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ANALYSIS OF TEMPE MATERIAL ON EXTREMELY LOW FREQUENCY MAGNETIC FIELD RADIATION

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Abstract :
Electromagnetic waves in physics are waves composed of a magnetic field and an electric field whose propagation does not require an intermediary medium. Very Low Frequency (ELF) magnetic fields have a frequency range of 0 to 300 Hz. Tempe is a prince made from soybeans fermented with Rhyzopus fungus. The purpose of the research carried out was to determine the effect of exposure to an Extremely Low Frequency (ELF) magnetic field on pH in the tempe fermentation process. This research uses an experimental method with a research design (completely randomized). The sample used was tempe which was divided into experimental groups (ELF) and control. Data obtained from data taken based on research that has been carried out such as pH, density, tempe color, tempe aroma, tempe texture and taste. Data collection techniques are obtained from data that has been obtained in research and then explained descriptively in tabular form. The research results show that exposure to an Extremely Low Frequency (ELF) magnetic field affects the pH in the tempe fermentation process, as can be seen from the variations in the table presented in the research results. The resulting taste tends to be less like tempe in general, the resulting color is brownish, and the texture of tempe exposed to ELF tends to have a mushy texture. The average density was greater in the experimental group and the aroma was almost typical like tempe in general. Conclusion is Extremely Low Frequency (ELF) magnetic field radiation can affect the tempe fermentation process.

Keywords: Electromagnetic Wave, Extremely Low Frequency, Tempe

INTRODUCTION

Physics is a branch of science that studies natural phenomena, including matter and its interactions. Physics is based on laws, theories, concepts and applications. Therefore, physics education is part of science learning, and in the process, it needs to include elements of process, scientific ethics, and the results of learning. In the context of physics learning, it is important to emphasize that students' active involvement in interacting with physical objects is a key aspect that must be prioritized (Khumairoh *et al.* 2023). Electromagnetic waves in physics are waves composed of magnetic fields and electric fields which in their propagation do not require an intermediate medium. Any electronic equipment can generate a magnetic field when there is a flow of electric current. Therefore, the use of electrical equipment has an important role in increasing the electric field around us and increasing the intensity of exposure to magnetic fields. Magnetic field with frequency *Extremely Low Frequency* (ELF) has a frequency range of 0 to 300 Hz, so it is easy to find around us where there is an electric current with that frequency. (Qumairoh *et al.*,2021). In the presence of electromagnetic waves, the strength of the electric field and also the strength of the magnetic field in each place where the electromagnetic waves pass will change with time. (Astutik & Sudarti, 2021). Electromagnetic waves have a wave field that is perpendicular to magnetic waves, electromagnetic waves cover various frequencies from gamma rays to radio waves. (Rahmadani *et al.,* 2023). When electricity is flowed through the transmission network, distribution, or used in various equipment, at that time an electric field and a magnetic field also arise. This is in accordance with the opinion of James Clerk Maxwell who argues that changes in the electric field will produce a magnetic field (Ma'rufiyanti *et al*. 2021).

The rapid development of technology means that the use of electronic devices in everyday life is increasing. Every electronic device produces a magnetic field when an electric current flows through it (Kanza *et al*. 2020). The ELF magnetic field has an electromagnetic wave spectrum at frequencies <300 Hz which is categorized as non-ionizing radiation. Non-ionizing radiation is electromagnetic radiation that does not have enough energy for ionization, such as infrared radiation and microwaves (Kamila & Sudarti, 2022). Electromagnetic waves arise due to the vibration of magnetic fields and electric fields that are perpendicular to each other in the direction of propagation. (Nur *et al.,* 2022) Electromagnetic waves can propagate without the need for a medium, so they are referred to as electromagnetic radiation with various kinds of electromagnetic waves that are distinguished by their frequency. There are characteristic differences between the two components in electromagnetic waves. The electric field is easily blocked, so its intensity will decrease if it is blocked by objects. Meanwhile, magnetic fields have characteristics that are not easily blocked so that they can penetrate almost all materials (Lutfiyah *et al*., 2022). The magnetic field has the characteristic of being able to penetrate any material, whether in the form of plates, solid materials, cross-sections and so on. Meanwhile, an electric field requires a medium to propagate the current source (Cahyono *et al.*, 2023).

