Increase The Value Of Substances Bio Activity In Garlic

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Abstract:
Article review of research related to processing and storage of garlic after harvest, review of research on bioactive enhancement in garlic related to black garlic processing, review of advanced studies Biologically active substances in garlic are involved in the processing of lactic acid fermented garlic. From the review of studies related to improving the biological activity of garlic, we propose a method to improve garlic bioactivity when processing black garlic in Vietnam.
Keywords: *Biologically active substances, garlic*

1. Introduction

Garlic is one of the oldest plants in the world and belongs to the Lily family. Although the exact geographical origin of garlic has not been determined, botanists are now reporting that garlic came from Central Asia. Some other authors claim that it is Siberia, where garlic was discovered and grown by people searching for food and medicinal herbs in the fields. The characteristic of white garlic bulbs is that it is odorless when left intact, but has a pungent taste when cut out (Borek, 2001). In today's modern life, garlic has become a popular health-enhancing herb in the Far and Near East, Europe and America. A part of Chinese people usually eat a fixed 20 grams of garlic / day, approximately 8 cloves of garlic on average. In Germany, most adults take garlic daily to enhance their health. In the US, the use of garlic supplements has rapidly increased over the years, with the most popular supplement being odorless aged garlic extract (Borek, 2001).

Garlic preparations are available in the market in many forms (Figure 1), such as garlic extract, heating garlic extract, and aged garlic extract.), garlic powder and garlic oil (Banerjee et al., 2003).

Figure 1. Some garlic products on the market

(Source: Block, 2010)

2. Literature review

2.1. Studies relating to harvesting and storage conditions of garlic bulbs after harvest

Rajesh and Yu (2010) studied the effects of harvesting stages on mass loss and germination during storage at room temperature and were conducted on two varieties of Great Leaf Black (GLB) garlic and Ho- mei (HM). The tubers of these 2 varieties are harvested at different defined harvesting stages, for example, the leaves turn yellow (not yet mature), 50% of the dry leaves (optimum maturity) and 100 dry leaves (beyond proficiency). Both varieties exhibited distinct morphological variation at the harvest stages. GLB garlic bulbs are harvested when they are immature, exhibiting excessive weight loss, egg-shaped tubers, and skin wrinkling and browning compared to HM. HM reaches optimal maturity obtained at the stage of 50-70% of dry leaves, while 100% dry leaves, garlic bulb is split and deformed. GLB garlic tubers harvested at the dry leaf stage of 50% are not fully mature. The loss of mass of immature garlic bulbs is very high during the drying process.

North type garlic "Seosan" and subtropical "Daeseo" garlic stored under controlled atmosphere (CA) (O_2 3%, CO_2 5%, -1□1oC) at low temperature. (-1□1oC), and room temperature (20□5oC). Germination rate, weight loss, pyruvic acid content, and greening level in crushed garlic were determined during storage. The germination rate was higher in "Daeseo" garlic compared to "Seosan" garlic under low temperature storage and CA. The mass loss in "Daeseo" garlic is higher than for "Seosan" garlic. The pyruvic enzyme (EP) content increased over 3 months of storage, and subsequently decreased due to prolonged storage at room temperature or low temperature. However, the EP concentration decreased significantly during storage under CA for both varieties (Choi et al., 2004).

Croci et al. (1987) applied a dose of 10.0 Gy after sleep significantly reduced germination; Sprouts changed in size (length), color and peroxidase activity. No change was observed in treatments during the sleep phase. After the time of preservation, the leaves did not change. Several growth regulators have been used that are effective in modulating gamma ray exposure. Acetic indole is most effective, followed by gibberellic acid; Benzyl-adenine showed no evidence of in vitro inhibition of germ growth inversion.

In Turkey, garlic can be stored at 0-5oC, 60-70% RH for at least 3-4 weeks in stock. As of 2012, no treatment has been performed before and after harvesting preserved garlic in Turkey. Garlic storage under atmospheric control and atmospheric regulation is widely used abroad with various irradiation, chemical and heating methods (Selenium and Nilgün, 2012).

Geraldine et al. (2008) evaluated the physical properties of agar-agar (1%) based on a coating combined with 0.2% chitosan and 0.2% acetic acid, as well as their effect on garlic coatings. Processing. The average moisture loss of coated garlic was 3 times lower than that of control (uncoated). There was a significant increase in the color difference (DE *) of the control compared with the other treatment. Moderate filamentous and aerobic mildew were inhibited on coated garlic in combination with antimicrobial acetic acid and chitosan compounds. During 6 days of storage, at 25oC, the numbers of mycelia and yeasts were maintained between 102-103 CFU / g for coated garlic and 106 CFU / g for the control garlic. The coating significantly reduced ($p <0.05$) garlic respiration. Membrane-coated garlic has respiration intensity (30 mg CO_2 / kg.h) reduced by half compared to the control garlic.

Currently, in Vietnam, the garlic bulbs, after being harvested from the garlic fields, will be processed, sun dried and stored in the sun for many days. This simple process will make garlic more susceptible to spoilage, dehydration and lead to economic loss. In addition, the garlic bulb postharvest studies have not been published much in our country.

