



The Effect of Irradiation to Sensoric Characteristic, Physic and Microbe in *Sie Balu*, Acehese Dried Meat

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Abstract

One of the Acehese traditional food preserved by the addition of salt, acid and dried was *sie balu*. The preservation method may lead to changes in the structure and nutritional content. *Sie balu* with the addition of vinegar, garlic and ginger can reduce the value of water activity (a_w), pH and bacterial counts. This condition affects the physical properties and sensory of *sie balu*. Irradiation can control pathogenic microorganisms in meat without affecting the physical condition. Low-dose irradiation is able to maintain the desired sensory attributes nutritious food products. This study aims to determine the characteristics of the sensory and physic *sie balu* that irradiated with increasing doses and the shelf life of 3-6 weeks. *Sie balu* was made of 10 kg fresh beef, dried in the sun to dry, vacuum and irradiated at doses of 5, 7 and 9 kGy. Sensory test conducted by taste *sie balu* by trained panelists and fill out the hedonic form. The physical properties based on pH and a_w . The microbe total calculated used Total Plate Count. The results showed that the irradiation dose significantly ($P < 0.05$) affected on microbe total, aroma, color, texture and taste of *sie balu*. Storage time does not affect the sensory properties. Irradiation dose and storage time significantly ($P < 0.05$) on pH and a_w *sie balu*. The study concluded that irradiation can improve the physical properties, sensory and microorganism reduction of *sie balu*.

Key words : Meat Preservation, *Sie Balu*, Irradiation, Shelf Life, Sensoric, Count of Bacteria.

Background

Beef is a food that contains of high nutritional value such as protein, fat, minerals and carbohydrates, which is also a good medium for the growth of spoilage microorganisms. The growth of these microorganisms result in physical and chemical changes so that the meat can be easily damaged and not safe for consumption (Komariah *et al.*, 2004). A decrease in the quality of the meat is marked with or through changes in color, aroma and flavor. Meat preservation is an attempt to prevent damage or changes to the meat. Preservation methods aims to control the activity of the microorganisms that cause the enzymatic activity and chemical reactions in meat. Preservation of meat is influenced by several factors, including the water activity (a_w) and pH. The meat can not deterioration if pH is too low (acid) and $a_w < 1$, the microorganisms can not growth, so the meat is not easily damaged. Fresh beef has a high water activity (0.99 to 0.98), the near neutral

pH and complete source of nutrients, so it can be an excellent medium for the growth of microorganisms (Nurliana *et al.*, 2003).

Many conventional food preservation methods such as drying, salting, heating, freezing and evaporation can cause changes in the structure and nutritional content (Andini and Harsojo, 2010). Therefore, its necessary to think of appropriate technologies that can prevent damage continues (BATAN, 2010). Irradiation is known as the best method to control pathogenic microorganisms in meat without affecting the physical condition (Gants, 1998 in Yazdi and Jouki, 2012). Irradiated food is not radioactive (Satin, 2002 in Yazdi and Jouki, 2012). Applications of irradiation as sterilization at high doses for ready meals based on Indonesian traditional recipes been studied both from the microbiological, physico-chemical characteristics and sensory testing (Irawati, 2007). One of the traditional food was *sie balu*, the dried meat of Acehese was preserved by the addition

of salt and acid, which preserve the flavor as well. Further pressed with ballast and dried. The people of Aceh have been doing this since decades ago. *Sie balu* with the addition of vinegar, garlic and ginger can reduce the value of water activity (aw), pH and the count of bacteria after preservation for 216 hours (Nurliana *et al.*, 2003).

