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Resistance of Broiler Meat through Exposure to Extremely Low Frequency Magnetic Fields of 700 µT and 900 µT Intensities and Safety Risks to Health

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Abstract: This study aims to examine "Resistance of broiler chicken meat through exposure to ELF MF and safety risks to health". Research samples of 140 packs of fresh broiler chicken meat (@ 50 grams) were divided into seven groups (@ 20 packs), one group as control, 3 groups were exposed to ELF MF intensity of 700 µT each with an exposure duration of 30, 45 and 60 minutes, and 3 groups were exposed to ELF MF intensity of 900 µT with exposure durations of 30, 40, and 60 minutes, respectively. Indicators of chicken meat resistance include pH, density, texture, color, aroma, and the appearance of mucus in chicken meat samples that have been stored for 6, 12, 18, and 24 hours after exposure to ELF MF. Research results: the physical endurance of chicken meat stored for 12 hours after being exposed to ELF MF intensity of 700 µT and 900 µT was better than the control. Conclusion: exposure to ELF MF intensity of 900 µT for 45 minutes and 60 minutes is able to maintain the quality of chicken meat at room temperature for up to 12 hours of storage and is safe for health.

Keywords; ELF MF; Resistance of Broiler Chicken Meat; Safety Risk to Health

Introduction

Consumer demand and preference for chicken meat is increasing. The main factors influencing this growth are economic growth due to urbanization and rising come levels of a growing middle class (Ovai et al., 2022). Chicken meat is very popular with the public because it contains a lot of protein. Apart from the many nutritional values contained in it, chicken meat also contains Staphylococcus aureus, *Salmonella spp*., and *Escherichia coli* (Wibawati et al., 2023).

The microbiological quality of chicken meat is very dependent on the process from slaughter to storage. One of the causes of decay is proliferation and interactions between members of the microbiota damage to chicken meat (Saenz-García et al., 2020). To avoid damage to chicken meat, a preservation process is needed. The preservation process itself can be done through chemicals or technology. You can be sure that consumers want chicken meat that is free of preservatives and has long shelf life (Gómez et al., 2020). So far, many preservation processes have been developed without involving chemicals, one of which is through exposure extremely Low Frequency (ELF).

Nowadays, study findings indicate that the presence of extremely low-frequency (ELF) magnetic fields can impede the growth and reproduction of bacteria. For instance, research has demonstrated that being exposed to an extremely low frequency (ELF) magnetic field with a strength of 500 µT effectively hinders the growth of salmonella bacteria in Vanamae shrimp and cow's milk (Sudarti et al., 2022a; Sudarti et al., 2022b). A magnetic field strength of 900 µT can help preserve the vitamin C content in red wine by

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suppressing the growth of harmful bacteria (Sudarti et al., 2022c). Research has demonstrated that being exposed to an extremely low frequency (ELF) magnetic field with an intensity of 1000 μT can effectively preserve the freshness of apple tomatoes by preventing the growth of harmful bacteria (Sudarti et al., 2022d). Another study says that the effective dose for inhibiting the activity of lactic acid-forming bacteria in green cayenne pepper was an exposure intensity of 500 μT for 120 minutes (Nuriyah & Sudarti, 2022).

Nevertheless, when the intensity reaches 200 μT, there is a propensity for bacterial development to accelerate during the cocoa bean fermentation process (Sudarti et al., 2022e), but an intensity of 300 μT effectively enhances the productivity of edamame fruit (Sudarti et al., 2023). Hence, our work demonstrates that the influence of being exposed to ELF magnetic fields can have either beneficial or detrimental effects, contingent upon the strength, duration of exposure, and biological attributes of cells (Nezamtaheri et al., 2022).

The extremely Low Frequency (ELF) magnetic subject is part of ELF electromagnetic waves with a frequency of much less than 300 Hz, has the ability to penetrate almost all rely, and the outcomes generated are non-ionizing radiation and non-thermal. More and more research results report That exposure to ELF magnetic fields can boom cell proliferation, but until now, this is still the subject of discussion. Exposure to the ELF magnetic area at an depth of 100 μT for 5 mins has been proven to be with a purpose to boom the proliferation of S. Thermophilus, L. Lactis, and L. Acidophilus bacteria inside the fermentation manner of making cream cheese (Sudarti et al., 2018). Meanwhile, exposure to the ELF magnetic field with an intensity of 646.7 μT for 30 mins was able to suppress the proliferation of Salmonella typhimurium in Gado-Gado seasonings by up to 56% and up to 17% in Gado-Gado vegetables. It was proven to not affect the texture, taste and color of vegetables in Gado-Gado (Sudarti, 2016).

Exposure to ELF electromagnetic waves (40–100 Hz) for 1 hour can increase the growth of E. coli bacteria, but after 16 hours of exposure, it has decreased (Chen et al., 2019). ELF-EMF exposure with a frequency of 7 Hz can inhibit cell growth in Anabaena culture compared to controls. The longer the exposure time, the higher the ELF-EMF inhibitory effect on Anabaena growth, and complete cell death was found in cultures exposed for 2 hours (Fadel et al., 2018). Other researchers also suggested that exposure to ELF magnetic fields between 500–1,000 μT intermittently 20 mins in step with day for seven days can increase mobile survival and proliferation, besides exposure to 1,000 μT intermittently forty minutes/day for seven days (Shahbazi-Gahrouei et al., 2017). Based totally on the outcomes of this look at, it is able to be said that publicity to the ELF magnetic field at a high intensity (≥ 500 μT) has the ability to inhib it the boom of microorganism, however aside from the intensity of the magnetic subject, other dominant factors that have an effect on encompass length of exposure, frequency, and characteristics of the bacteria.