2.2.Studies that enhance the bioactive in garlic are involved in black garlic processing

Researchers around the world are particularly interested in the medicinal properties of organic sulfur compounds extracted from garlic in prevention and treatment such as alliin, diallyl disulfide, S-allylmercaptocysteine and S-trityl-L- cysteine. These organic sulfur compounds may inhibit the development of cancer, cardiovascular, neurological, liver disease, allergic symptoms and arthritis (Yun et al., 2014).

In Vietnam before that, black garlic was only studied at the Military Medical Academy at the state level, code KC10.TN05 / 11-15. According to the director of the project "Research on fermentation of black garlic from Ly Son garlic and evaluate the biological impact of the product created", said the fermentation process, the biological activity of Ly Son garlic increased significantly, in Total sugar content increased about 13 times, fructose increased about 52 times and SAC increased 6 times. Black garlic extract was tested on rats, the results showed that the antioxidant effects were 2-4 times increased and the immunity of organs was much higher than that of fresh garlic. Besides, the topic "Research and evaluate the inhibitory effect of some cancer cell lines in experiment and preparation of black garlic capsules" belongs to the Program of Research, Application and Development of Advanced Technology for protection and public health care (KC.10 / 11-15).

Black garlic is processed from fresh garlic harvested in Quang Hoa commune, Quang Trach district, Quang Binh province to incubate and ferment black garlic after 35-55 days. The incubator uses the inner lid is a rubber rim to keep heat. , vent holes attached to a 100oC thermometer to monitor the temperature in the pot (Nguyen Duc Vuong et al., 2015). In addition, Nguyen Duc Vuong et al. (2017) also used a natural heat fermentation process to convert white garlic into black garlic. Fermentation is carried out under 70oC conditions and fermentation time is from 35-45 days.

Black garlic is processed from indigenous varieties of garlic Dong Mu, Cao Bang. Garlic collected and washed to drain off the water and then soaked in Hanoi beer (beer contains 14 g total fat, 9 g saturated fat, 0g trans fat, 55 mg cholesterol, 40 mg Sodilum, 17 g total carbohydrate, fiber eat 1 g, sugar 14 g, protein 3 g, vitamin A 10%) for 20 minutes. Then drain and fan dry. Next, the garlic was placed in the oven at 55oC and fermented for 55 days in the oven. The results showed that the black garlic product from the study had reduced sugar content of 46.93 (g / 100 g), protein 11.30 (g / 100 g), lipid 0.27 (g / 100 g), polyphenol 47 , 06 (mg / g) and flavonoid is 14.68 (mg / g) (Nguyen Thi Tinh et al., 2019). Dao Van Minh (2015) also researches to improve the quality and economic value of garlic products by researching black garlic production. From there, initially set out the process and identified some active ingredients such as SAS, SOD enzyme, polyphenol.

The study has examined the quality indicators of black garlic dry powder, thereby giving a set of product quality indicators including: sensory appearance, moisture, fineness, heavy metal content, qualitative, quantitative, bacterial contamination. Including important quality criteria and characteristics of high dry black garlic powder such as the SAC content in the powder is not less than 350 /g / g, heavy metals not more than 10 ppm, humidity no more than 5%. . With the surveyed quality indicators, it can be used in testing black garlic dry powder in medicine and black garlic supplements (Vu Binh Duong and Vu Dinh Tien, 2016).

Vu Dinh Tien et al. (2014) researched to build a process of extracting black garlic extract by ultrasonic extraction at sonic frequency at 60 MHz frequency, with water solvent (the ratio of medicinal herbs / solvents is 1/10), extracting 2 times. During 60 minutes at 60 ° C, evaporate dry at 60 ° C under reduced pressure. SAC extraction efficiency reached 87.36%.

Vu Binh Duong and Nguyen Trong Diep (2014) investigated the suitable conditions for spray drying black garlic including: adjuvant drying spray: maltodextrin: aerosol (9: 1) with 1: 1 ratio and heat Spray drying is 140oC, solids rate in spray drying 15%, fluid feeding rate 50 mL / min. The recovery efficiency and drying efficiency were 91.60% and 86.06%, respectively.

Most studies of garlic in other countries demonstrate garlic's good properties against chronic diseases. Sovová and Sova (2004) reported that garlic supplementation reduced the accumulation of cholesterol on the blood vessel walls of animals. Yeh and Liu (2001) did a similar study but performed on humans. Another study showed that garlic extract supplementation inhibited vascular calcification in patients with high cholesterol in the blood (Durak et al., 2004). The effect on garlic's ability to dilate blood vessels is caused by catabolism of garlic polysulfides derived from sulfur hydrogen gas in red blood cells. Hydrogen sulfide protects the cardiovascular endogenous signaling cell molecules (Benavides et al., 2007).

Garlic is used as an antiseptic to prevent necrosis. Garlic is used as a remedy for infections (especially chest problems), digestive disorders and fungal infections (Shuford et al, 2005; Jones and Goebel, 2001). Simonetti (1990) also confirmed that garlic has antibacterial and bactericidal properties. Garlic also enhances thiamin absorption, and thus reduces the likelihood of developing beriberi due to thiamin deficiency (Jones and Goebel, 2001).