Electromagnetic radiation is a combination of of electric and magnetic fields that oscillate and propagates through space and carries energy from one place to another (Wijaya *et al*., 2019). Differences in radiation effects occur due to frequency, distance of exposure to the source, length of exposure, wavelength (Niati *et al.*, 2021). This radiation can be used to improve food security by killing microorganisms at certain doses, which are different for each type of food. Although killing microorganisms in food can be done by giving gamma rays or beta rays, the rest of the radiation in food has the potential to mutate cells in the body and trigger the growth of cancer cells when consumed. In addition to improving food security, ELF magnetic field radiation also has the potential to increase the shelf life of fruit by maintaining its pH value. Magnetic field radiation *Extremely Low Frequency* (ELF) has several advantages, namely more effective, easier, cheaper, and does not change the taste and quality of food ingredients (Uswatun & Sudarti, 2022). Exposure to ELF-EMF has detrimental biological effects depending on the current intensity, magnetic field strength, and duration of exposure (Sulistiyowati & Ulfah, 2023). Sources of electromagnetic waves can be produced by several electronic devices that are often used in daily activities such as electrical cables and others. (Astutik *et al*., 2022).The resulting field will spread into the environment and spread pollution and how far it is detrimental can be called ELF. (Munawaroh and Sudarti, 2022). Electromagnetic waves are produced by a flowing electric current. (Yulianto *et al.,* 2022).

Use of magnetic fields *Extremely Low Frequency* (ELF) has a wide range of benefits, including in the food industry such as tempe. Magnetic *Extremely Low Frequency* (ELF) can increase the speed of the fermentation process and also increase efficiency in the fermentation process by lowering the pH. The technology used in preserving food using exposure to magnetic fields will not cause a temperature increase that can damage the nutrients in the food (Setiani *et al*. 2023). *Extremely Low Frequency* (ELF) in foodstuffs refers to the influence of electromagnetic waves with ELF frequencies on the growth and quality of foodstuffs. Flux density is one of the important parameters that influences the characteristics of the electromagnetic field around *extremely low frequency* (ELF) systems. At ELF frequencies, flux density refers to the number of magnetic field lines of force that cross a given area. The higher the flux density, the stronger the magnetic field produced (Afkarina *et al*., 2023). Medan Elf has a positive impact in various fields, for example in the food sector and agriculture. (Rahman *et al*., 2022). Exposure to Elf's electromagnetic field has an influence on microorganisms and cell tissue which can later influence the germination process, plant size, increase in dry weight and also the formation of chlorophyll in a plant. (Jannah & Hariyono, 2022).

Low intensity ELF (*Extremely Low Frequency*) magnetic fields can optimize the process fermentation with various indicators (Purbawati *et al.,* 2021). The use of ELF magnetic field radiation in the food sector can be a new alternative as a preservation method (Ariyani *et al.*, 2019). Exposure to an ELF magnetic field of intensity 100 μT and 300 μT affects changes in pH in fermented tempe. (Maghfiroh *et al.,* 2022). In the food sector, the use of exposure to the ELF magnetic field can be used to inhibit the growth of spoilage bacteria which can be detrimental and to maintain the quality of food (Yuniarta *et al*., 2022). Magnetic fields with an intensity below 500 μT can support the cell proliferation process, while an intensity above 500 μT can play a role in the process of cell death (apoptosis) so that it can inhibit the growth of bacteria in food (Nuriyah *et al*., 2022). The ELF magnetic field applied to dormant seeds is known to increase the growth rate and can also produce very fast seedlings. (Djoyowasito *et al.,* 2019)

Tempe is a prince made from fermented soybeans by molds of the Rhyzopus type such as *Rhizopus Oryzae*). (Alvina *et al.*, 2019).Tempe is one of the fermented products that generally uses soybeans as the main raw material that has been fermented and has excellent nutritional content. Fermentation in making tempe occurs due to the activity of the *mold Rhyzopus oligosporus* which is able to produce phytase enzymes that function to hydrolyze phytic acid into inositol and phosphate. The mold does not produce toxins and can even protect tempe from aflatoxins. In addition, tempe also contains antibacterial compounds produced by mold during the fermentation process. *Rhyzopus oligosporus* grows well in the pH range of 6.0 – 7.0 (Azizah *et al.*, 2022). Modern Elf magnets are an alternative technology that can help in the process of preserving food without damaging the quality of the food. (Rahayu *et al.,* 2023). The Elf field can activate bacteria so that it can be applied in the food sector where it is used in preservation methods. (Utoyo *et al.*, 2023). The existence of Elf waves in a place on earth can also influence the cultural mindset of that community regarding various management. (Mauko *et al.*,2020).