Inspired by the results of this research, it is hoped that this research can underlie the development of technology for utilizing ELF magnetic fields to improve food security, especially chicken meat. Chicken meat, especially broiler chickens, is straightforward to spoil, only surviving in the open air for about 6-8 hours. Traders often carry various ways of preserving chicken meat, generally using chemicals such as formaldehyde or borax, which negatively impact health. Therefore, this research is very important to do in order to prevent the bad effects of chemicals used during the preservation process and to maintain the durability of chicken meat for a long time without using chemical preservatives.

Consequently this study goal is to take a look at exposure to ELF magnetic fields of the depth of 700 μT and 900 μT to growth the resistance of broiler chicken meat. The novelty of this research is the potential for utilizing an ELF magnetic field with an intensity of 900 μT to increase the durability of chicken meat at room temperature.

Method

Research design

The research is a laboratory experimental test, with a completely randomized design. The independent variable is exposure to an ELF magnetic field with an intensity of 700 μT and 900 μT and exposure time of 30, 45, and 60 minutes. The research sample was 140 packs of fresh broiler chicken meat (@50 grams), divided into 7 groups. One group as a control, three groups were exposed to an ELF magnetic field with an intensity of 700 μT, with exposure times of 30, 45, and 60 minutes, and 3 groups were exposed to an ELF magnetic field with an intensity of 900 μT, respectively for 30, 45, and 60 minutes according to the research design as follows.

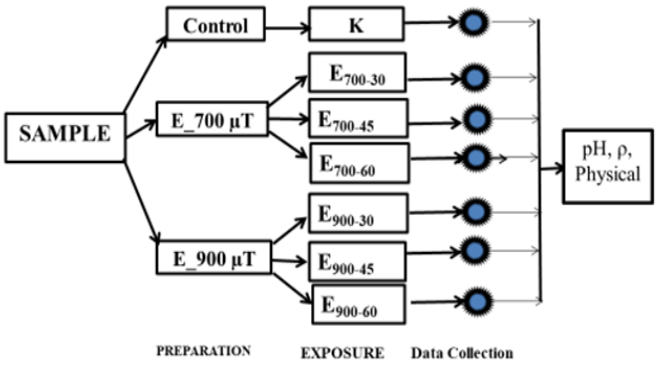

Figure 1. Research flow

Information:
K: control group, not exposed to ELF magnetic discipline
E700-30, E700-45, E700-60: The pattern group become uncovered to a 700 μT ELF magnetic field for 30, 45 and 60 mins
E900-30, E900-45, E900-60: The pattern group become uncovered to a 900 μT ELF magnetic field for 30, 45, and 60 mins.

ELF Magnetic Field Exposure Process

The ELF magnetic subject is generated through an ELF Electromagnetic area producing machine Generator (EM ELF), as proven beneath.

Figure 2. Field Source Generator and EMF-meter

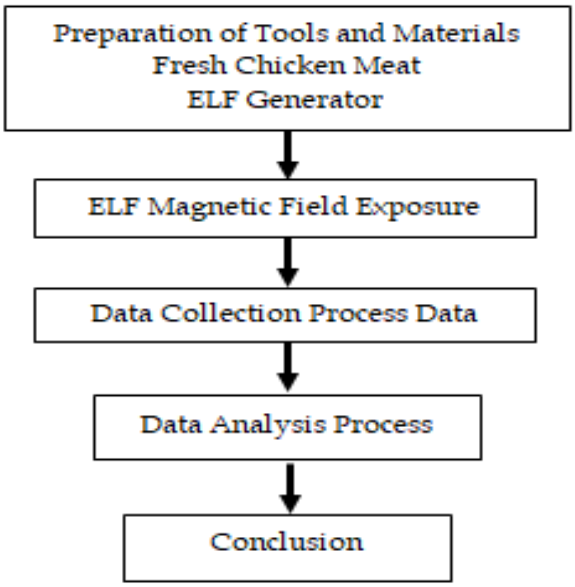

Figure 3. Research Stages

The technique of exposure to the ELF magnetic field on chicken meat samples was accomplished with the aid of placing the sample into the publicity chamber, then adjusting the electric modern-day electricity so that an ELF magnetic area exposure of intensity of seven hundred μT or 900 μT was produced inside the publicity area indicated by using the EMF-meter measuring instrument. Then set the length of exposure for 30 mins, 45 mins, and 60 mins, according to the research design. Samples of chicken meat that had been uncovered to the ELF magnetic field and manage samples had been saved in a condition wrapped in plastic wrap at a temperature of around 26^0 C. As an indicator of the durability of chicken meat, measurements of density, pH, and observation of physical conditions (change in color, texture, appearance of foul odor, and the formation of slime) were carried out after the samples were stored for 6, 12, 18, and 24 hours. The information of the results of this examine were analyzed using Anova analysis and supported by a qualitative analysis of the physical situations to determine the resistance of chicken meat because of publicity to the ELF magnetic area.

Research Stages

The stages of this research are presented in the following Figure 3.

Result and Discussion

Research data include: pH of chicken meat, density, and physical condition (color and aroma) of chicken meat at storage for 6, 12, 18, and 24 hours will be discussed as follows.