Destruction of microorganisms in meat using irradiation is influenced by several factors including the dose of irradiation, meat composition, temperature, atmospheric gases and microbial factors. Reduction of large population of microbes in meat can be achieved by using high doses of radiation, but such an approach could have a negative effect on the sensory attributes desired meat. Therefore, emerging trends in the application of irradiation include the use of technology and other interventions (eg, antimicrobial food preservatives, heat, high hydrostatic pressure, etc.) as part of the hurdle technology approach to control pathogens meat. This approach allows the use of relatively low doses of irradiation to improve microbial safety of meat while maintaining desirable sensory attributes nutritious food products (Ahn *et al.*, 2006). Therefore it is necessary to know the effect of increasing doses of gamma irradiation and shelf life of *sie balu* to sensory, physical characteristics and count of bacteria.

MATERIALS AND METHODS

Research design

Experiment design used in this research was completely randomized design (CRD) factorial pattern consisting of two factors or variables: variations in irradiation dose of 5, 7, 9 kGy and shelf life of 0, 3 and 6 weeks (Nazir, 2009). Each treatment was repeated two times.

Processing of *sie balu*

Sie balu was made of 10 kg fresh beef cut into slices 2.5 cm thickness. Furthermore, the meat covered with 500 g salt, 400 ml vinegar, 400 g garlic, and 200 g ginger were pulverized in advance. Meat left on for 30 minutes. Subsequently meat put into *umpang* and pressed with a weight of

10 kg for 12 hours. Then dried under the sun (Nurliana *et al.*, 2003).

Irradiation of *sie balu*

Sie balu samples packaged in vacuum packs, subsequently irradiated at the Center for Isotope and Radiation Technology Applications at National Nuclear Energy Agency Jakarta in irradiators with ^{60}Co source at doses of 5, 7 and 9 kGy.

Sensory, physic and Microbiology Test

Sensory test conducted by taste *sie balu* with 15 people (trained panelists) and fill out a questionnaire (form hedonic) (Setyaningsih *et al.*, 2010). pH testing is done using a pH meter. Testing is done using a tool Novasina aw (model TH2 / RD-33BDS) (Torres *et al.*, 1994). Microbiological test is done by calculating the count of bacteria, using the TPC (Total Plate Count).

Analysis of Data

Effect of gamma irradiation on sensory, pH, aW and the count of microbes were analyzed using ANOVA through SPSS for Windows version 17.0 and to determine whether there is a difference in the treatment effect followed by a test of Duncan Multiple Range Test (DMRT) at the level of significance = 0.05.

Results and Discussion

Irradiation effect on *Sie Balu* Sensory

Effect of irradiation on the sensory test of *sie balu* shown in Table 1. The sensory test on a product that has significance with regard to consumer acceptance of the product. The parameters used to sensory test of *sie balu* include colour, aroma, texture and flavor. Irradiated unchanged *sie balu* sensory after storage for 0, 3 and 6 weeks.

Table 1. The average score of *sie balu* sensory test based on the effect of irradiation dose.

Irradiation dose (kGy)	Sensory				Means
	Colour	Aroma	Texture	Taste	
0	2.5 ± 0.19	3.0 ± 0.3	2.5 ± 0.35	2.6 ± 0.1	2.7 ± 0.24
5	3.1 ± 0.14	3.4 ± 0.1	3.3 ± 0.21	3.3 ± 0.06	3.3 ± 0.13
7	3.6 ± 0.13	3.7 ± 0.1	3.9 ± 0.15	3.6 ± 0.21	3.7 ± 0.14
9	4.2 ± 0.08	4.2 ± 0.1	4.4 ± 0.17	4.2 ± 0.1	4.3 ± 0.10
Means	3.4 ± 0.72	3.6 ± 0.51	3.5 ± 0.82	3.4 ± 0.67	

Based on the analysis of variance showed that the irradiation dose significantly ($P < 0.05$) affected on colour, aroma, texture and taste of *sie balu*. The shelf life of *sie balu* after irradiation had no effect ($P > 0.05$) on colour, aroma, texture and flavor. Furthermore, irradiation dose and storage time had no effect ($P > 0.05$) on colour, aroma, texture and taste of *sie balu*.