Previous research conducted by Azizah et al (2022) had the aim of examining the effect of exposure to *Extremely Low Frequency* (ELF) magnetic fields on pH in the tempe fermentation process. *Extremely Low Frequency* (ELF) magnetic field exposure to pH in the tempe fermentation process. This prompted this study with the aim of proving the effect of *Extremely Low Frequency* (ELF) magnetic field on pH, density, taste, aroma, texture and color in tempe. The limitation of this study is that the results generated from this study are less consistent which makes it difficult to make definite conclusions to determine the effect of *extremely low frequency* magnetic fields on the tempe maturity process. The formulation of the problem that we will use is How does the influence of *extremely low frequency* magnetic field on the pH of tempe, the influence of extremely low frequency magnetic field on the density of tempe, the influence of *extremely low frequency* magnetic field on the aroma of tempe, the influence of *extremely low frequency* magnetic field on the color of tempe, the influence of *extremely low frequency* magnetic field on the taste of tempe, the influence of *extremely low frequency* magnetic field on tempe.

RESEARCH METHOD

The research was carried out in the Advanced Physics Laboratory in the Physics Education study program building, Faculty of Teacher Training and Education, Jember University as a place for generating Very Low Frequency magnetic fields. The design used in this research was a *Completely Randomized Design* (CRD) research design to test the effect of several treatments with a number of replications for several experiments. The samples in this study used tempe at the start of fermentation 10 to 15 hours after fermentation. The number of samples in this study was 20 samples, of which 10 samples were the control group and 10 samples were the experimental group. The tool used in this research is an *Extremely Low Frequency* (ELF) magnetic field source in the form of a CT or (Current

Transformer) which produces an *Extremely Low Frequency* (ELF) magnetic field. The pH meter used is a pH value measuring tool, a scale that functions to weigh the tempe for each group, and ziplock plastic which is used to wrap the tempe. The procedure of this research begins with preparing the samples and dividing them into two groups, namely the experimental group and the control group, after that they are left for 2 days after which they will be taken back to see the results of the fermentation process in the control group and the experimental group who were exposed to Medan ELF.

The data collection stage was carried out after two days of samples from the control group which had been left at room temperature and also the experimental group which had been exposed to ELF's magnetic field. Various measurements were carried out such as measuring PH using a PH meter and also measuring density using a digital balance and also measuring volume by adding water to tempe and then measuring it in a beaker. In collecting this data, parameters such as taste, color, area of Rhizopus, texture must be used. After data collection, continue with analyzing the data using descriptive data analysis. Where by describing data analysis from the data that has been collected and making conclusions about the research that has been carried out.

RESULTS AND DISCUSSION

This research aims to prove the effect of exposure to elf magnetic field radiation on the ripening process of food, namely tempe. In this study, tempe only had 20 samples with 10 control groups and 10 experimental groups by distinguishing between aroma, color, texture and taste by 3 observers. The intensity of exposure to the ELF magnetic field is 300 uT with a duration of exposure of 60 minutes and after exposure to the Elf magnetic field of 48 hours.

Table 1. pH measurement of raw tempe

Control group		Experimental group	
K1	5.54	E1	5.03
K2	5.03	E2	5.54
K3	5.13	E3	5.54
K4	5.44	E4	5.54
K5	5.44	E5	4.52
K6	4.32	E6	5.44
K7	5.13	E7	6.25
K8	5.54	E8	5.34
K9	4.93	E9	4.83
K10	5.04	E10	6.36
Average	5.154	Average	5.429

Based on the data in Table 1, it is known that there are differences in the pH value of tempe in the control group and also the experimental group. The control group was only placed at room temperature, while the experimental group experienced different conditions, namely exposure to ELF radiation. One of the parameters observed was the pH value in both groups. The results showed that the control group had an average pH of 5.154, while the experimental group showed a slightly higher average pH value of 5.429. This difference may indicate the effect of the treatment on the pH parameter of the observed material. Based on the research of azizah *et al.*, (2022), the pH in the experimental group tends to be higher than the control group because exposure to magnetic fields can affect the growth of microbial cells in the fermentation process, and affect the movement of ions.

