Journal of Applied Food Technology

Home page : https://ejournal2.undip.ac.id/index.php/jaft

Aging Process of Black Garlic using Natural Material as Spontaneous Fermentation Medium

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Abstract

This research aims to produce black garlic using various traditional material such as clay chamber (kendil), bamboo chamber (besek), banana leaves, and aluminium foil. Single garlic var lanang (Allium sativum Var. Solo garlic) were cleaned up, weighed, covered by banana leaves, then put in clay chamber and bamboo chamber. Garlic were covered by alluminium foil used as control. All samples were aged using rice warmer in 60-70˚C for 20 days. Brix (%) was measured using hand refractometer and antioxidant activity content was analyzed using 2, 2, diphenyl-1-picrylhydrazil (DPPH) assay. Result shows that black garlic aged using different material resulted in significant differences ($p<0.05$) on brix and antioxidant activity. The black garlic aged using bamboo chamber has the highest brix (6.2˚Brix) as compared to black garlic aged using clay chamber (5.2˚Brix) and alluminium foil (4˚Brix). Moreover, the highest antioxidant activity content was also found on black garlic aged using bamboo chamber (62,52±0,23%) following by black garlic aged using clay chamber (60.5±0.15%), and black garlic aged using alluminum foil (52.81±0.38%), respectively. In can be concluded that bamboo chamber the use of bamboo chamber (besek) is recommended for making black garlic traditionally due to its brix and antioxidant activity.

Article information:
Received: 09 October 2020
Accepted: 20 December 2020
Available online: 30 December 2020

Keywords:
aged process
black garlic
functional food
herbs
spontaneous fermentation

doi:10.17728/jaft.9129

Introduction

Black garlics were produced conventionally by home industry in Indonesia. It known as herbal food and commonly consumed by civil society as traditional medicine, supplements, or functional foods. The widespread behavior of consuming this herbal product is due to the tendency of society to go back to nature. Most of them believe that herbal medicine could be positioned as an antioxidant (scavenging free radicals), immunomodulator (enhancing the immune system), and degenerative (preventing disease) (Marwati and Amidi, 2018). It was supported by the resources which Indonesia has around 31 types of medicinal plants used as raw materials for the traditional medicinal industry (*jamu*), non-herbal industry, and spices, as well as for export needs, with demand volume of more than 1.000 ton/year (Pribadi, 2009). Black garlic has antioxidant activity that higher than fresh garlic (Bae *et al.*, 2012). Antioxidants are compounds that can inhibit oxidation and protect cells from the harmful effects of free radicals associated with disease (Wibawanti, *et al.*, 2019). Black garlic was preferred to be consumed because it has sweet taste, no spicy, and strong odor. Beside that, black garlic has some advantages such as anticancer, immunomodulatory, hypolipidemic, antioxidant, and hepatoprotective (Gia Buu Tran, *et al.*, 2019). Some method for black garlic production have been reported. Generally, fresh garlic was covered by alluminium foil (Lee *et al.,* 2009), aged using thermal treatment in 60-80°C for 15-40 days (Chessa, *et al.,* 2020; Wange *et al.*, 2010; Zhafira, 2018). Quality of black garlic was affected by thermal, period, and condition during aged processing (Zhang, *et al*., 2015). Therefore, this research aims to investigate the antioxidant activity and brix of black garlic aged using natural material as spontaneous fermentation medium. This research may provide beneficial information to home industry to open the ways for utilizing indonesian fermentation method to produce black garlic.

Materials and Methods

Materials

Fresh single garlic var lanang (*Allium sativum Var. Solo garlic*) was obtained from farmers in Magetan, East Java. Alluminium foil and natural material for fermentation medium such as banana leaves, clay chamber (kendil), and bamboo chamber (besek) were obtained from local market.

Method

The study was conducted from June–July, 2020. The fresh single garlic was cleaned and sorted. 250g sample single garlic were put in three different fermentation medium: banana leaves-clay chamber namely "kendil" (Figure 1), banana leaves-bamboo chamber namely "besek" (Figure 2), and alluminium foil as a control (Nelwida et al, 2019). Aged processing was conduct using rice warmer is 60-70^{o}C for 20 days. Total dissolved solids (% brix) were measured using a hand refractometer (Atago) (Anoraga and Bintoro, 2020). Antioxidant activity was analyzed using DPPH assay following the method used by Sari and Hardiyanti (2013), and. Sample was diluted using ethanol with 1:10 ratio. The analysis conducted by adding 1 ml of reagent DPPH (400 µM in ethanol), 5 ml ethanol, and 0.1 ml of the sample. The mixture was homogenized in a vortex and was allowed to stand for 20 minutes. The absorbance value was measured at a wavelength of 515 nm by a spectrophotometer. Antioxidant activity is expressed as inhibition (Hardiyanti *et al*., 2020).

The obtained data were statistically analyzed using one-way ANOVA and Duncan's Multiple Range Test (DMRT) using SPSS 19.0. The level significance was set at α = 0.05.

Results and Discussion

Some physical change of garlic occurred during aging process. The change of garlic appearance indicated by color or darkness which caused by browning reaction. The longer of aging process, the garlic will be darker. It was influenced by temperature of aging process (Anoraga *et al*., 2021). Furthermore, the hardness level of garlic also change during aging process. The black garlic texture was softer than fresh garlic. Black garlic tends to be chewy and the aroma was not as strong as fresh garlic. It has sweet taste while the spicy gradually disappears through the aging process.

