of microorganisms in meat include temperature and the presence or absence of oxygen. Temperature is a factor that should be considered to regulate bacterial growth because the higher the temperature the greater the growth rate. Prihharsanti (2016) [12] state that, the average number of bacteria in meat storage at room temperature, refrigerator, and freezer at different times, an increase in the number of bacterial colonies was found to stand out in meat that had been stored for 9 hours at room temperature, whereas in refrigerator storage and freezer, bacterial spores are inactivated. At room temperature, the number of bacteria after being stored for 9 hours increased very rapidly, but the other treatments did not. Furthermore, research conducted by Rahayu *et al.* (2022) that beef that was placed at room temperature for 0 hours, 3 hours, 6 hours, and 9 hours experienced a significant increase in the number of bacterial colonies. This is because the chemical composition and moisture of meat are ideal for bacterial life processes to take place and proteins are used by microorganisms through enzymatic metabolic processes. Bacteria will grow by dividing twice every 30 minutes so that the longer the meat is left at room temperature the bacteria will continue to multiply in the meat relatively quickly [13]. The number of bacterial colonies in storage in the refrigerator and freezer did not show a significant difference [14], so it appears that the bacteria that live in the two places have not grown up to 18 hours of storage. At room temperature, it began to appear to increase at 6 hours of storage and at an interval of 6 hours to 9 hours the fastest growth. The effect of temperature is mainly on the activity of enzymes produced by bacteria in catalyzing the biochemical changes that occur inside and

outside the cell. At low temperatures, the growth of bacteria is inhibited, even though to a certain extent the bacteria do not experience death, these bacteria are called psychrophilic bacteria.
This bacterium is present in meat stored in the refrigerator. Bacterial death at low temperatures is caused by changes in the colloidal state of the protoplasm that are not reversible [12].

Comparison of meat odor based on research groups

The results showed that meat samples left in the open air showed a daily increase in odor intensity. Whereas in the meat samples that were vacuumed and placed in the refrigerator and freezer, the odor intensity remained unchanged even up to the 15th day [15]. The factor that affects taste is the smell detected by the nose, Dina *et al.* (2017) [16] stated that the aroma of beef is influenced by the type of feed given when the cow is alive. An abnormal aroma will usually be smelled immediately after the animal is slaughtered. This can be caused by abnormalities, including sick animals and animals on medication. Sick animals, especially those with acute inflammation of the internal organs, will produce meat that smells like rancid butter. Animals in the treatment period, especially with antibiotics, will produce meat that smells of medicine. Odor evaluation is highly dependent on the taste panel. The process of spoilage in meat is characterized by the activity of microorganisms that destroy fat and protein in meat. The activity of microorganisms such as fungi and bacteria is carried out using enzymes (enzymatic) because bacteria need fat and protein in their metabolic processes. Researchers usually calculate the level of spoilage in meat by detecting the ammonia compound (NH3) resulting from the decomposition of meat protein-ammonia gas is also one of the causes of the pungent smell of rotting meat [16, 17].

Table 7: Meat texture normality test

Normality Test				
	Meat Texture	Shapiro-Wilk		
		Statistic	df	Sig.
Meat Samples	Day 5	0.596	6	0.006
	Day 10	0.822	6	0.091
	Day 15	0.866	6	0.212

Table 8: Meat texture descriptive analysis of packaging

	Texture		
Meat Samples in Days	5	10	15
Open Air	2	3	3
Refrigerator	1	1	2
Freezer	1	2	2
Vacuum + Open Air	1	2	2
Vacuum + Refrigerator	1	1	1
Vacuum + Freezer	1	1	1

Texture
Chewy. Symbolized 1
Tough. Symbolized 2
Crushed. Symbolized 3

Comparison of meat color by research group

The color change in the meat samples left in the open air had occurred since the 5th day of the study and reached a maximum since the 10th day. Meanwhile, the color changes in the meat samples stored in a vacuum and placed in the refrigerator and freezer remained until the 15th day of the study. The main determinants of meat color are the concentrations of myoglobin and hemoglobin, where myoglobin differs between muscles (red and white), age, species, nation, and muscle location. Several factors also affect the color of raw meat, including the sex of the animal,

how to cut the meat, the water-holding capacity of the meat, drying on the surface of the meat, decay on the surface of the meat, and light hitting the surface of the meat. The paler color of the meat is affected by the increase in bacteria every hour [18, 19]. Discoloration of meat can also be associated with aerobic or anaerobic bacterial contamination. The high demand for oxygen for aerobic bacteria in the logarithmic phase of growth results in the formation of metmyoglobin, resulting in a discoloration effect. The increase in the number of aerobic bacteria causes the surface of the meat to change color from oxymyoglobin red to metmyoglobin brown, and then to purple and black due to reduced myoglobin. The color of bright red meat will turn brown or gray due to oxidation compounds or the presence of H2S produced by bacteria [18, 20-21].