Table 2. Density Measurement of raw tempe

Control group				Experimental group			
Sample name	m	Δv	ρ	Sample name	m	Δv	ρ
K1	100gr	70	1.4	E1	100gr	30	3.3
K2	100gr	40	2.5	E2	100gr	40	2.5
K3	100gr	50	2.0	E3	100gr	20	5.0
K4	100gr	30	3.3	E4	100gr	30	3.3
K5	100gr	70	1.4	E5	100gr	30	3.3
K6	100gr	30	3.3	E6	100gr	40	2.5
K7	100gr	60	1.6	E7	100gr	30	3.3
K8	100gr	50	2.0	E8	100gr	20	5.0
K9	100gr	30	3.3	E9	100gr	40	2.5
K10	100gr	30	3.3	E10	100gr	40	2.5
Average density			2.41	Average density			3.32

Based on table 2, the tempe is divided into 2 groups, namely the control group with a density of 100 grams has a different volume, namely K1 = 70, K2 = 40, K3 = 50, K4 = 30, K5 = 70, K6 = 3, K7 = 60, K8 = 50, K9 = 30, K10 = 30. Density will be calculated by dividing by volume and the resulting density in each control group is different where in the control group the average density is 2.41. The experimental group is also treated the same as the control group where the experimental group is a material that has been exposed to ELF which makes the experimental group have a higher average density than the control group with an average density of 3.32. The control group has a smaller density because many soybeans have become Rhyzopus, many experimental groups are still soybeans. Based on research conducted by Astutik and Sudarti (2021) "The Effect of Exposure to ELF (*Extremely Low Frequency)* Magnetic Fields 500 µT on pH, Density, and Physical Quality of Silk Tofu" shows that the density of the control group is smaller than the experimental group due to the decrease in water content in the food can hinder development spoilage bacteria, so silken tofu will last longer over time which is quite long.

Table 3. Physical Condition (color) of Tempe Control Group

Sample	Normal			Brownish			Black		
	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)
K1	-	-	-	✓	✓	✓	-	-	-
K2	-	-	-	✓	✓	✓	-	-	-
K3	-	-	-	✓	✓	✓	-	-	-
K4	-	-	-	✓	✓	✓	-	-	-
K5	-	-	✓	✓	✓	-	-	-	-
K6	-	-	✓	✓	✓	-	-	-	-
K7	-	-	✓	✓	✓	-	-	-	-
K8	-	-	✓	✓	✓	-	-	-	-
K9	-	-	-	✓	✓	✓	-	-	-
K10	-	-	-	✓	✓	✓	-	-	-

Table 4. Physical Condition (color) of Tempe Experimental Group

Sample	Normal			Brownish			Black		
	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)
E1	-	-	-	✓	✓	✓	-	-	-
E2	-	-	-	✓	✓	✓	-	-	-
E3	-	-	-	✓	✓	✓	-	-	-
E4	-	-	-	✓	✓	✓	-	-	-
E5	-	-	-	✓	✓	✓	-	-	-
E6	-	-	-	✓	✓	✓	-	-	-
E7	-	-	-	✓	✓	✓	-	-	-
E8	-	-	-	✓	✓	✓	-	-	-
E9	-	-	-	✓	✓	✓	-	-	-
E10	-	-	-	✓	✓	✓	-	-	-

Based on table 3, the results of the physical condition of tempe color carried out by 3 observers obtained that group K1, K2, K3, K4 had a tempe color that was more brownish than its normal color. According to observers 1 and 2, control groups K5, K6, K7, K8, K9, K10 also have a tempe color that is more brownish than the normal color, while according to observer 3, K5, K6, and K7 have a normal color like the original, but K9 and K10 have a more brownish color than the color of tempe in general. And based on table 4, the results of the experimental group on the color of tempe according to 3 observers have a browner color than the original color.

Table 5. Physical Condition (Area of Rhyzopus) Tempe Control Group

Sample	Long (mm)	Wide (mm)	Extensive (mm)	Rhyzopus thickness
K1	135	59	7965	23
K2	125	60	7500	20
K3	125	60	7500	20
K4	130	70	9100	10
K5	120	65	7800	15
K6	120	65	7800	10
K7	110	60	6600	15
K8	120	60	7200	10
K9	125	57	7125	10
K10	120	60	7200	15

Table 6. Physical Condition (Area of Rhyzopus) Tempe Experimental Group

Sample	Long (mm)	Wide (mm)	Extensive (mm)	Rhyzopus thickness
E1	100	60	6000	20
E2	100	60	6000	20
E3	95	60	5700	20
E4	100	55	5500	30
E5	100	55	5500	20
E6	100	60	6000	20
E7	100	60	6000	20
E8	100	55	5500	15
E9	100	55	5500	20
E10	100	55	5500	15

