Acta Scientific Pharmaceutical Sciences (ISSN: 2581-5423)

Volume 4 Issue 2 February 2020

Short Communication

Black Garlic: What Do We Need to Know About It?

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DOI: 10.31080/ASPS.2020.04.479

Received: January 04, 2020

Published: January 10, 2020

Black Garlic (BG) is simply fresh garlic (*Allium sativum* L.) that has been fermented for a period of time at a high temperature under high humidity. The process turns garlic cloves dark, gives them a sweet taste, and alters their consistency to chewy and jelly-like the duration of fermentation varies depending on cultures, manufacturers, and purposes them a sweet taste, and alters their consistency to chewy and jelly-like. The duration of fermentation varies depending on cultures, manufacturers, and purposes

- **Nutritional content of garlic:** The enhanced biological activity of BG when compared with fresh garlic lies in the conversion of phytochemical compounds during the fermentation process. In the following section, we will summarize the changes of garlic components between fresh garlic and BG.

Comparison of the components between fresh garlic and BG

Fresh garlic contains approximately 63% of water, 28% of carbohydrate (fructans), 2.3% of organosulfur compounds, 2% of proteins (alliinase), 1.2% of free amino acids (arginine), and 1.5% of fibre. Nontreated fresh garlic also contains a high amount of γ-glutamylcysteines These compounds can be hydrolyzer and oxidized to form alliin, which accumulates naturally during the storage of garlic at a cool temperature. After processing, such as cutting, crushing, chewing, or dehydration, alliinase rapidly lyses the cytotoxic cysteine sulfoxides (alliin) to form cytotoxic and odoriferous alkyl alkane-thiosulfinates such as allicin. Alicia contributes to the characteristic flavour and taste of garlic. Allicin and other thiosulfinates are immediately decomposed to other compounds such as diallyl sulphide, diallyl disulfide, and diallyl trisulfide, dithiins, and ajoene. At the same time, γ-glutamylcysteines are converted to SAC through its catabolism pathway other than the alliin–allicin pathway. SAC contributes to health benefits of garlic, such as its antidiabetic, antioxidant, and anti-inflammatory activities As for BG, during the thermal process, some chemical compounds from fresh garlic are converted into Amadori/Heyns compounds, which are key intermediate compounds of Maillard reaction. The chemical compounds of aged BG (ABG) are complicated, and the quality of its products depends on the manufacturing process. Nevertheless, BG contains much more functional compounds such as SAC than fresh garlic.

The contents of chemical compounds of BG depend on the conditions during thermal processing. Some researchers reported that many valuable components within BG against diseases increased during the aging process, especially polyphenol, flavonoids, and some intermediates of Maillard reaction have been known as antioxidant agents. Furthermore, the antioxidant activity of garlic varies across regions; nevertheless, BG demonstrates significantly much higher biological activity, such as antioxidant properties, than fresh garlic.

Several studies have reported that water-soluble sugars, amino acids, total polyphenols, and flavonoids increased or decreased during thermal processing. Three of Amadori and three of Heyns compounds in BG increased significantly—up to 40–100-fold higher than those in fresh garlic. In contrast, through the aging process for converting fresh garlic to BG, the amount of fructans decreased simultaneously, owing to the fact that fructose and glucose with some of amino acids play important roles in Maillard reaction in garlic processing.

BG processing

Effects of aging temperature on the quality of BG

It is well known that the aging period of garlic is shorter at higher temperatures. In the case of aging process at 70°C, the speed of aging is two-fold faster than that at 60°C. According to sensory evaluation, the quality of BG is better and its black colour is homogeneous between 70°C and 80°C. Even though BG is produced faster at 90°C, it produces noni deal tastes, such as bitter and sour tastes. In the case of aging process at 60°C, the colour of garlic was not completely black; thus, 60°C is also not an ideal condition for the aging process.

When the moisture content of garlic reaches 400–500 g/kg, BG can be suitable for eating because of its softness and elasticity. If moisture content is about 350–400 g/kg, BG would be much drier and its elasticity would be poor. In particular, when moisture content goes below 350 g/kg, BG becomes too hard to eat. Moreover, the aging speed of fresh garlic to BG is markedly slow when processed at 60°C. Although aging occurs smoothly at 80°C and 90°C, an adequate condition is relatively difficult to find because of its fluctuating phenol content and reducing sugar content.

Content of reducing sugar is also considered an important factor during the aging process. Some types of sugar and amino acids are required for Maillard reaction. The reducing sugar content gradually increases at 60°C and 70°C during the whole process, which means that at these temperatures, the rate of formation of reducing sugar is faster than its rate of consumption. Although the content of reducing sugar increases at high temperatures, in the case of processing at 80°C and 90°C, ABG does not have an appropriate sweet flavour because of the consumption of a large amount of reducing sugar at high-temperature conditions. Besides, reduction of amino acid content is also accelerated depending on the progress of Maillard reaction.

One of the main antioxidant compounds in BG is 5-hydroxymethylfurfural (5-HMF), and it is also an important intermediate product in Maillard reaction. Regardless of temperature, the amount of 5-HMF is increased during the aging process. However, in the case of processing at 60°C, 5-HMF content increases very slowly during the whole process.

Effects of fermentation condition on the quality of BG

As we mentioned in the previous section, the quality of BG including its bioactivity and texture depends on the temperature during thermal processing. However, according to the discovery of Jung., et al. fermented BG displays more effective bioactivity than ABG. In this section, we will summarize the quality of fermented BG and its potentials against several kinds of diseases.

Improvement of antioxidant activity will effectively prevent diabetes and its related complications. Bioactivities of garlic such as antioxidant activity and hypoglycemic effect are already well known, and the antioxidant activity of garlic could be enhanced by processing. In recent years, Hien-Trung., et al. discovered that the bioactivity of ginseng could be enhanced by yeast fermentation. Therefore, they hypothesized that the bioactivity of BG may also be enhanced by yeast fermentation.

According to Jung., et al. yeast-fermented BG exhibited much better bioactivity against syndromes such as obesity, hyperlipidaemia, nephropathy, and hepatopathy than ABG. For example, yeast-fermented garlic-treated mice demonstrated marked improvement in body weight, periovarian fat weight, adipocyte diameters, deposited abdominal fat pad thicknesses, serum total cholesterol, triglyceride, low-density lipoprotein (LDL) level, high-density lipoprotein (HDL) level, aspartate transaminase (AST), alanine transaminase (ALT), steatohepatitis, hepatocyte hypertrophy, serum blood urea nitrogen (BUN), and the number of abnormal kidney tubules compared with the high-fat diet (HFD)-treated controls. Furthermore, fermented BG 400 mg/kg and 200 mg/kg revealed significantly higher effects than ABG 400 mg/kg. In other words, fermented BG has more effective bioactivity against HFD-induced obesity, hyperlipidemia, nephropathy, and hepatopathy than ABG. Therefore, the bioactivity of BG could be enhanced by yeast fermentation, and fermented BG may be more qualified to improve diabetes and its related complications. Owing to this reason, the components of fermented BG might be more or less different from those of ABG. However, the differences of the components between ABG and fermented BG have still not been investigated. Therefore, their component analysis should be required [1-10].

In summary, the aging period of BG is shorter at a high temperature; however, controlling the amount of some components might be difficult at a high temperature because their contents change rapidly during the aging process. Based on the results mentioned above, 70°C is considered the best condition for garlic aging. However, the quality of BG is affected by not only temperature, but also other factors such as humidity and fermentation. Therefore, further investigations are also required.

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