Garlic extract is excellent for reducing systolic blood pressure in patients treated for hypertension but not in control (Ried et al., 2010). Research on the inhibition of streptolysin O (a toxin made up of group A streptococci strains) by allicin (active ingredient in garlic) has also been performed (Arzanlou and Bohlooli, 2010) and the stability of the compound allicin in Garlic extracts were also reported.

Research results of Queiroz et al. (2009) suggested that garlic's antioxidant activity could be affected by its processing. Black garlic is one of the garlic products with strong antioxidant capacity, produced by processing at high temperature (70oC) and high humidity (90% RH) (Jang et al., 2008; Kang et al., 2008). During aging, unstable compounds of fresh garlic including alliin are converted into stable compounds including S-allyl cysteine (SAC), water-soluble compounds that have antioxidant effects. strong (Corzo-Martinez et al., 2007; Imai et al., 1994). In vivo studies showed that black garlic had more antioxidant activity in vitro than fresh garlic (Jang et al., 2008).

In addition, other research results in the world related to this study were done with results showing an increase or decrease in bioactive substances in processed black garlic product (mentioned above). in section 2.1). However, black garlic or fermented garlic with controlled technology, the kinetic transformation of valuable active ingredients in garlic, and optimization of the applied technology process has yet to be widely publicized.

S-allyl cysteine (SAC) (the main breakdown product from γ-glutamyl-S- allyl-L-cysteine) is water-soluble sulfur-containing organic compounds. SAC concentration increases with increasing extraction time in water environment. Amagase and Milner (1993) showed that aging garlic contains SAC content of 0.45 mg / g. Yoo et al. (2010) also announced that Korean garlic extracted in water contains SAC of about 0.36-0.6 mg / g.

Increased S-allyl cysteine (SAC) content is also an important change in the black garlic processing. Fresh garlic contains 20-30 g / g SAC (Kodera et al., 2002) and the amount of SAC in black garlic is 5-6 times higher than fresh garlic (Bae et al., 2012; Wang et al., 2010) . SAC is formed by the hydrolysis of -glutamyl-S-allyl cysteine (GSAC) by -glutamyl transpeptidase (-GTP, EC 2.3.2.2) (Kodera et al., 2002). SAC is one of the main sulfur-containing amino acids and garlic's most beneficial compounds, such as antioxidant, anti-cancer, and anti-liver and neurological diseases (Kodera et al., 2002) .

Ajoene (4,5,9-trithiadodeca-1,6,11-triene-9-oxide) is a product of the breakdown of allicin. The aging temperature is considered to be very important for the formation of ajoene. When the aging temperature is 40, 60 and 80oC, the ajoene concentration increases gradually. The highest amounts of E-ajoene (172 µg / g garlic) and Z-ajoene (476.3 µg / g garlic) were found in Japanese garlic mixed with bran oil at 80 ° C (optimum temperature) (Naznin et al., 2008). Particularly garlic in soybean oil, the amount of E-ajoene formed is 172 µg / g garlic and Z-ajoene 120 µg / g garlic.

The total polyphenol content (TPC) in garlic at different heat treatment stages was much higher ($p < 0.05$) than fresh garlic. The TPC in black garlic increases about 4-10 times that of fresh garlic. Choi et al. (2008) claimed that the content of polyphenol and free flavonoid compounds in heated garlic was much higher than that of fresh garlic and steam-blanched garlic.

According to Bae et al. (2014), DPPH free radical removal activities in heated garlic samples were significantly higher than in fresh garlic samples. Furthermore, free radical removal activity increases with increasing temperature from 40 ° C to 85 ° C ($P < 0.05$). Fresh garlic free radical removal activity was 6.21%, which increased to 44.77% when heating fresh garlic at 85oC for 45 days. While the garlic samples heated at 40oC increased only 22.50%. The reduction of the Fe3 + / ferricyanide complex to an iron-containing form takes place in the presence of an antioxidant, which reduces the reduction capacity. Changes in reducing capacity at different temperatures during black garlic production. The reduction in reducing capacity of the heat-treated garlic samples increased significantly with temperature and time (P <0.05) and was highest at high temperature after 45 days of heat treatment.

Guihua et al. (2007) also showed that the heating process increased the phenol content due to the destruction of their combined state (esterification and glycosylation activity) which increased the free state. In addition, another reason for the increase in phenol content in heated garlic samples is the reduction / inhibition of oxidation by enzymes including antioxidant compounds in the fresh starting materials (Dewanto et al., 2002; Nicoli et al., 1999). The increase in polyphenol content was also caused by increased content of complex polyphenol compounds formed at the end of the Maillard reaction (Robards et al., 1999). The content of total phenolic acid in black garlic increased by 4.6-7.8 times compared to fresh garlic. Furthermore, hydroxycinnamic acid derivatives were found to be the main phenolic acid present in heat-treated garlic (Kim et al., 2013).

