Formosa Journal of Science and Technology (FJST)
Vol. 4, No. 6, 2025: 1695-1704

Evaluation of Physical Properties of Dry Sausage Made from Cull Laying Hen Meat Stored at Room Temperature

Stevano D. Dehe[1], Erwin H.B. Sondakh[2*], Jerry A.D. Kalele[3], Delly B. Rumondor[4]
Faculty of Animal Science, Sam Ratulangi University
Corresponding Author: Erwin H.B. Sondakh, ehb_sondakh@unsrat.ac.id

ARTICLE INFO

Keywords: Dry Sausage, Physical Quality, Cull Laying Hen

Received : 14, May
Revised : 28, May
Accepted: 29, June

ABSTRACT

This research aims to determine the physical quality of dry sausage products from cull laying hens stored at different times. The materials used in this study are meat from culling layer hens and the seasonings for sausage production. The research uses a completely randomized design (CRD) with 4 treatments and 4 replications. The treatments in this study are P0 = day one with no storage, P1 = 7 days of storage, P2 = 14 days of storage, P3 = 21 days of storage, all stored at room temperature. The variables measured in this study include physical properties such as water activity, moisture content, water-holding capacity, and pH. Data analysis was performed using variance analysis followed by Duncan's test for mean differences. The results of the analysis of variance for water activity showed that the storage duration of dry sausage made from culling hen meat had a significant effect on water activity values ($P<0.05$). The moisture showed that the storage duration had a significant effect on moisture content values ($P<0.05$). The water-holding capacity indicated that the storage duration significantly affected water-holding capacity values ($P<0.05$). The pH values indicated that the storage duration of dry sausage made from culling hen meat significantly affected pH values ($P<0.05$). Based on the results of this study, it can be concluded that dry sausage made from culling layer hen meat stored at room temperature is still suitable for consumption up to the 21st day of storage.

ISSN-E: 2964-6804
DOI: https://doi.org/10.55927/fjst.v4i6.127
https://traformosapublisher.org/index.php/fjst

INTRODUCTION

Cull laying hens are those that have become unproductive in their egg production. According to data from the BPS (2021), Indonesia produced approximately 1.6 million tons of chicken meat annually, with the majority derived from broiler chickens. However, cull laying hens are often discarded or used as animal feed, resulting in a wastage of resources. With the increasing societal awareness of the importance of sustainability and waste reduction, the processing of cull laying hens into value-added products presents an appealing solution. Moreover, these processed products can serve as a practical and affordable source of protein for consumers. Several meat products can be created from cull laying hens, one of which is dry sausages.

Dry sausage is crafted through a processing method that incorporates fermentation and drying. This process aims to diminish the moisture content of the product, thereby prolonging its shelf life and inhibiting the growth of microorganisms. Dry sausage stored at room temperature may undergo changes in flavor, aroma, and texture as time progresses. Data indicate that improper storage conditions and excessive duration can heighten the risk of microbial contamination, potentially endangering consumer health. Consequently, it is vital to ascertain the appropriate duration for which dry sausage can be stored at ambient temperature. The production process of dry sausage from cull laying hens comprises several stages, beginning with raw material selection, followed by processing, and concluding with packaging. Research conducted that the meat of cull laying hens contains a relatively high protein content, approximately 20-25%, while being low in fat. This renders cull laying hen meat an ideal raw material for producing healthy dry sausage. Additionally, the utilization of cull laying hens contributes to waste reduction within the livestock industry.