Change in the pH of chicken meat due to exposure to ELF magnetic fields of 700 μT and 900 μT

Potential hydrogen is an important indicator to determine the quality of chicken meat, which is closely related to the presence of microbes in chicken meat. The pH measurement of chicken meat samples was carried out before acquiring exposure to the ELF magnetic field (0 hour) and after obtaining exposure to the ELF magnetic field for 6, 12, 18, and 24 hours of storage. The pH value of chicken meat stored in plastic wrap will undergo an anaerobic decay process. Figure 4. shows the pH value of chicken meat from fresh conditions (0 hour), after 6, 12, 18, and 24 hours of storage, it appears significantly ($p < 0.05$) decreased with storage time. This proves that the pH value of chicken meat that has undergone an anaerobic decay process has decreased linearly with storage time.

The decrease in pH is an indication of the continuous activity of lactic acid-producing microbes, which causes the acidity of chicken meat to increase so that the pH value decreases. This is because meat has a high nutritional content making it a good breeding medium for pathogenic microbes (Pal et al., 2018). The results of previous studies proved that fresh meat has a pH of 7.2 after slaughtering livestock, there is a decrease in pH due to the accumulation of lactic acid in muscle tissue due to the process of anaerobic glycolysis (Marsidah, 2017). Comparison of the pattern of changes in the pH value of chicken meat that gained exposure to ELF magnetic fields with intensity of 700 μT and 900 μT for 30, 45 minutes, and 60 minutes, and the control is presented in Figure 4.

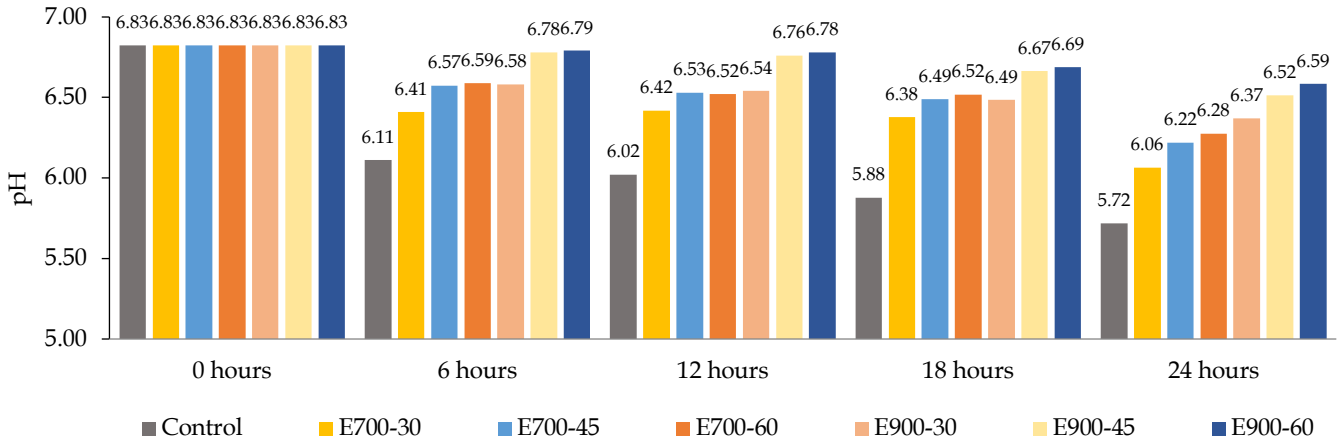

Figure 4. Changes in the pH of Chicken Meat After Exposure to ELF Magnetic Fields

Figure 4 above indicates a alternate in the pH of hen meat uncovered to an ELF magnetic area of 700 µT intensity for 30, 45, and 60 mins (determine three) additionally shows a decrease, but was appreciably higher ($p < 0.05$) as compared to the pH price of chook meat in the manipulate institution at either 6, 12, 18, or 24 hours garage. This proves that publicity to the ELF magnetic area of seven hundred µT depth is capable of hold the pH value of chicken meat.

The sample of adjustments in the pH of chicken meat affected to an ELF magnetic discipline of 900 µT depth for 30, 45, and 60 mins turned into appreciably better ($p < 0.05$) than the manage, each at 6, 12, 18, and 24 hours of garage. Clock (discern five). This indicated that exposure to the ELF magnetic discipline with an intensity of 900 µT turned into capable of resist and suppress proliferation of lactic acid-generating microorganisms. It is able to be seen that the pH of fowl meat that become uncovered ELF magnetic area with a depth of 900 µT for 45 minutes and 60 minutes, become able to survive around 6.8 to 12 hours of garage.

This situation might be due to the inhibition of the proliferation of lactic acid-producing microorganisms due to ELF magnetic discipline with an depth of seven-hundred µT and 900 µT. This truth is supported by using previous proof that exposure to an ELF magnetic field with a depth of 646.7µT for 30 minutes has been shown to suppress the proliferation of Salmonella typhimurium by means of as much as 56%. The inhibition of the proliferation of lactic acid-generating microorganisms changed into inhibited, resulting within the pH price of chicken meat exposed to an ELF magnetic discipline depth of seven-hundred µT and 900 µT appreciably higher than the manipulate until 24 hours of garage.

Previous evidence shows that exposure to a magnetic discipline for 2 hours can inhibit the growth of microorganisms, and affect pH. Electromagnetic fields cannot simplest have an effect on hydrogen bonding in aqueous solutions, however can also disrupt the balance of the gasoline/liquid interface, produce a few oxygen species, and probably induce CO_2 hydration, which adjustments the pH of liquid structures. Fresh meat has a pH of 7.2 after slaughtering livestock, there is a decrease in pH due to the accumulation of lactic acid in muscle tissue due to the process of anaerobic glycolysis. Low pH values in chook meat can stimulate protein denaturation, so that it will increase the quantity of water content material, low pH reasons the oxidation of myoglobin (pink color) and myoglobin oxygen (pink shade) to metamyoglobin (brown meat coloration).