2.3. Studies on garlic bioactive enhancement related to lactic acid fermented garlic processing

Pickled garlic from five companies in Spain was analyzed for its physicochemical properties, approximate composition, ascorbic acid, thiamin, riboflavin, - tocopherol, and amino acid content. The titration acid ranges from 0.70 to 2.66%, while the salt content ranges from 2.39 to 7.40%. Water, protein, and fiber content showed low variation between samples, averaging 86.89%, 3.35%, and 2.1%, respectively. The concentration ranges (wet base weight, wwb) of the key ingredients are fat (0.21- 0.35%), ash (2.65-8.40%), and sugar (2, 21-4.22%). Total essential amino acids range from 46.3-53.9% of total protein, limited amino acids are lysine and sulfur-containing amino acids. A significant difference in vitamin content, as well as physical and chemical characteristics. Analytical vitamin levels were thiamine (0-0.055 mg / kg), riboflavin (0.013-0.032 mg / kg), -tocopherol (0.36-2.53 mg / kg), and ascorbic acid (0-47, 9 mg / 100 g) (Casado et al., 2004).

Garlic is peeled, processed (blanched and not blanched) and fermented in brine with the participation of the bacterium L. plantarum. Fermentation took place for 7 days at a place where the temperature was maintained at 30oC. Monitor the chemical and physical properties of garlic after fermentation and after 3 months of storage. No yeast or mold growth was detected in blanched or blanched garlic for 7 days of fermentation. For blanched garlic, the pH of the brine gradually decreased, reaching a value of 3.77 at 7 days. For blanched garlic there was a decrease in the pH of the medium (4.00), but as growth of L. Plantarum did not take place, the pH increased (5.65), perhaps due to Diffuse acid formation into garlic in salt water (de Castro et al., 1998).

Fresh (peeled) garlic soaked in 2% acetic acid solution and NaCl stored at 20oC for 60 days. The pH of the pickled garlic drops to about 4 by day 20 of storage. The amount of allicin (the main spicy ingredient) of pickled garlic by HPLC analysis decreased by 5.9% on day 40 of storage compared with allicin in fresh garlic. A sensory table of 10 sensory panelists on pickled garlic cloves (0, 10, 20, 30, 40, 50, 60 days of storage) by scoring (scale 7). The results of sensory evaluation showed that the pungent taste of pickled garlic gradually decreased and the score reached 3.07 on the 40th day of storage. illustrates a very clear correlation (r = 0.9646) (Kim et al., 1993).

Domestic studies on garlic are also limited. In particular, in-depth studies on the effects in the processing, storage and absorption of bio-valuable active ingredients in garlic products are still very limited, not seen published on Scientific documents in the country and around the world.

2.4. Studies of creating nanoparticles carrying bioactive substances from garlic or garlic products and related activity tests

The advent and development of nanotechnology has been making great strides in many scientific fields. Among them, the nano-carrier systems have been studied and applied to improve the effectiveness of drugs and biological active ingredients used in pharmaceuticals, cosmetics and foods. By encapsulating active components inside to create nanoscale conduction systems, the nano-carrier systems are able to protect the active ingredients from the impact of the environment such as temperature, light. or the effects of the physiological environment inside the body. Thereby, it increases the durability of active ingredients (Milad et al., 2014). Not only that, the nano-carrier systems also increase permeability through the intestinal wall, thereby improving the efficiency of active ingredients used orally. The absorption of nanotubes across the intestinal wall is 15-250 times higher than drug conduction systems ranging in size from 1 to 10 micrometres. The reason for this, a lot of studies have been done and demonstrated the superiority of the nanoscale drug delivery systems. Saltzman and Olmsted have shown that the 38 nm and 55 nm nanoparticles have the ability to diffuse easily through the lining of the intestinal wall because the size of the gaps in the mucosa is approximately 100 nm (Olmsted). et al., 2001; Saltzman et al., 1994). Jani et al. (1990) evaluated the intestinal absorption ability of polystyrene nanoparticles with different particle sizes (50–100–200–300–1000–3000 nm). Results showed that absorption was greatest for particles with size 50 nm (34%) and decreased to a very low level of 0.8% for particles with size 1000 nm.

To improve the durability of allicin under the influence of external environment such as temperature, light, acidity (pH) and improve the solubility of allicin, Wang et al. (2012) used a mixture of beta-cyclodextrin and starch to create an allicin carrier with micrometer size. The results showed that the stability and solubility in water of allicin increased significantly. However, the biological activity of allicin in this carrier system has not been increased, only to a degree similar to that of pure allicin.

According to Lu et al. (2014) allicin, the main active ingredient derived from a traditional garlic odorant, has a wide range of biological effects. Unfortunately, garlic's great potential for processing is limited by its sensitivity to heat and alkaline conditions accompanied by its pungent odor. In the study of Lu et al. (2014), the allicin nanoliposome was prepared using the reverse evaporation method to overcome the mentioned limitations.

In Vietnam, black garlic hard capsules have been studied and evaluated for acute toxicity on experimental animals, mice. The results showed that no acute toxicity was detected at a maximum dose of 10 g / kg body weight after mice took a single dose of black garlic capsule powder derived from Vietnamese garlic. The test results also showed that there were no significant differences in the changes in systemic status, number of blood cells, liver and kidney function of experimental mice compared with the control group (Vu Binh Duong and Ho Anh Son, 2016).