According to the BPS (2022), sausage consumption in Indonesia has surged by 15% over the past five years. This indicates a significant market opportunity for dry sausage producers. However, this product is susceptible to spoilage if not stored properly. Research conducted by Kameník et al. (2021) reveals that storage temperature and relative humidity can significantly impact the quality of dry sausage, influencing its flavor, texture, and microbiological safety. Therefore, it is imperative to conduct an in-depth study regarding the optimal storage duration for this product. Furthermore, dry sausage that is stored for extended periods may undergo significant organoleptic changes, leading to a marked decline in flavor and aroma quality. Such alterations can diminish consumer interest and potentially harm producers. Hence, this study is not only pertinent to academics but also to food industry practitioners seeking a deeper understanding of dry sausage storage. Many existing studies have concentrated on fresh sausages or other meat products, whereas dry sausage, as a unique product with its own characteristics, has yet to be thoroughly explored. According to research by Prihharsanti (2009), there is an urgent need to identify the most relevant physical quality parameters for dry sausage. It is vital to ascertain the physical quality of dry sausage to provide guidance for producers in enhancing its quality, which, in turn, can improve the product's competitiveness in the market. This research aims to evaluate the physical quality of dry sausage made from cull laying hen meat stored for varying durations.

THEORETICAL REVIEW

Utilization of Cull Laying Hen Meat

Cull laying hens are typically characterized by tougher muscle fibers and lower economic value due to their age and reduced meat tenderness (Soeparno, 2009). However, with appropriate processing techniques, such as grinding, fermentation, and drying, their meat can be utilized effectively in processed meat products like sausages (Ali et al., 2011). The conversion of low-value meat into shelf-stable, value-added products such as dry sausage is a strategic approach to minimize waste and enhance the economic utility of cull laying hens (Kusnandar et al., 2010).

Physical Properties of Dry Sausage

The physical characteristics of dry sausage—such as water activity (Aw), moisture content, water-holding capacity, and pH—are critical indicators of product quality, safety, and shelf life (Lawrie & Ledward, 2006). These properties influence microbial stability, texture, appearance, and consumer acceptability. Sausages with controlled Aw and moisture content are more resistant to microbial spoilage, especially when stored at ambient temperatures (Deumier & Collignan, 2003). Moreover, the ability of meat to retain water, known as water-holding capacity, is closely associated with protein structure, pH, and fat content, impacting both yield and texture (Suharyanto et al., 2023).

Impact of Storage on Sausage Quality

Storage duration and temperature play a significant role in altering the physical properties of dry sausages. Prolonged storage can lead to moisture migration, pH shifts, and changes in Aw, which in turn affect the microbial ecosystem and sensory attributes (Afrila & Jaya, 2012). Room temperature storage (typically around 28°C in tropical regions) poses challenges in maintaining product stability, especially in the absence of refrigeration or vacuum packaging. Therefore, understanding how physical properties evolve over time at room temperature is crucial for ensuring food safety and quality compliance with standards such as the Indonesian National Standard (SNI, 2015).

Role of Natural Preservatives and Packaging

The incorporation of natural preservatives (e.g., spices, salt) in dry sausages aids in reducing Aw and inhibiting microbial growth (Tapia et al., 2017). Packaging material also significantly influences the product's ability to retain moisture and resist environmental humidity. Studies have shown that proper packaging can limit moisture absorption, thus stabilizing physical parameters throughout storage (Coşkuner et al., 2010). Edible films and vacuum sealing are among the promising solutions to prolong shelf life while maintaining the desired physical and microbiological characteristics.

METHODOLOGY

Research Materials

The research materials comprised 1000 grams of cull laying hen meat. The seasoning was formulated as follows: garlic 15 grams, pepper 5 grams, ginger 7.6 grams, nutmeg 5 grams, all provided in powdered form, along with 150 grams of oil, 57 grams of tapioca flour, 35 grams of skim milk, 167 grams of ice cubes, 3 grams of STPP, and 25 grams of salt. The instruments employed in this research included a blender, cups, scales, oven, desiccator, measuring glass, pH meter, filter paper, glassware, casings, aluminum foil, plastic wrap, tissues, gloves, and paper plates.