Comparison of meat texture based on research groups

Changes in the texture of the meat samples occurred in samples placed in the open air even from the 5th day of the study, whereas in the other 5 sample groups, there was no change on the 5th day. Meat samples that were placed in the open air experienced the maximum changes in texture since day 5 of the 10th study, while samples that were vacuumed and placed in the refrigerator and freezer did not experience changes in texture until the 15th study day. Meat texture is determined by the myofibril protein content which is related to pH and water-holding capacity. Microbial activity at room temperature will degrade the protein structure in the meat so that the texture of the meat will change. At refrigerator and freezer temperatures, microbial activity decreases and the number of microbes decreases over time. Vacuum packaging also reduces the risk of contamination with outside air [22, 23]. In research conducted by Firdaus [17]. The texture did not change in stored meat samples.

Conclusion

There was a significant difference in bacterial colonies on the day of observation and meat packaging where the least number of bacterial colonies was found in meat with vacuum packaging and stored in the refrigerator. Also found a relationship between meat packaging and the day of observation on the growth of bacterial colonies. For odor-intensity and color change in meat samples that were left in the open air, more and more showed an increase in odor intensity and meat color changes. Whereas in the meat samples that were vacuumed and placed in the refrigerator and freezer, the odor intensity and color of the meat remained unchanged even up to the 15th day. Changes in meat texture have occurred in samples placed in the open air since the 5th day of the study, whereas the samples that were carried out in a vacuum and placed in the refrigerator and freezer did not experience a change in texture until the 15th day of the study.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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References

[1]. Hadiwiyoto S., Rahayu E.S.,Bawono I.Y., Pengawetan daging segar dengan ekstrak

metabolik bakteri asam laktat dari buah tomat, *Buletin Peternakan*, 2005, **29**:35 [Crossref], [Google Scholar], [Publisher]

[2]. a) Ravilov R.K., Volkov A.K., Papunidi E.K., Yusupova G.R., Yakupova L.F., Medethanov F.A., Gracheva O.A., The influence of food supplements and calcium fumarate on chemical composition and energy value of poultry meat, *Bali Medical Journal*, 2017, **6**:354 [Crossref], [Google Scholar], [Publisher]; b) Manuel M., Jennifer A. A Review on Starch and Cellulose-Enhanced Superabsorbent Hydrogel. *Journal of Chemical Reviews*, 2023, **5**:183 [Crossref], [Publisher]

[3]. Aduloju E.I., Yahaya N., Mohammad Zain N., Anuar Kamaruddin M., Ariffuddin Abd Hamid M., An Overview on the Use of DEEP Eutectic Solvents for Green Extraction of Some Selected Bioactive Compounds from Natural Matrices, *Advanced Journal of Chemistry - Section A*, 2023, **6**:253 [Crossref], [Publisher]

[4]. Lorenzo J.M., Munekata P.E., Dominguez R., Pateiro M., Saraiva J.A., Franco D., Main Groups of Microorganisms of Relevance for Food Safety and Stability: General Aspects and Overall Description. *Innovative Technologies for Food Preservation*, 2018, 53 [Crossref], [Google Scholar], [Publisher]

[5]. Purwani E., Retnaningtyas R., Widowati D., Pengembangan Pengawet Alami dari Ekstrak Lengkuas, Kunyit, dan Jahe pada Daging dan Ikan Segar, *Laporan penelitian Fakultas Ilmu Kedokteran Universitas Muhammadiyah Surakarta*, 2008 [Google Scholar], [Publisher]

[6]. Hadidi S., Farzaei M.H., Inhibitory Activity of Natural Flavonoids against Protein Aggregation in Alzheimer's disease: A Computational Simulation Study, *Advanced Journal of Chemistry Section A*, 2023, **6:**123 [Crossref], [Publisher]

[7]. Hazards E.P.o.B., Growth of spoilage bacteria during storage and transport of meat, *EFSA Journal*, 2016, **14**:e04523 [Crossref], [Google Scholar], [Publisher]

[8]. Rameesa C., Drisya M., Orodispersible tablet: a patient friendly dosage form (a review), *Bali Medical Journal*, 2015, **4**:17 [Google Scholar], [Publisher]

[9]. Bozorgian, A., Investigation of the effect of Zinc Oxide Nano-particles and Cationic Surfactants on Carbon Dioxide Storage capacity, *Advanced Journal of Chemistry-Section B: Natural Products and Medical Chemistry*, 2021, **3**:54 [Crossref], [Google Scholar], [Publisher]