Vu Binh Duong and Ho Anh Son (2015) have evaluated the inhibitory effect of A549 human non-small cell lung cancer cell lines of black garlic dried extract by trypan blue and MTT test. Results showed that at 24 hours, 48 hours and 72 hours after incubation with black garlic concentration of 2.5-10 mg / mL, black garlic strongly inhibited A549 cell proliferation with concentrations causing IC50 in 24 hours is 10.57 mg / mL.

Active ingredients have biological effects mainly due to organic sulfur components in garlic, which are highly effective in inhibiting the proliferation of cancerous cells in the culture environment through a lethal mechanism. program (apoptosis). In this study, the anti-cancer ability of black garlic was assessed on human colon cancer cell line HT 29 by using FACS machine system. At 24 hours after incubation of cells with black garlic medium concentration of 0.1 mg / mL, apoptosis of colon cancer cells HT 29 was killed (Pham Xuan Phong and Ho Anh Son, 2015a). Pham Xuan Phong and Ho Anh Son (2015b) studied the anticancer effects of black garlic on immune-deficient mice carrying human liver cancer with a dose of 10 g / kg / day daily for a month, with a curative effect. significantly reduced cancer growth compared to the control group ($p <0.05$). At the same time, mice with human liver cancer that were given black garlic had a higher survival rate and significantly longer life time than the control group without treatment ($p <0.05$).

Immune-deficient mice (athymic mouse) are given a daily dose of black garlic at a dose of 1 g / kg and 10 g / kg body weight for 1 month. After that, the mouse was transplanted with 106 human liver cancer cells. The dose of black garlic 10 g / kg body weight / day, lasting 1 month, the rate of mice forming tumors decreased significantly compared to the control group ($p <0.05$) and also inhibited tumor growth, dragging long life time and rat survival compared to the control group ($p < 0.05$) (Pham Xuan Phong, 2015).

In this study, Nguyen Trong Tai and Nguyen Viet Trung (2014) evaluated the anti-cancer ability of SAC and black garlic extract on Hep-3B liver cancer line. The results showed that Hep-3B cells were inhibited at SAC concentration of 100 mM and black garlic extract with concentrations calculated according to SAC was 0.25 mM, 0.5 mM, 1 mM.

Up to now, there have been no studies inside and outside the country that have successfully fabricated nanoparticles with the size less than 100 nm carrying active ingredients from black garlic accompanied by in-vitro and in-vivo tests to evaluate the activity. of them.

2.5. Garlic

Of all the herbal remedies consumed for health benefits, garlic ranked the highest, in both popularity and effectiveness. Garlic (Allium sativum L.), one of the oldest plants used in medicine, has become an important part of human life over the centuries. Garlic was used as a food spice, to enhance the health of soldiers during the war, cure colds, infections and treat a variety of diseases, from heart disease to cancer and even plague. (Amagase, 2006).

In Vietnam, garlic is grown in many regions of Hai Duong, Hanoi, Bac Giang, Phan Rang - Ninh Thuan, Ly Son - Quang Ngai, Da Lat - Lam Dong, ... In which, the largest garlic growing area in Hai Duong (5,100 ha), Ly Son (307 ha), ... In Ninh Thuan, according to statistics of the Department of Agriculture and Rural Development, in the 2011-2012 winter-spring crop, the area of growing garlic in the whole province was 126 ha, accounting for 11.54% of the total area under cultivation of garlic in the province. Ninh Thuan garlic is grown mainly in 3 districts, that city is Phan Rang - Thap Cham city (44 ha), concentrated in Van Hai ward; Ninh Hai district (70 hectares), concentrated in the communes of Nhon Hai, Thanh Hai, Vinh Hai; Thuan Bac district (12 ha) in Bac Son commune. The area of growing garlic in the whole province will tend to increase in 2013 and 2014 (expected to reach over 210 hectares), the output is estimated at 1,600 tons, concentrated in the districts of Ninh Hai, Thuan Bac and Phan Rang - Thap Cham city. (Center for Agriculture - Fisheries Promotion Ninh Thuan, 2012).

Garlic is classified into two categories: a stiff neck and a soft neck, based on the central stalk formation (Figure 2).

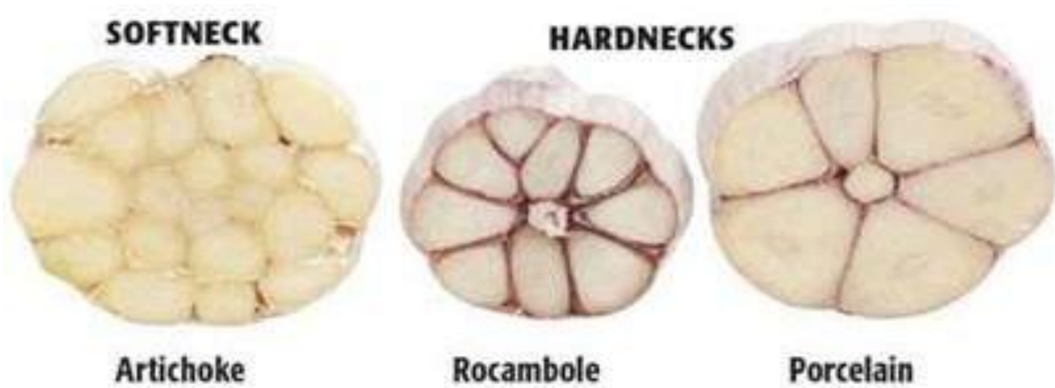

Figure 2. Inner structure of a soft-necked bulb and a hard-necked garlic bulb

(Source: https://www.garlicfarm.ca/garlic-bulbils.htm)