Research Methodology

This study utilized a Completely Randomized Design (CRD) with four treatments and four replications. If any significant differences arise, Duncan's test will be conducted. The treatments in this research pertain to storage duration (P), organized as follows:

P0 = without storage,
P1 = The storage for 7 days
P2 = The storage for 14 days
P3 = The storage for 21 days

Research Procedure

The materials used for the preparation of sausage comprise cull laying hen meat that has been skinned, washed, cut, and divided into four portions for the four treatments, each weighing 250 g. The meat is ground and subsequently combined with seasonings, fillers, and binders according to the following formulation: garlic 1.5%, pepper 0.5%, ginger 0.75%, nutmeg 0.5% (all provided in powdered form), oil 15%, tapioca flour 5.7%, skim milk 3.5%, ice cubes 16.7%, STPP 0.3%, and salt 2.5%. The mixture is then ground again before being placed into casings measuring 10 cm in length and 1.65 cm in diameter. The sausages are then cooked by steaming at a temperature of 80°C for 30 minutes. Afterward, they are cooled and placed in an oven at 60°C for 12 hours. The sausage preparation process is illustrated in Figure 1.

RESEARCH RESULTS

The result of research mean of water activity, moisture content, water-holding capacity, pH of dry sausage from cull laying hen meat can seen in Table 1.

Table 1. Mean Values of Water Activity, Moisture Content, Water-Holding Capacity, pH of Dry Sausage from Cull Laying Hen Meat.

Parameter	Storage			
	P0	P1	P2	P3
Water activity	0,90±0,22[a]	0,85±0,11[b]	0,82±0,05[c]	0,82±0,05[c]
Moisture	30,04±0,14[a]	31,14±0,11[b]	32,68±0,54[c]	33,04±0,07[c]
Water-Holding Capacity	10,12±0,01[a]	11,05±0,03[b]	17,91±0,02[c]	23,36±0,04[d]
pH	6,88±0,02[a]	6,54±0,03[b]	6,38±0,02[c]	6,21±0,25[d]

Note: Different superscripts in the same line indicate significant differences (P<0.05)

Water activity (Aw)

The research data for water activity (Table 1) reveals that the highest mean water activity value is found in treatment P0, with a mean of 0.90, followed by treatment P1 with a mean of 0.85, and subsequently P2 with a mean of 0.82, which remains stable up to P3. Analysis of variance results indicate that the storage duration of dry sausage from cull laying hen meat has a significant effect on water activity values (P<0.05). Further Duncan's test analysis suggests that the water activity value in treatment P0 significantly differs (P<0.05) from P1, P2, and P3; treatment P1 also significantly differs (P<0.05) from P2 and P3, while P2 is similar to P3. According to Afrila and Jaya (2012), water activity in food products significantly affects their shelf life; the higher the water activity value, the shorter the shelf life. Conversely, lower water activity values extend the shelf life of the product. Based on the research by Deumier and Collignan (2003), dry sausages often contain high levels of salt, which serves to reduce the availability of free water in the product. Salt binds water, ensuring that even post-drying, the water remains chemically bound and is less susceptible to environmental factors (such as humidity). Additionally, natural preservatives like spices utilized in sausage production play a crucial role in regulating the stability of the Aw value, thereby preventing fluctuations. Coşkuner et al. (2010) note that changes in moisture content in dry sausage during storage can occur minimally, even remaining insignificant. If sausages are stored in adequately sealed containers, the moisture absorption from the surrounding air can be minimal, helping to maintain a stable Aw value. According to Afif (2013), the water activity value in sausages using edible films is 0.96, compared to this study where the water activity of dry sausage from cull laying hens stored at room temperature (28°C) until day 21 is 0.82. Various microorganisms have a minimum Aw necessary for optimal growth; for instance, bacteria require an Aw of 0.90 (Tapia et al., 2017). The SNI (2015) recommends that the water activity in meat ranges from 0.40 to 0.90. If a material falls within this range, whether not excessively high or low, it can withstand storage for an extended period. Therefore, the water activity value of dry sausage from cull laying hen meat remains compliant with SNI (2015) up to day 21.