Antioxidant activity of black garlic using bamboo chamber, clay chamber and alluminium foil was 62.52±0.23%, 60.5±0.16%, and 52.81±0.38%, respectively (Figure 3) resulting in significantly differences ($p<0.05$) on all treatments. Black garlic aged process which used natural material for spontaneous fermentation have higher antioxidant activity value than that used alluminium foil. Antioxidant activity of garlic could enhanced by fermentation processing. In accordance with the previous research investigated by Ningsih *et al.* (2018), that the fermentation process in tempeh production can increase antioxidant activity. Futhermore, Novita *et al.* (2011) stated that fermentation on bran are able to increase antioxidant contents. For baverage product, fermentation also has an effect on the antioxidant activity of local Kombucha drinks in Bali with the gambier product as a substrate (Chanjaya *et al*., 2014). Thus, it can be said that the antioxidant activity of black garlic may also be enhanced by spontaneous fermentation.

Figure 1. Clay chamber namely "kendil" was used as aged medium

Figure 2. Bamboo chamber namely "besek" was used as aged medium

The improvement of antioxidant activity in fermented soybean products is caused by the enzyme produced by natural bacteria during fermentation. The amount of increased antioxidants in fermented products is affected by the microorganisms used and the fermentation conditions (Lin *et al*., 2006). The thermal treatment during spontaneous fermentation could cause non-enzymatic browning reactions such Maillard reaction, which are associated with the formation of compounds that have strong antioxidant properties (Bae *et al*., 2014). Increasing treatment temperature and time also caused an increase in antioxidant activity (Molaveisi, 2019). The Maillard reaction has a great potential to be done effectively by home industry to generate efficacious antioxidant compounds (Amarowicz, 2009).

There are several possibilities that cause an increase in antioxidant activity after heat treatment: (1) the release of a large number of antioxidant components due to damage to cell walls due to heat, (2) the formation of a number of strong antioxidant compounds that can ward off radicals due to chemical reactions in the heating process, (3) suppression oxidation and antioxidant capacity through thermal inactivation of oxidative enzymes, or (4) formation of non-nutrient antioxidant compounds or new compounds such as Maillard reaction products that have antioxidant activity (Morales and Babel, 2002) .

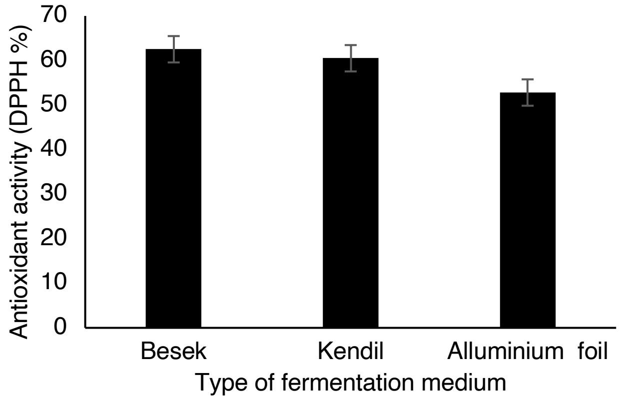

Figure 3. Antioxidant activity of black garlic aged using fermentation mediun variation

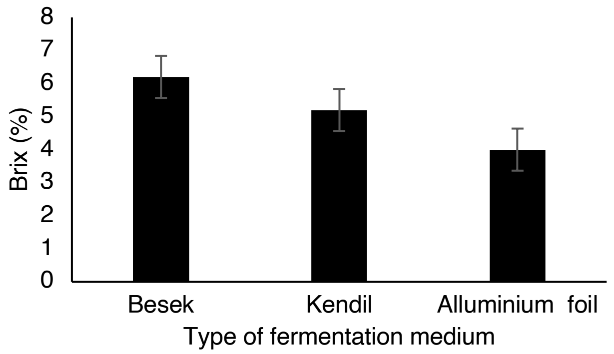

Figure 4. Total soluble solid (brix) content of black garlic aged using fermentation mediun variation

Brix content of black garlic after spontaneous fermentation for 20 days can be seen on Figure 4. The highest brix content of black garlic was shown at 6,2% with bamboo chamber (besek) aged medium. Nelwida (2019) reported that time of thermal treatment could reduce carbohydrate content on black garlic during fermentation. It caused by enzymatic process that convert carbohydrates into sugar. It affect the increased total dissolved solids (brix) which longer the heating takes place, the more dissolved sugar as a component of carbohydrates so that the total dissolved solids increase (Buckle *et al.*, 2009).

Conclusion

Banana leaves, bamboo chamber and clay chamber as natural medium fermentation significantly affected antioxidant activity and brix content of blac garlic. Black garlic that produced by bamboo chamber has the higher antioxidant activity and Brix. It can be suggestion for home industry to produce high quality black garlic traditionally using rice cooker and bamboo chamber as aging medium

Acknowledgment

Authors would like to thank to Agroindustrial Product Development, Vocational College for infrastructure and facilities, also Universitas Gadjah Mada for the financial support to conduct this research.

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