The hard neck garlic (Allium sativum ophioscorodon) is very close to the wild garlic, known as the variety of ophioscorodon. Soft neck garlic (Allium sativum sativum) is the most common type of garlic. Most of the garlic sold in supermarkets is this type. Soft neck garlic does not have garlic flower stalks, withstands hot climates (while hard-necked garlic is usually grown in cold climates), garlic bulbs have more cloves than hard necks, often forming layers around the central core and having the skin is as thin as white paper. The storage capacity of this type of garlic is also better. Soft neck garlic is easy to braid into bunches. The internal structure of a hard-necked and soft-neck garlic bulb is not the same. Hard neck garlic has a garlic flower stalk in the center of the bulb and the number of cloves per garlic is less than the soft neck garlic.

The varieties of garlic are commonly used in our country's production (Figure 3):

Hanoi Garlic: The leaves are dark green, the leaves are blanket and ivory green, the leaves are thin, the tubers are light purple when young, light brown, round and flat when old, the average yield is 14-15 tons. / ha / crop.

White Garlic: ivory green leaves, thin leaf blade, purpleish-purple tuber when young, white in old age, large tubers and bulb diameter from 4.0 to 4.5 cm, average yield 12-13 tons / ha / crop and when storing, tubers are often dented.

Garlic Yunnan - China: dark green leaves, young tubers and old tubers are purple in color, round and flat, with an average yield of 15-20 tons / ha / crop.

Purple garlic: leaves are dark green, standing leaf and trough shape, green leaf stalks, tall plants, dark purple in young trees, purple old tubers, round bulb shape, bulb size from 3, 5 - 4.0 cm and each bulb has 10 - 11 shrimp, average yield 13 - 15 tons / ha / crop.

There are also some local specialty garlic varieties such as Ly Son garlic from Quang Ngai, white garlic from Ninh Thuan.

Hanoi Garlic White Garlic Chinese Garlic

Purple Garlic Ly Son Garlic Phan Rang

Today, after more than 6000 years of folklore, modern science has confirmed many of garlic's benefits. With a rich source of phytochemicals, rich organic sulfur compounds and high antioxidant activity, garlic has been shown to have a wide range of benefits for human health and anti-aging effects, helping to prevent disease and pathological conditions related to aging. Scientific and clinical studies have shown that garlic can boost the immune system, protect against infections and infections, and help reduce the risk of cancer, heart disease, dementia, and most forms of Alzheimer's. Scientific research shows that garlic is not eaten fresh or raw to be effective, but aging garlic, deodorized garlic extract (kyolic) is rich in antioxidant activity (Borek, 2001; Imai et al., 1994; Amagase et al., 2001; Ide et al., 1999; Borek, 2006a; Rahman, 2003), generally performed better than fresh garlic, without causing digestive disturbances and "garlic breath".

2.6. Chemical composition of garlic bulb

The composition of garlic is complex, with more than 200 different compounds contributing to its beneficial effect. The most important and unique feature of garlic is its high content of organic sulfur compounds. Garlic contains more sulfur (at least 4 times) than many other high-sulfur vegetables: onions, broccoli and cauliflower. Garlic is also high in carbohydrates that contain fructose, protein, fiber, saponins, phosphorus, potassium, zinc, moderate amounts of selenium and vitamin C, steroid glycosides, lectins, prostaglandins, essential oils, adenosine, vitamins B1, B2, B6, and E, biotin, nicotinic acid, fatty acid, glycolipid, phospholipid, anthocyanin, flavonoid, phenol, and essential amino acids (Borek, 2001; Imai et al., 1994; Amagase et al., 2001; Ide et al., 1999; Borek , 2006; Rahman, 2003).

Depending on growing conditions, garlic can contain at least 33 different organic sulfur compounds. The allyl sulfur composition in garlic is responsible for the majority of garlic's health benefits. The main allyl sulfur content in crushed / chopped / chopped fresh garlic is allicin. Allicin is unstable and rapidly broken down to form di-allyl sulfide, di-allyl disulfide, di-allyl trisulfide and oil-soluble odor ajoene. The main allyl sulfur components in aging garlic extract (AGE) include S-allyl-cysteine and S-allyl-mercaptocysteine that is water-soluble and is formed by natural aging bio-metabolism (Borek, 2001; Imai et al., 1994; Amagase et al., 2001; Ide et al., 1999; Borek, 2006a; Rahman, 2003).