Fenema (1985) in Santoso *et al.*, (2013) colour is the most important quality attributes. Although a product of high nutritional value, good taste and texture, but if the color is not attractive, it will cause the product is less desirable. Unirradiated *sie balu* was dark brown and the irradiated one primarily at dose of 9 kGy have a brighter colour than *sie balu* with irradiation 5 and 7 kGy.

According to Desrosier (1988), a dry food ingredient in order to compete with the kind of durability that other foodstuffs should have the good taste, smell and appearance comparable with fresh products or products processed in other ways. Testing the organoleptic properties of food is needed in order to determine directly the quality of foodstuffs. Besides the testing of the physico-chemical properties and microbiological tests, organoleptic properties is a subjective

test which can determine the quality of food quickly (Buckle, *et al.* 1987).

Irradiation effects on physical characteristics of *sie balu*

pH measurement is performed to determine the tendency of increase or decrease in pH during storage. The amount of pH associated with the formation of compounds which are alkaline during storage and will affect microbial growth (Hadiwiyoto, 1993).

The pH values obtained from all the samples tested varied between 5.4-5.8 as presented in Table 2. It is in accordance with the opinion of Brewer (2004) that irradiation only result in a very small change in the pH of the meat.

Table 2. Average values of pH *sie balu* based on the effect of irradiation dose and storage time

Irradiation Dose (kGy)	Shelf life (week)			Means
	0	3	6	
0	5.7 ± 0.01 ^{Aa}	5.7 ± 0.01 ^{Ba}	5.7 ± 0.03 ^{Ba}	5.7 ± 0
5	5.5 ± 0.02 ^{Aa}	5.8 ± 0.01 ^{Ba}	5.8 ± 0.03 ^{Ba}	5.7 ± 0.17
7	5.6 ± 0.01 ^{Ab}	5.6 ± 0.01 ^{Bb}	5.7 ± 0.03 ^{Bb}	5.6 ± 0.06
9	5.4 ± 0.02 ^{Ac}	5.5 ± 0.04 ^{Bc}	5.6 ± 0.01 ^{Bc}	5.5 ± 0.1
Means	5.6 ± 0.13	5.7 ± 0.13	5.7 ± 0.08	

Note: The big different superscript letters in the same row indicate significant differences ($P < 0.05$). Little different superscript in the same column indicate significant differences ($P < 0.05$).

Based on the analysis of variance showed that the irradiation dose, duration of storage and interaction significantly ($P < 0.05$) affected pH of *sie balu*. According to Forrest *et al.*, (1975) the normal conditions of the meat has a pH value ranging from 5.3-5.7 (ultimate pH) which is an interval of pH environment could inhibit the growth of bacteria.

The pH value of *sie balu* that stored up to 6 weeks showed no difference in all

treatments. The tendency of the pH value on the stability of the irradiated *sie balu* occur because of bacteria and enzyme activity is inhibited by irradiation. These results are consistent with research Yulianita, (2007), which shows a decrease in the pH value on the meat irradiated with 7 kGy dose after 7 days of storage time.

Table 3. Average aW values of *sie balu* based on the effect of irradiation dose and storage time

Irradiation Dose (kGy)	Shelf life (week)			Means
	0	3	6	
0	0.8 ± 0.00 ^{Aa}	0.7 ± 0.00 ^{Ca}	0.7 ± 0.00 ^{Ba}	0.7 ± 0.04
5	0.8 ± 0.00 ^{Ac}	0.7 ± 0.00 ^{Cc}	0.6 ± 0.00 ^{Bc}	0.7 ± 0.07
7	0.8 ± 0.00 ^{Ab}	0.7 ± 0.00 ^{Cb}	0.7 ± 0.00 ^{Bb}	0.7 ± 0.06
9	0.7 ± 0.00 ^{Ad}	0.6 ± 0.00 ^{Cd}	0.7 ± 0.00 ^{Bd}	0.6 ± 0.06
Means	0.7 ± 0.03	0.6 ± 0.04	0.7 ± 0.03	

Note: The big different superscript letters in the same row indicate significant differences (P<0.05). Little different superscript in the same column indicate significant differences (P<0.05).