Potential hidrogen value of chicken meat uncovered to an ELF magnetic field intensity of 900 µT for 45 minutes and 60 minutes after 6 hours of storage, 12 hours was not significantly different ($p > 0.05$) compared to the pH of fresh chicken meat (at 0 hour measurement). This proves that exposure to the ELF magnetic field intensity of 900 µT for 45 mins and 60 mins is effective in maintaining the pH of chicken meat until the 12th hour.

Modifications in the density of chook meat by using publicity to the ELF magnetic area

Density of chicken meat stored in plastic wrap will experience anaerobic decomposition. Figure 5. shows the density of chicken meat from fresh conditions (0 hour), after 6, 12, 18, and 24 hours of storage, significantly ($p < 0.05$) decreased with storage time. This proves that the density of chicken meat that has undergone an anaerobic decay process has decreased linearly with the length of storage. The process of meat decomposition caused by bacterial activity can affect organic materials intensively, such as causing smelly gases which affect the decrease in the nutritional content of meat (Oncul et al., 2016). The process of natural chicken meat spoilage is caused by increased microbial activity accompanied by the release of intracellular and extracellular microbial enzymes, such as extraintestinal pathogenic *Escherichia coli* strains (Rasmussen et al.,

2015). Foodstuffs that are contaminated with pathogenic bacteria can endanger health, the presence of *E. coli* bacteria in poultry meat can cause meningitis and pepsis in the human body (Stromberg et al., 2017). The emergence of gas in the process of decomposition of chicken meat during storage for 6, 12, 18, and 24 hours will affect the volume, so that the density decreases along with the storage time.

The density of fowl meat after being uncovered to the ELF magnetic field depth of 700 µT and 900 µT for 30, 45, and 60 minutes reduced linearly with storage time, starting at zero hours (fresh situation), 6, 12, 18, and 24 hours. The results of the one-manner ANOVA evaluation proved that the density cost of fowl meat exposed to an ELF magnetic area depth of 700 µT for 30, 45, and 60 mins become notably ($p < 0.05$) higher than the manipulate at 6, 12, 18, and 24 hours of garage.

Figure 5 explains that the density of hen meat exposed to ELF magnetic area with an depth of 900 µT for 30, 45, and 60 mins become extensively ($p < 0.05$) higher than the sample institution uncovered to an ELF magnetic discipline with a depth of 700 µT for 30, 45, and 60 mins as properly as compared to the control. It may be visible that the density of the chicken meat pattern group which became exposed to a 900 µT magnetic area for 60 mins had the highest fee until the twenty fourth hour of storage. The value of the density of chicken meat uncovered to the ELF magnetic subject depth of 900 µT proved to be better, this illustrates that the extent of chicken meat has not accelerated due to bacterial activity, and this lower isn't always followed by way of the advent of excess mucus. Oxidative processes in proteins, fats, pigments, and vitamins have a negative impact on meat quality, including changes in color, texture, aroma, reduced nutrient content, and the formation of toxic compounds (Domínguez et al., 2019). As a result, the decomposition process will result in a softer texture and increased water content, increasing the volume of chicken meat while decreasing its density.

The effects of this examine proved that publicity to an ELF magnetic discipline intensity of 900 µT for 45 mins and 60 mins become capable of keep the density of chicken meat till the 18th and twenty fourth hours, respectively, notably ($p > 0.05$) better than the manipulate pattern. The mechanism of resistance to the density of chook meat uncovered to an ELF magnetic subject with a depth of 900 µT, is idea to be due to inhibition of the proliferation of spoilage bacteria, in order that the activity of the chicken meat putrefaction process is hampered. The sample of changes within the density of chicken meat uncovered to the ELF magnetic subject with intensities of 700 µT and 900 µT for 30, 45, and 60 mins as compared to the manage as an entire, is presented inside the graph in Figure 5.

Treatment of publicity to ELF magnetic fields with intensities of 700 µT and 900 µT for 30, 45, and 60 mins objectives to boom the resistance of fowl meat, because it is believed that high intensity ELF magnetic fields (> 500 µT) have the capability to inhibit bacterial boom. Giving microorganism a magnetic discipline can have an effect on their activity and metabolism (Khokhlova et al., 2018). The physical condition of the chicken meat in the control group sample of this study showed that, at the 12th hour, a foul and slimy odor had begun to appear, the amount of mucus was increasing, the stench was more pungent, and the texture condition was getting softer at the 18th and 24th hours compared to other groups. This is caused by the proliferation of putrefactive bacteria during the putrefaction process, which produces odors, slime, and changes in texture, resulting in an increase in the volume of chicken meat while its mass remains relatively unchanged. This condition causes the density of chicken meat to get smaller and smaller. Colonies of -hemolytic Streptococcus in fermented culture media decreased when exposed to magnetic fields of 1200 and 1500 T (Zhang et al., 2016).Therefore, exposure to an ELF magnetic field intensity of 700 µT. The effects of this observe imply that exposure to the 700 µT ELF magnetic subject has the capacity to growth the sturdiness of hen meat until the 18th hour.