Based on table 5, which is the control group, the physical conditions regarding the thickness and area of Rhizopus in tempe have different thicknesses and also different areas. K1 has an area of 7,965 mm and a thickness of 23 mm, K2 has an area of 7,500 mm and a thickness of 20 mm, K3 has the same area and thickness as K2 and also has the same thickness as K2. K4 has a rhyzopus area of 9,100 mm and a thickness of 10 mm. K5 has the same area as K6 which is 7,800 but K5 has a thickness of 15 mm while K6 has a thickness of 10 mm. K7 with an area of 6,600 mm and a thickness of 15 mm, K8 with an area of 7,200 mm and a thickness of 10 mm is the same as K9 which has a thickness of 10 mm but the area in K9 is 7,125mm, while K10 has an area of 7,200mm and a thickness of 15 mm. And based on table 6 which is the experimental group for the area and thickness of Rhyzopus in E1 and E2 have the same area of 6,000 mm and a thickness of 20 mm, E3 has an area of 5,700 mm and a thickness of 20 mm. E4, E5, E8, E9, E10 have the same area of 5,500 mm but have different thicknesses in E4 has a thickness of 30 mm, E5 (20) mm, E8 (15mm), E9 (20mm), E10 (15mm). E6 and E7 have the same area of 6,000 mm and also a thickness of 20 mm.

Table 7. Physical Condition (Aroma) of Tempe Control Group

Sample	Normal /khas			No scent			Rotten		
	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)
K1	-	-	-	-	-	-	✓	✓	✓
K2	-	✓	-	-	-	-	✓	-	✓
K3	✓	✓	-	-	-	-	-	-	✓
K4	✓	✓	-	-	-	-	-	-	✓
K5	✓	-	-	-	-	-	-	✓	✓
K6	✓	✓	-	-	-	-	-	-	✓
K7	✓	✓	-	-	-	-	-	-	✓
K8	✓	✓	-	-	-	-	-	-	✓
K9	✓	✓	-	-	-	-	-	-	✓
K10	-	-	-	-	-	-	✓	✓	✓

Table 8. Physical Condition (Aroma) of Tempe Experimental Group

Sample	Normal /khas			No scent			Rotten		
	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)
E1	✓	✓	✓	-	-	-	-	-	-
E2	✓	✓	-	-	-	-	-	-	✓
E3	✓	✓	✓	-	-	-	-	-	-
E4	✓	✓	-	-	-	-	-	-	✓
E5	✓	✓	✓	-	-	-	-	-	-
E6	✓	✓	✓	-	-	-	-	-	-
E7	✓	✓	✓	-	-	-	-	✓	-
E8	✓	✓	✓	-	-	-	-	-	-
E9	✓	✓	-	-	-	-	-	-	✓
E10	✓	✓	-	-	-	-	-	-	✓

Based on table 7, which is the control group for tempe aroma, it is obtained from observer 1 that K1, K2, K10 have a foul aroma while K3, K4, K5, K6, K7, K8, K9 have a normal or typical tempe aroma. According to observer 2, the aroma of tempe in K2, K3, K4, K6, K7, K8 and K9 has a normal aroma or typical tempe smell but in K1, K5 and K10 according to observer 3 the aroma is rotten. And based on table 8 which is the experimental group, the physical condition of the aroma in the experimental group tempe according to observer 1 is all the tempe aroma in the experimental group is normal or typical tempe odor. According to observer 2, the aroma of tempe in the experimental group was all normal or typical, except for E7 which smelled rotten. According to observer 3, the aroma of the experimental group tempe in E1, E3, E5, E6, E7, E8 had a normal and distinctive aroma but in E2, E4, E9 and E10 had a foul smell.