From a medical point of view and its effects in preventing aging-related diseases, garlic's water-soluble stable organic sulfur compounds in garlic are highly effective. Organic sulfur is present in very limited amounts in fresh garlic, and their levels increase significantly during aging (Borek, 2001; Imai et al., 1994; Amagase et al., 2001; Ide et al., 1999).

2.7. Health benefits of garlic

According to Watson and Preedy (2010), there is a lot of research showing garlic's health benefits and anti-aging effects. Due to being rich in organic sulfur and antioxidant compounds, garlic has been shown to help prevent many chronic diseases and conditions associated with the aging process, especially cardiovascular disease and cerebrovascular disease, cancer, and Alzheimer's disease. Garlic reduces disease and aging risk factors, including reducing oxidative stress and inflammation, lowering cholesterol, triglycerides and homocysteine, inhibiting coronary plaque formation, and preventing platelet aggregation. Garlic treatment increases vasodilation and blood circulation, reduces blood pressure, prevents nerve cell death and increases memory and cognitive abilities, boosts immunity, enhances glutathione, an internal antioxidant Importantly, increase physical stamina and improve fatigue. Among the many studies on garlic's anti-aging effects, the consistent results, reported in more than 600 scientific papers, are both preclinical and clinical studies with aging garlic extract (Kyolic).) (highly standardized odorless supplement) created by extracting and aging fresh garlic for a long time, this action enriches the antioxidant content of garlic and water soluble compounds stability of garlic, as S-allyl cysteine has a high bioavailability (Kasuga et al., 2001). Overall, a garlic-rich diet and a standardized, stabilized garlic supplement promote general well-being and help enhance body protection from many chronic diseases and aging.

3. Apply heat treatments in processing black garlic

3.1. Low temperature

Freezing is the act of lowering the temperature of food below its freezing point and a proportion of water undergoing a change in state to form ice crystals. Food preservation is incorporated using low temperatures and reduced water activity. The nutritional value and sensory quality of food is only slightly changed when frozen and properly stored (Fellows, 2000). Traditional processing method of black garlic is extremely simple but time consuming. Black garlic is processed for a long time without any pretreatment. The high temperature destroys the cell structure and allows the substrates to react with each other. Meanwhile, frozen treatment before processing pre-damages the plant cells. Intracellular substrates flowing out of cells are broken by cryogenic pretreatment. Therefore, the frozen phase can be used to destroy the garlic cell membranes before processing the black garlic to shorten the processing time.

3.2. High temperature

In order to shorten the aging time of black garlic (similar to freezing,), blanching alters the physical properties of tissue, causing destruction by high temperature on the cell membrane and some physical properties. as porosity.

Black garlic is prepared from fresh garlic by controlling temperature and humidity without any additional treatment and additives (Jang et al., 2008; Kang et al., 2008; Wang et al. ., 2010; Kim et al., 2013). Stinging and unpleasant compounds are lost during production, and their unique black color and flavor are developed by biochemical and chemical reactions (mainly Maillard reaction). Garlic's antioxidant activity can be influenced by its processing (Queiroz et al., 2009), related to the formation of phenolic compounds and the presence of allicin (Kim et al., 2013). .

The Maillard reaction that occurs between reducing sugars and proteins, peptides or amino acids during food processing and / or storage, may also increase antioxidant activity in many different products (Del Castillo et al. ., 2002a; Delgado-Andrade et al., 2005; Farag et al., 1982; Friedman, 1996; Nicoli et al., 1997; Somoza, 2005). Ide et al. (1999) and Ryu et al. (2001) demonstrated the antioxidant role of the derivative Amadori fructosyl arginine (derived during the initial phase of the Maillard reaction) in concentrated aging garlic extracts obtained by storage at temperatures. room for longer than 10 months. The authors described fructosyl arginine as a hydrogen peroxide (H2O2) cleaner equivalent to vitamin C. Cardelle-Cobas et al. (2005) reported that the presence of several Amadori compounds, measured as 2-furoylmethyl-amino acids (2-FM-AA), in commercially dehydrated garlic. In addition, the water-soluble S-allyl cysteine compound has also been shown to have antioxidant activity in the processing of black garlic. Therefore, many compounds derived from processed garlic products also contribute to increased antibacterial properties. The transformation into a beneficial compound in the garlic bulb during processing is shown in Figures 3 and 4.