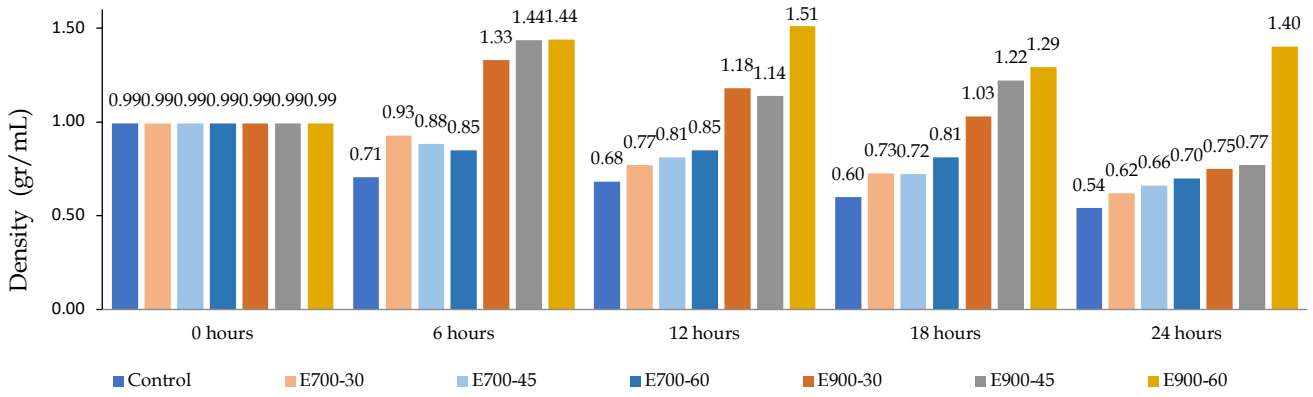

Figure 5. Change in Density of Chicken Meat Due to Exposure to ELF Magnetic Fields of 700 µT and 900 µT

This fact is supported by previous research on the effect of the ELF magnetic field on inhibiting bacterial growth. The provision of an ELF magnetic field with a frequency range of 1–15 Hz at 20°C can affect the survival and morphology of *E. coli* and *Saccharomyces cerevisiae* bacteria. At a frequency of 3 and 13 Hz the growth of *S. cerevisiae* bacterial cells became significantly more inhibited, whereas the survival of *E. coli* bacterial cells was much smaller than that of *S. cerevisiae* bacteria (Plutakhin et al., 2018). The ELF magnetic field causes changes in the physicochemical properties of Gram-positive and Gram-negative bacteria (Oncul et al., 2016).

Changes in the Physical Condition of Chicken Meat by Exposure to ELF Magnetic Fields

Tabel 1. Indonesian National Standard (SNI) for Color and Aroma of Chicken Meat (Badan Standarisasi Nasional, 2006)

Score	Colour	Aroma	Texture
5	Fresh white, slightly yellowish	Fresh typical chicken meat	Chewy, not slimy
4	Pale white, slightly yellowish	Fresh typical chicken meat	Slightly chewy, not slimy
3	Fresh white, slightly yellowish	A bit fishy	A bit chewy, a little slimy
2	Pale white	Fishy	Slightly soft and slimy
1	Very yellow	Very fishy	Soft and slimy

Assessment of the physical condition of chicken meat in this study used color and aroma indicators in the Indonesian National Standard (SNI) is shown in Table 1.

Change in Color of Chicken Meat by Exposure to ELF Magnetic Fields

The color of chicken meat is one of the main attractions for consumers when assessing the quality of chicken meat. Figure 6 shows the assessment by 3 observers of the color of chicken meat after 24 hours. Chicken meat without exposure to the ELF magnetic field gets highest score of 1, with a yellow color indication. While the highest score was given to chicken meat with exposure to 900 µT with indications of fresh white and slightly yellowish chicken meat. Respondents' assessment of the color of chicken meat showed that chicken meat exposed to a magnetic field of 900 µT was better than the control class and in accordance with SNI standards, so that it was safe and healthy for consumption.

The color of poultry meat is basically influenced by several factors, including storage, water content, and pH (Handayani et al., 2020). The pH value of chicken meat exposed to 900 µT was higher than that of the control group, both at 6, 12, 18, and 24 hours of storage. This indicated that exposure to the ELF magnetic field with an intensity of 900 µT was capable of suppress the proliferation of lactic acid-producing microorganisms.