Table 9. Physical Condition (Texture) of Tempe Control Group

Sample	Dense			Soft			Juicy		
	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)
K1	-	✓	-	✓	✓	✓	-	-	-
K2	-	-	-	✓	✓	✓	-	-	-
K3	-	-	-	✓	✓	✓	-	-	-
K4	-	-	-	✓	✓	✓	-	-	-
K5	-	✓	-	✓	-	✓	-	-	-
K6	-	-	-	✓	✓	✓	-	-	-
K7	-	-	-	✓	✓	✓	-	-	-
K8	-	-	-	✓	✓	✓	-	-	-
K9	-	-	-	✓	✓	✓	-	-	-
K10	-	-	-	✓	✓	✓	-	-	-

Table 10. Physical Condition (Texture) of Tempe Experimental Group

Sample	Dense			Soft			Juicy		
	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)
E1	-	-	-	✓	✓	✓	-	-	-
E2	-	-	-	✓	✓	✓	-	-	-
E3	✓	✓	✓	✓	-	-	-	-	-
E4	-	-	-	✓	✓	✓	-	-	-
E5	-	-	-	✓	✓	✓	-	-	-
E6	-	-	-	✓	✓	✓	-	-	-
E7	✓	✓	✓	✓	-	-	-	-	-
E8	✓	✓	✓	✓	-	-	-	-	-
E9	✓	✓	✓	✓	-	-	-	-	-
E10	-	-	-	✓	✓	✓	-	-	-

Based on table 9, the physical condition of the control group on the texture parameter according to observer 1 is that all control group tempe is mushy as well as according to observer 3 the texture of the control group tempe is mushy. According to observer 2, most of the control group tempe had a mushy texture, but in K1 and K5 the texture was still solid. Based on table 10, according to observer 1, tempe had a mushy texture but some tempe also had a solid structure in one experimental package, namely in E3, E7, E8, E9. According to observer 2, the texture of the experimental group tempe had a mushy texture in E1, E2, E4, E5, E6 and E10 while E3, E7, E8, E9 had a solid texture. According to observer 3, the texture of tempe in the experimental group had the same texture as that observed by observer 2.

Table 11. Physical Condition (Taste) of Tempe Control Group

Sample	Good/typical			Bitter			Sour		
	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)
K1	1	1	1	-	-	-	-	-	-
K2	1	1	1	-	-	-	-	-	-
K3	1	1	1	-	-	-	-	-	-
K4	1	1	1	-	-	-	-	-	-
K5	1	1	1	-	-	-	-	-	-
K6	1	1	1	-	-	-	-	-	-
K7	1	1	1	-	-	-	-	-	-
K8	1	1	1	-	-	-	-	-	-
K9	1	1	1	-	-	-	-	-	-
K10	1	1	1	-	-	-	-	-	-

Table 12. Physical Condition (Taste) of Tempe Experimental Group

Sample	Good/typical			Bitter			Sour		
	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)	P (1)	P (2)	P (3)
E1	1	1	1	-	-	-	-	-	-
E2	1	1	1	-	-	-	-	-	-
E3	2	2	2	-	-	-	-	-	-
E4	1	1	1	-	-	-	-	-	-
E5	1	1	1	-	-	-	-	-	-
E6	1	1	1	-	-	-	-	-	-
E7	2	2	2	-	-	-	-	-	-
E8	2	2	2	-	-	-	-	-	-
E9	1	1	1	-	-	-	-	-	-
E10	1	1	1	-	-	-	-	-	-

Based on table 11, the tempe control group on the taste parameter according to observer 1, observer 2, and observer 3 in the control group has indicator number 1 where the taste of tempe in this control group is less than the original tempe taste. and based on table 12, the physical condition of taste in the experimental group according to observer 1, observer 2 and also observer 3 has the same taste observation that is in E1 has a taste that is less than the normal tempe taste as well as in E2, E4, E5, E6, E9, E10 while in E3, E7 and, E8 have the same taste as the normal tempe taste. Based on research conducted by Astutik and Sudarti (2021) "The Effect of Exposure to ELF (*Extremely Low Frequency*) Magnetic Fields 500 μT on pH, Density, and Physical Quality of Silk Tofu" observation results were obtained physical qualities given exposure during 90 minutes showing color, texture, aroma, and better mucus than other exposure times. This mattercaused by exposure capable ELF magnetic field inhibits the growth of bacteria on silken tofu so it has an impact on physical quality of silken tofu itself. In accordance with this research, color, taste, texture and aroma tended to be better in the experimental group exposed to the ELF magnetic field.

CONCLUSION

Extremely Low Frequency (ELF) magnetic field radiation can affect the pH value of tempe in the fermentation process based on various tables. As a result, the sample smelled distinctive, even rotten, the color of the tempe changed, the texture of the tempe became dense, and it had an unusual taste, resulting in an unpleasant odor like tempe in general. Exposure to an ELF magnetic field with an intensity of 300 μT was not effective enough in inhibiting spoilage bacteria in tempe food.

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