Based on the analysis of variance showed that the irradiation dose, shelf life and interaction significant (P <0.05) affected the AW of *sie balu*. Water activities (abbreviation: AW) is a number that calculate the intensity of the water in the elements instead of water or solid objects. Foodstuffs which has around aw 0.70 is considered good enough and hold it for storage. Various microorganisms have a minimum Aw order to grow well, for example for bacteria has a value of Aw = 0.90; for yeasts and molds aw = 0.80 to 0.90 aw = .60 to .70 (Nilatany et al., 2014).

Effect of irradiation on the count of bacteria in *sie balu*

Effect of irradiation on the count of bacteria in irradiated *sie balu* and unirradiated one listed in Table 4. Irradiation can reduce bacteria in *sie balu*. The count of bacteria in *sie balu* also influenced by

vacuum packaging because it can inhibit the growth of aerobic bacteria. *Sie balu* conditions with very low aW also affect the growth of bacteria. According to EFSA (2011) the effectiveness of irradiation affected by the condition and composition of food, the temperature and the amount of initial contamination.

Table 4. Average count of bacteria (TPC in log cfu/g) in *sie balu* based on the effect of irradiation dose and storage time

Irradiation Dose (kGy)	Shelf life (week)			Means
	0	3	6	
0	4.70 ± 2.38 ^{Aa}	4.90 ± 0.31 ^{Aa}	2.00 ± 0.21 ^{Ba}	3.87 ± 1.62
5	1.79 ± 0.25 ^{Ab}	2.20 ± 0.40 ^{Ab}	1.52 ± 0.28 ^{Bb}	1.84 ± 0.34
7	2.28 ± 0.95 ^{Ab}	1.56 ± 0.33 ^{Ab}	1.27 ± 0.32 ^{Bb}	1.70 ± 0.52
9	2.47 ± 0.96 ^{Ab}	0.00 ± 0 ^{Ab}	0.00 ± 0 ^{Bb}	0.82 ± 1.43
Means	2.81 ± 1.29	2.17 ± 2.04	1.20 ± 0.85	

Note: The big different superscript letters in the same row indicate significant differences (P<0.05). Little different superscript in the same column indicate significant differences (P<0.05).

Based on the analysis of variance showed irradiation dose and storage time significantly (P<0.05) affected the count of bacteria in *sie balu*. Furthermore, the interaction of irradiation dose and shelf life had no effect (P> 0.05) to the count of bacteria in *sie balu*.

The count of bacteria in irradiated *sie balu* decreased significantly (P <0.05) in the storage 0 to 6 weeks. These results are consistent with research Yazdi and Jouki (2012) which states that the count of bacteria decreased at doses of 0 to 1 and 3 kGy for a period of 0 to 21 days. Based on research Aly, et al. (2012) the higher the irradiation dose the greater reduction in the count of microbes without reducing the sensory and chemical properties of food.

Fardiaz (2006) stated that irradiation of food will cause a number of chemical bonds in DNA disconnected so the cells can no longer replicate. Thus, small changes in the DNA of bacteria will kill the cells. International Consultative Group on Food Irradiation (ICGFI) in 2000 resulted in an opinion that of all the post-harvest handling to reduce microbial pathogens that irradiation is considered the most comprehensive with more than 40 years of worldwide research on the benefits and food security of this technology for the improvement of the quality of food safety. The main purpose of food with irradiation treatment is to reduce or eliminate microbial spoilage and pathogens that may be present in food without causing sensory changes in the product.

CONCLUSIONS AND SUGGESTIONS

The study concluded that irradiation can improve the sensory and physical properties as well as reduce the count of microbes in *sie balu*. Irradiation *sie balu* produce color, aroma, texture and taste better than without unirradiation. Based on the research results suggested *sie balu* processing should pay attention to hygiene and sanitation in all stages of processing. Further observation is needed to see the effect of irradiation on the growth of microbes in food dry molecular biology.

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