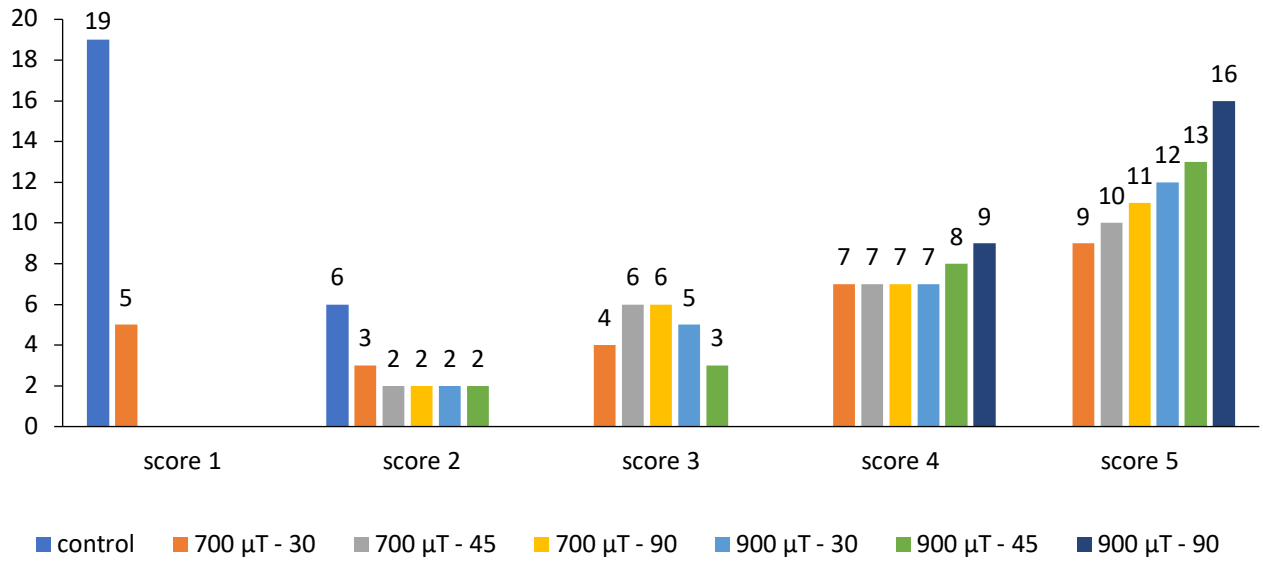

Figure 6. Color Change Pattern of Chicken Meat After Exposure to 700 T and 900 T ELF Magnetic Fields Compared to Control

Adjustments in chicken Aroma by using publicity to ELF Magnetic Fields

Aroma of poultry meat is naturally formed through various processes, such as heating and chemical reactions. According to SNI standards, chicken meat has a distinct aroma that does not smell rancid or rotten, does not sting, and does not smell fishy (Badan Standarisasi Nasional, 2006). The results of assessing the aroma of chicken meat after 24 hours are shown in Figure 7.

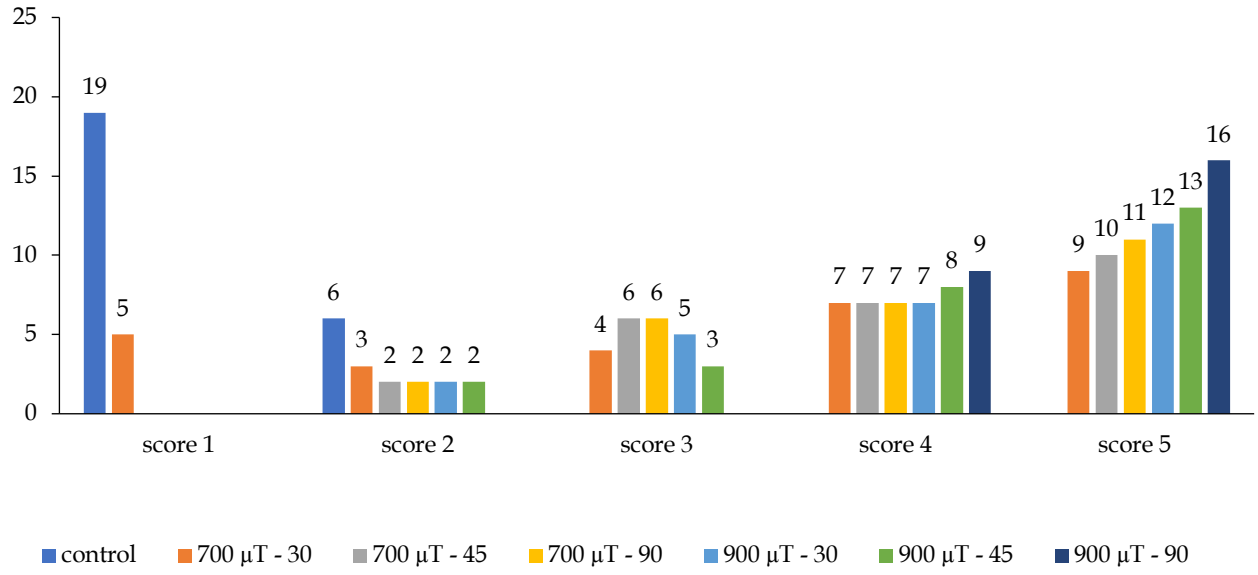

Figure 7. Change of Chicken Aroma Pattern by Exposure to 700 µT and 900 µT ELF Magnetic Fields Compared to Control

Score 5 is an indication of the distinctive fresh aroma of chicken given to chicken meat exposed to a 900 µT magnetic field. While score 1 is more often chosen by respondents for chicken meat in the control group. Exposure to the ELF magnetic area is capable of suppress the quantity of microorganism to carry out metabolic activities, so chicken meat exposed to a 900 µT magnetic field is effective in maintaining the quality of chicken meat that is healthy and safe for consumption according to established standards.

At 0 hours, the physical condition of chicken meat is fresh, brightly colored, not slimy, and has a distinct chicken meat aroma. The effects of observations at the sixth hour, it has started to look slimy and yellowish red in color, but has not smelled of rot and is still a bit chewy. Observations at the 12th hour, had secreted more mucus, the texture was getting soft, the color was pale yellow, and it gave off an unpleasant odor. At the 18th hour, observations revealed that the animal had secreted a lot of mucus; the texture was soft; the color was paler; and it emitted a foul odor. Observation at 24 hours, had secreted a lot of mucus, the texture was soft, the color was pale, and it gave off a pungent foul odor. Animal food ingredients such as chicken meat contain protein, which makes it a vehicle for pathogenic bacteria to grow and reproduce. Raw meat is a major source of infection with food-borne pathogenic bacteria (Pal et al., 2018). Chemical reactions cause sensory changes in food ingredients caused by microbial activity. In food that is decomposed, there is an increase in the microbial population, which causes the nutritional content of the food to decrease (Rawat, 2015). The result of this damage is the formation of mucus, discoloration, change in smell, change in taste, and rancidity caused by the breakdown or oxidation of meat fat. Other research also shows that exposure to ELF magnetic fields does not affect the texture, taste and color of vegetables in gado-gado (Sudarti, 2016). This proves that the ELF magnetic field is very safe to apply in the process of preserving chicken meat.