Moisture

The research findings regarding moisture content (Table 1) demonstrate that the lowest mean value is observed in treatment P0, with a mean of 30.04%. This value increases in treatment P1 to 31.14%, followed by P2 at 32.68%, and reaches the highest mean moisture content in treatment P3 at 33.04%. Analysis of variance results indicate that the storage duration of dry sausage from cull laying hen meat significantly affects moisture content values (P<0.05). Further Duncan's test analysis reveals that the moisture content in treatment P0 significantly differs (P<0.05) from P1, P2, and P3, and treatment P1 also significantly differs (P<0.05) from P2 and P3, while treatments P2 and P3 show no significant difference. According to Lalu et al. (1992), the moisture content in meat tends to rise concomitantly with a decrease in pH, as moisture content is one of the factors influencing pH levels, which relates to the interaction of hydrogen ions in the meat. Dry sausage products are characterized by their low moisture content, yet they experience an increase in moisture during storage. Kusnandar et al. (2010) assert that the rise in moisture content in food products is influenced by several factors, such as the permeability of packaging materials to water vapor, the hygroscopic nature of the packaged food, environmental humidity levels, and the storage temperature conditions. Nurlaila et al. (2018) explain that moisture content in sausage can determine its shelf life; excessively high moisture levels may facilitate the proliferation of microorganisms, resulting in changes in color, aroma, flavor, and texture. Conversely, if the moisture content is too low, the growth of microorganisms will slow down, extending the spoilage process. The SNI (2015) recommends a moisture content value of 67%. Therefore, the moisture content of dry sausage from cull laying hen meat remains compliant with the SNI (2015) up to day 21.

Water-Holding Capacity

The study's findings regarding water-holding capacity (Table 1) indicate that the lowest mean value is found in treatment P0, with a mean of 10.12%, which increases in treatment P1 to 11.05%, followed by P2 at 17.91%, and reaches the highest mean value in treatment P3 at 23.36%. Analysis of variance results demonstrate that the storage duration of dry sausage from cull laying hen meat significantly affects water-holding capacity values (P<0.05). Further Duncan's test analysis reveals that the water-holding capacity in treatment P0 significantly differs (P<0.05) from P1, P2, and P3, while treatment P1 also significantly differs (P<0.05) from P2 and P3, and treatment P2 shows a significant difference (P<0.05) compared to P3. According to Suharyanto et al. (2023), the water-holding capacity of sausage reflects its ability to retain added water or the water inherent in the ingredients themselves; thus, a higher water-holding capacity correlates with improved sausage quality. Soeparno (2009) states that the water-holding capacity of meat generally ranges between 20-60%.

The results of this study suggest that as storage duration increases, the percentage of the dry sausage's ability to retain water also rises. This aligns with the perspective of Anggraeni et al. (2005), who assert that higher protein content in a material enhances its water-holding capacity. According to Bulkaini et al. (2017), sausages contain a blend of protein, fat, and water. During the drying process, interactions between proteins and fats occur, potentially enhancing the product's ability to retain water. Fat molecules can encapsulate water within a fatty matrix, and these fat-protein interactions can significantly improve the water-holding capacity of the product. The moisture content on day 21 is recorded at 23.36%. The SNI (2015) recommends a minimum moisture content value of 20% for chicken sausage. Therefore, the water-holding capacity of dry sausage from cull laying hen meat in this study remains acceptable according to SNI (2015).

pH value

The research findings on pH values (Table 1) indicate that the highest mean value is recorded in treatment P0 at 6.88, followed by P1 at 6.54, P2 at 6.38, and the lowest mean value is found in treatment P3 at 6.21. The analysis of variance results demonstrate that the storage duration of dry sausage made from cull laying hen meat significantly influences pH values ($P<0.05$). Further analysis using Duncan's test reveals that the pH value in treatment P0 significantly differs ($P<0.05$) from P1, P2, and P3. Additionally, treatment P1 significantly differs ($P<0.05$) from P2 and P3, while treatment P2 also significantly differs ($P<0.05$) from P3.