[10]. Aduloju E.I., Yahaya N., Zain N.M., Kamaruddin M.A., Abd Hamid M.A., A Green, Sustainable, and Unified Approaches towards Organic and Inorganic Analytes Extraction from Complex Environmental Matrices, *Advanced Journal of Chemistry-Section A,* 2023, **6**:198 [Crossref], [Publisher]

[11]. Hernando D., Septinova D., Adhianto K., Kadar air dan total mikroba pada daging sapi di tempat pemotongan hewan (TPH) Bandar Lampung, *Jurnal Ilmiah Peternakan Terpadu*, 2015, **3**:[Crossref], [Google Scholar], [Publisher]

[12]. Prihharsanti A., Populasi bakteri dan jamur pada daging sapi dengan penyimpanan suhu rendah, *Sains Peternakan: Jurnal Penelitian Ilmu Peternakan*, 2009, **7**:66 [Crossref], [Google Scholar], [Publisher]

[13]. Rahayu N., Agustina K., Swacita I., The Effect of Laying at Room Temperature on The pH Value and Total Bacteria of Bali Beef. *Buletin Veteriner Udayana*, 2022, **14**:217 [Crossref], [Publisher]

[14]. Muhamed Musa A., Abdul-Hassan W. Iron (II), cobalt (II), and nickel (II) complexes of bis-(3-chloroacetylacetonate) ethylenediimine and bis-(acetylacetonate) ethylenediimine and their viologen molecular switches. *Journal of Medicinal and Pharmaceutical Chemistry Research*, 2023, **5**:492 [Publisher]

[15]. A. Jassem I., S. Abdul-Hassan W., A. Flafel I. Novel molecular switches based on viologen ligand and its transition metal complexes. *Journal of Medicinal and Pharmaceutical Chemistry Research*, 2023, **5**:758 [Publisher]

[16]. Dina D., Soetrisno E., Warnoto W., Pengaruh Perendaman Daging Sapi dengan Ekstrak Bunga Kecombrang (Etlingera elatior) terhadap Susut Masak, pH dan Organoleptik (Bau, Warna, Tekstur), *Jurnal Sain Peternakan Indonesia*, 2017, **12**:199 [Crossref], [Google Scholar], [Publisher]

[17]. Nabu E.K.Y., Mahartini N.N., Wirawati I.A.P., Herawati S., Pardosi B.B.H., Krisnawati N.K., Prawita A.A.A.L., Prabawa I.P.Y., Gaucher's disease in a 4-year-old child at Sanglah General Hospital, Bali, Indonesia, *Bali Medical Journal*, 2021, **10**:724 [Crossref], [Publisher]

[18]. Rinaldi N.A., Pertumbuhan Bakteri Selama Penyimpanan Daging Sapi dengan Pengemas Daun Jati (Tectona Grandis) dan Daun Pisang (Musa Paradisiaca), *Institut Teknologi Sain dan Kesehatan PKU Muhammadiyah Surakarta*, 2019 [Google Scholar], [Publisher]

[19]. Lubis A.K., Munir D., Nursiah S., Kusumawati R.L., Eyanoer P.C., The aerobic-anaerobic bacteria pattern and its sensitivity pattern in chronic rhinosinusitis patients, in Medan, Indonesia, *Bali Medical Journal*, 2018, **7**:51 [Crossref], [Publisher]

[20]. Kharisma V.D., Probojati R.T., Murtadlo A.A.A., Ansori A.N.M., Antonius Y., Tamam M.B., Revealing potency of bioactive compounds as inhibitor of dengue virus (DENV) NS2b/NS3 protease from sweet potato (Ipomoea batatas L.) leaves, *Indian Journal of Forensic Medicine & Toxicology*, 2021, **15**:1627 [Crossref], [Google Scholar], [Publisher]

[21]. Daodee S., Punya T., Chansri N., Application of Dipterocarpus alatus oil for Permeation Enhancement of Some compounds, *Research Journal of Pharmacy and Technology*, 2018, **11**:245 [Crossref], [Google Scholar], [Publisher]

[22]. Jagadeesan M., Kumar S.K., Sarvesh S., Yalavarthi L., A Case Report on Dengue Fever with Mental Retardation due to Consanguineous Marriage, *Research Journal of Pharmacy and Technology*, 2019, **12**:3575 [Crossref], [Google Scholar], [Publisher]

[23]. Andini A., Prayekti E., Kamaliyah N.I., Halimah N., Effectivity of uv-light exposure on bacterial and fungal growth in Channa striata collagen-chitosan composite dressing for wound healing, *Bali Medical Journal*, 2022, **11**:1130 [Crossref], [Publisher]

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