Fresh meat has a pH of 7.2 after slaughtering livestock, there is a decrease in potential hydrogen due to the accumulation of lactic acid in muscle tissue due to the process of anaerobic glycolysis (Marsidah, 2017). Low potential hydrogen or pH values in chicken meat can stimulate protein denaturation, in order to growth the quantity of water content. Low pH reasons the oxidation of myoglobin (crimson shade) and myoglobin oxygen (crimson shade) to metamyoglobin (brown meat color) (Kralik et al., 2017).

Changes in Chicken Meat Texture by Exposure to ELF Magnetic Fields

The results of the observations of the control group proved that the texture of chicken meat at 12 hours for all indicators got a score of 1, that is, it had a soft texture, secreted mucus, had a yellow/pale color, and gave off an unpleasant odor. While the chicken meat sample was exposed to a 700 µT ELF magnetic field, all indicators had a score of 4, namely slightly chewy texture, no mucus visible, no color change, and still smelling of chicken meat. Chicken meat samples exposed to a 900 µT ELF magnetic field had a chewy texture, no mucus was visible, no color change had occurred, and the smell of chicken meat was still felt.

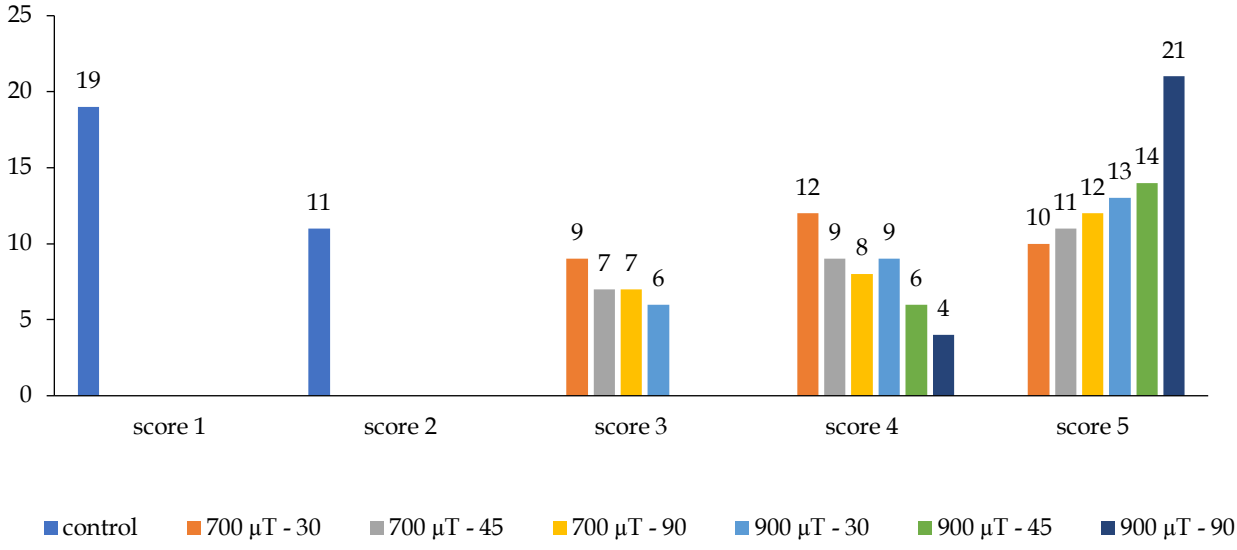

Figure 8. Texture Change Pattern of Chicken Meat by Exposure to ELF Magnetic Field 700 µT and 900 µT compared to Control

Texture, aroma, and look are the maximum essential factors of meat, regularly as a result of volatile aromatic materials which includes aldehydes, ketones, esters, phenols, alcohols, natural acids, and alkanes, among others. Consequently, the content material of different risky components and the presence or absence of those additives decide the aroma and taste traits (Zhan et al., 2019). Biologically, the damage to fowl meat is typically because of the boom of microorganisms, and might without delay affect the bodily and chemical high-quality of chicken meat (Hajrawati et al., 2016). Pathogenic microorganism can reason meat spoilage by means of secreting lipase and protease ensuing within the formation of sulfide and trimethylamine (odorless), and secreting mucus on the floor of the body (Rawat, 2015).

Exposure to an ELF magnetic field intensity of 900 µT for 45 minutes and 60 mins became proven to enhance the bodily excellent of broiler meat until the 12th and 18th hours, respectively. The underlying mechanism is that exposure to the ELF magnetic discipline is able to inhibit the proliferation of spoilage microorganism, resulting in a slowdown inside the procedure of chook meat spoilage. Static magnetic fields at 18,000 T and 20,000 T intensities for ninety minutes extensively reduced *E. coli* microorganism (Mousavian-Roshanzamir & Makhdoumi-Kakhki, 2017). While ELF-EMF with an average intensity of 250 µT was able to inhibit the growth of the bacterial species *Serratia marcescens*, while the static magnetic field was not statistically significant (Tessaro et al., 2015). Administration of a magnetic field with an intensity of 107 mT for 30 minutes was able to reduce the auto aggregation of the *Escherichia coli* E2348/69 bacteria and modify its adherence pattern, with both events most likely related to changes in BFP expression (Quiñones-Peña et al., 2017).