The pH of the base materials can lead to variations in the pH of the sausage. According to Lawrie (2003), shifts in hydrogen balance within the sausage are influenced by the pH of the base materials employed in its preparation. Ojha (2015) asserts that lactic acid bacteria (such as *Lactobacillus* spp.) play a critical role in the fermentation process of dry sausages. These bacteria convert sugars present in the meat or other ingredients into lactic acid, resulting in a decrease in pH within the product. Ali et al. (2011) report that the average pH of chicken sausage is 6.57, and the SNI (2015) recommends a pH range of 5.5 to 6.5 for sausages. Although the pH value decreases up to day 21 in this study, the dry sausage from cull laying hen meat remains within acceptable limits according to SNI (2015).

CONCLUSION

Based on the results of research on dry sausages from discarded laying hen meat stored until the 21st day, it can be concluded that:

1. Water activity (Aw) decreased significantly during storage, from 0.90 at P0 to 0.82 at P2 and P3. This value is still in accordance with the SNI standard (0.40–0.90) and supports a longer shelf life.
2. Water content increased with storage time, from 30.04% (P0) to 33.04% (P3), but was still far below the SNI maximum limit (67%) so that it remained safe for consumption until the 21st day.
3. Water binding capacity also increased significantly from 10.12% to 23.36%, indicating that the ability of dry sausages to maintain internal moisture improved during storage.
4. The pH value decreased from 6.88 to 6.21, but remained within the safe range according to SNI (5.5–6.5), indicating that natural fermentation activity was still within reasonable limits.

5. Overall, the physical and chemical quality of dry sausages from retired laying hen meat remained stable and met quality standards until the 21st day of storage at room temperature.

RECOMMENDATION

It is recommended that dry sausages from discarded laying hen meat be packaged with airtight materials to maintain stable water content and water activity so that the shelf life of the product can be extended. The use of natural preservatives such as spices also needs to be optimized to help maintain pH stability and inhibit the growth of microorganisms during storage. In addition, further research is needed that includes microbiological aspects and organoleptic tests to obtain a comprehensive picture of the quality and safety of the product during storage. The use of discarded chicken meat for processed products such as dry sausages can also be further developed as an effort to diversify products with economic value, as long as the quality is maintained according to applicable standards.

FURTHER STUDY

Further research is recommended to evaluate the microbiological stability and sensory characteristics of dry sausages from culled laying hens during long-term storage with various types of packaging, including vacuum packaging and active materials. This study can include testing for total microbes, specific pathogen growth, and organoleptic tests including taste, aroma, texture, and color by trained panelists. In addition, further research also needs to explore the effectiveness of natural preservatives (such as spice extracts or edible films based on natural materials) in maintaining pH stability and product quality. Economic studies on the market potential and competitiveness of processed products from culled hens can also be the focus of additional research to support sustainable product industrialization.

REFERENCES

Afif, T.M., 2013. Pengaruh Lama Penyimpanan sosis dengan Coating Edible Film Gelatin Kulit Shank Ayam Broiler Terhadap Cemaran Mikroba, Skripsi, Universitas Sebelas Maret, Surakarta.

Afrila, A., dan F. Jaya. 2012. Keempukkan, pH dan aktivitas air (Aw) dendeng sapi pada berbagai konsentrasi ekstrak jahe (Zingiber officinale roscoe) dan lama perendaman yang berbeda. *Jumal Ilmu Dan Teknologi Hasil Ternak*. 7(2) : 6 - 12.

Ali, M.S., G.D.Kim, H.W. Seo, E.Y. Jung, B.W. Kim, H.S. Yang, dan S.T. Joo. 2011. Possibility of making lowfat sausages from duck meat with addition of rice flour. *Asian Aust. J. Anim*. Sci. 24(3): 421-428.