The condition of chicken meat with an ELF magnetic field intensity of 900 µT for 45 minutes of exposure time was classified as a score of 5 because the physical condition appeared fresh and yellowish white. Besides that, chicken meat with an intensity of 900 µT for 45 minutes of exposure gave off an aroma like chicken meat. So that chicken meat exposed to an ELF magnetic field of 900 µT is still feasible and safe for consumption. However, in the control group, the chicken meat looked pale and dark and started to secrete mucus, causing an unpleasant mell. Mucus resulting from the activity of organisms causes the physical condition of chicken meat to tend to be stickier.

Greater harm to chicken meat is due to the boom of microorganisms, and might directly affect the physical and chemical quality of hen meat (Hajrawati et al., 2016). Changes that occur in rotting meat include the appearance of odors caused by the production of volatile final products, color changes due to the production of bacterial pigments or natural oxidation of meat components such as oxidation of myoglobin, texture that changes to softness due to proteinase, accumulation of gases caused by the production of CO_2, H_2, H_2S.

Other changes include the appearance of mucus which is caused by the production of dextran, exopolysaccharides, or the increasing number of microbial cells. And the last one is the presence of liquid which is caused by breaking down the hydration barrier structure in the mea. Microbes will experience growth during the storage period and will produce enzymes that will decompose food components such as proteins, fats and sugars (Pal et al., 2018).

Publicity to the ELF magnetic area depth of 900 µT for forty five and 60 minutes became concept so as to

suppress the proliferation of spoilage bacteria in fowl meat, in order that the density and pH of the bird meat were appreciably ($p < 0.05$) better than the manage sample. The results of observations of bodily conditions also proved that the hen meat pattern institution, which was exposed to an ELF magnetic area with an depth of 900 µT for forty five minutes and 60 mins, respectively, confirmed the bodily resistance of hen meat (elastic, no longer slimy, and no rotten scent), until the 12th hour.

A number of the underlying studies results, particularly publicity to ELF-EMF 4000 µT, 20 Hz for 6 hours, have been able to inhibit the capacity to form CFU colonies as compared to controls, each inhibition turned into 95.23% for *S. aureus* and 85% for *E. coli* (Bayir et al., 2015). A thousand µT ELF magnetic subject for 2 hours, brought on adjustments in the physicochemical residences of Gram-effective and Gram-bad microorganism, and a slight decrease in bacterial growth became located (Oncul et al., 2016). Exposure to ELF magnetic fields with intensities of 730 µT and 880 µT each for 2 x 30' on fresh Exposure to ELF magnetic fields with intensities of 730 µT and 880 µT each for 2 x 30' on fresh milkfish, become proven with a purpose to suppress bacterial boom up to 73% and 62%, respectively at five hours after exposure in comparison to manipulate (Sudarti et al., 2020). Theoretical effects can provide an explanation for the magnetic sensitivity of *E. coli* cells and show that intracellular enzymatic reactions are the primary magnetoreceptors in residing organisms (Kim et al., 2017). Exposure to a 300 µT ELF magnetic field for 25 minutes significantly ($p < 0.05$) suppressed the proliferation of *S. thermophilus*, *L. lactis*, and *L. acidhopilus* Log phase bacteria (Sudarti et al., 2018).

Based on the results of the research and review of the literature, it can be stated that exposure to the ELF magnetic field with an intensity of 900 µT is likely to be able to inhibit the proliferation of pathogenic bacteria, so that the process of decomposition of chicken meat will be hampered, meaning that the resistance of chicken meat will increase. This was proven from the results of this study, that exposure to a magnetic field intensity of 900 µT for 45 minutes and 60 minutes was able to maintain the physical condition of chicken meat until the 12th hour.

Food Safety Risk to Health by Exposure to ELF Magnetic Fields

The Extremely Low Frequency (ELF) magnetic field has the ability to penetrate almost any material but is non-ionizing radiation and non-thermal. But until now, there have been suspicions about the possibility of toxic effects from exposure to ELF magnetic fields. Several studies have been reported that prove that exposure to ELF magnetic fields does not cause toxic effects. The results of Sudarti (2016), proved that exposure to the ELF magnetic field with an intensity of 646.7 had no effect on changes in the texture, color, and taste of Gado-gado vegetables. The exposure to ELF electromagnetic fields acts as a non-toxic substance. Meanwhile, exposure to 50Hz ELF-EMF at an intensity of up to 1000 µT has been shown to have no neurotoxic effects (de Groot et al., 2014). Meanwhile, exposure to a 50Hz ELF magnetic field at an intensity of 2000 µT did not cause a genotoxin effect (DNA damage) (Su et al., 2017).

Based at the effects of this examine, It proves that exposure to the ELF magnetic discipline does now not purpose poisoning in food, along with fowl meat. The results of this examine have temporarily proven that the bodily condition of hen meat uncovered to ELF magnetic fields nevertheless meets SNI health standards with a score of 5 to 12 hours. A rating of five manners that it meets the standards for a slightly yellowish, fresh white colour and a exclusive clean aroma of chook meat. This indicates that the fowl meat is of suitable fine and meets the necessities for a healthful food. This proves that publicity to the ELF magnetic subject can increase the resistance of chicken meat which is safe for health.

Conclusion

Exposure to an extremely low frequency magnetic field (ELF MF) intensity of 900 µT for both 45 and 60 minutes can effectively preserve the quality of chicken meat at room temperature for up to 12 hours of storage. Furthermore, this level of exposure is considered safe for human health.

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Author Contributions
Conceptualization and methodology, Sudarti(.S); formal analysis, S, Elok Permatasari (EP) and Tania Ardiani (TA); writing—original draft preparation, S, EP, and Lutfiana Dita Sari (LDS); writing—review and editing, S, EP, TA.; Visualization. LDS, TA. All authors have agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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