Anggraeni, D.A., S.B. Widjanarko, D.W. Ningtyas. 2014. Proporsi tepung porang (Amorphophallus muelleri blume): Tepung maizena terhadap karakteristik sosis ayam. *Jurnal Pangan dan Agroindustri*, 2(3):214- 223.

Badan Pusat Statistik (BPS). 2021.Statistik Peternakan. Jakarta: BPS

Badan Pusat Statistik (BPS). 2022. Statistik Konsumsi Makanan. Jakarta: BPS.

Badan Standar Nasional. 2015. Sosis Daging. SNI 01-3820.2015. Departemen Perindustrian, Jakarta.

Bulkaini, B., D. Kisworo, S. Sukirno, R. Wulandani, and M. Maskur. 2020. Kualitas sosis daging ayam dengan penambahan tepung tapioka. *Jurnal Ilmu dan Teknologi Peternakan Indonesia* (JITPI), 6(1): 10-15.

Coşkuner, Ö., A.H. Ertaş, and A. Soyer. 2010. The effect of processing method and storage time on constituents of Turkish sausages (sucuk). *Journal of food processing and preservation*, 34, 125-135.

Deumier, F., and A. Collignan. 2003. The effects of sodium lactate and starter cultures on pH, lactic acid bacteria, Listeria monocytogenes and Salmonella spp. levels in pure chicken dry fermented sausage. *Meat Science*, *65*(3), 1165-1174.

Kameník, J., A. Saláková, G. Bořilová, Z. Pavlík, E. Standarová, and L. Steinhauser. 2021. Effects of storage temperature on the quality of dry fermented Sausages polican. *Czech Journal of Food Sciences*, 30(4), 293-301.

Kusnandar, F., D.R. Adawiyah, and M. Fitria. 2010. Pendugaan umur simpan produk biskuit dengan metode akselerasi berdasarkan pendekatan kadar air kritis. *Jurnal Teknologi dan Industri Pangan*. 21(2), 97-104.

Lalu, I.M.W., G.E.M. Malelak, and G.M. Sipahelut. 2019. Uji kualitas sosis darah tradisional (ta'bu) yang diberi tambahan tepung beras hitam (Oriza sativa L. Indica)(The quality of traditional blood suasage (ta'bu) added black rice (oriza sativa l. Indica) flour*). Jurnal Nukleus Peternakan.* 6(2), 71-79.

Lawrie, R.A. 2003. Ilmu Daging. Diterjemahkan oleh Aminuddin Parakkasi. UI-Press. Jakarta. Hal 245-298.

Nurlaila, N., A. Sukainah, and A. Amiruddin. 2018. Pengembangan produk sosis fungsional berbahan dasar ikan tenggiri dan tepung daun kelor. *Jurnal Pendidikan Teknologi Pertanian*. 2(2):105–113.

Ojha, K.S., J.P. Kerry, G. Duffy, T. Beresford, and B.K. Tiwari. 2015. Technological advances for enhancing quality and safety of fermented meat products. *Trends in Food Science & Technology*, 44(1), 105-116.

Prihharsanti, A.H.T. 2009. Populasi bakteri dan jamur pada daging sapi dengan penyimpanan suhu rendah. Jurnal Sains Peternakan, 7 (2), 66-72.

Soeparno. 2009. Ilmu dan Teknologi Daging. Gadjah Mada University Press. Yogyakarta.

Suharyanto, S., A.H.K. Amrullah, and A. Harahap. 2023. Menekan oksidasi sosis daging sapi yang disimpan pada suhu ruang dengan penambahan ekstrak daun senduduk (Melastoma malabathricum L.). *Jurnal Agripet*. 23(2), 134-141

Tapia, M.S., S.M. Alzamora, and J. Chirife. 2020. Effects of water activity (Aw) on microbial stability as a hurdle in food preservation. *Water activity in foods: Fundamentals and applications*, 323-355.