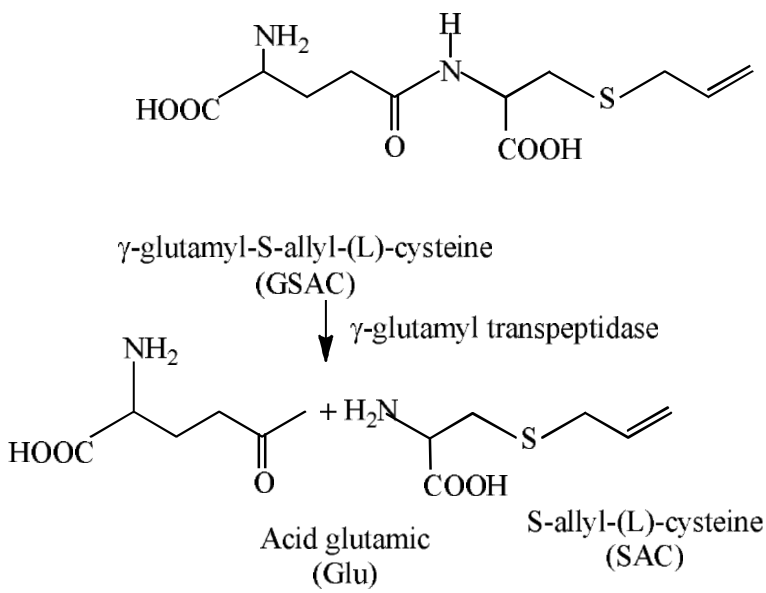

Figure 3. The conversion of GSAC to SAC in black garlic clove
(Source: Majewski, 2014)

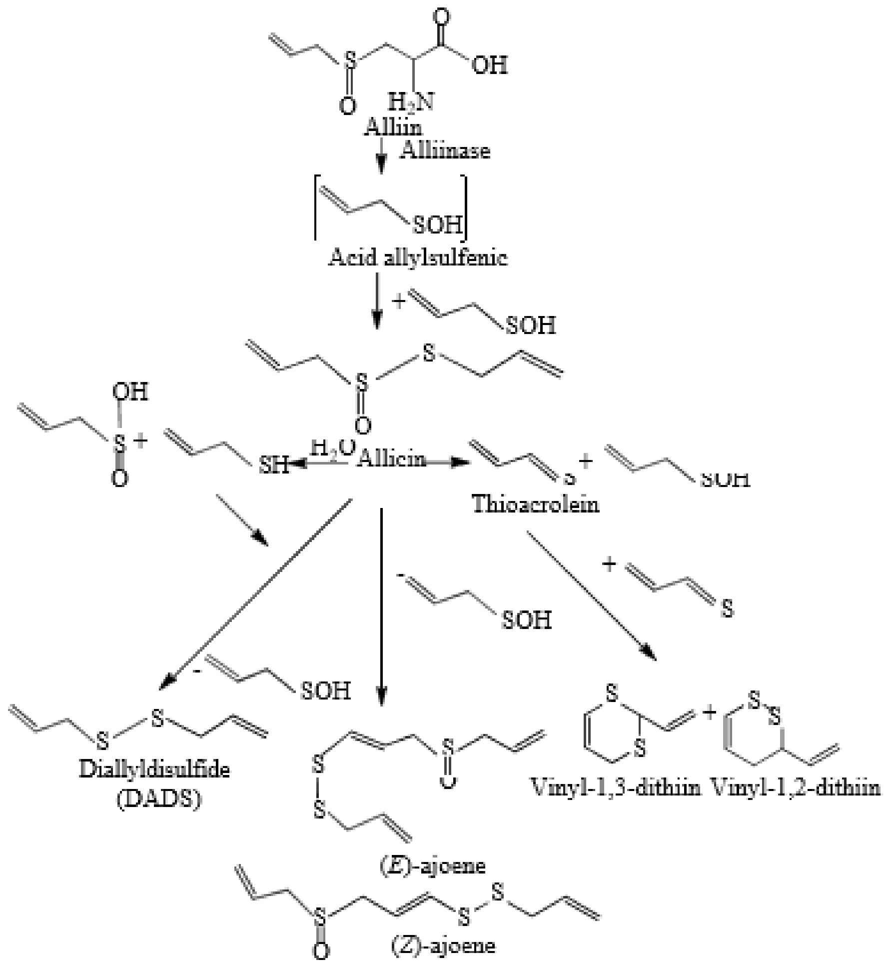

Figure 4. Various compounds created when garlic clove is damaged
(Source: Majewski, 2014)

4. Processing by lactic fermentation method

4.1. Summary of lactic acid bacteria (LAB)

Lactic acid bacteria (LAB) are a heterogeneous group of bacteria characterized by their ability to produce common metabolites (lactic acid) from sugar. Their proteolytic and lipid-breaking activity is often noted primarily and does not contribute to the taste of fermented foods. The main activity of this group of bacteria is to use carbohydrates to ferment, creating lactic acid (Mehta et al., 2012).

Lactic acid fermentation technology is the main fermentation reaction in most fermented dairy, meat and vegetable foods. Lactic acid fermentation is carried out under anaerobic conditions by microorganisms belonging to the group of bacteria that support lactic acid production. In homolactic fermentation, the next route is the Embden-Meyerhof-Parnas pathway and only lactic acid is the final product. In heterolactic fermentation, the next pathway is the pentose phosphate pathway (phosphogluconate pathway) and the final product is lactate, ethanol, and finally acetate. On the basis of the types of lactic acid fermentation performed, the LAB types are divided into: (1) compulsory isomer fermentation, (2) compulsory heterofermentative fermentation, (3) arbitrary isomorphic fermentation (Mehta et al., 2012).

During the fermentation process, using the lactic acid microbiota in NaCl solution and aiming to lower the pH is the first choice (increase from 1% of the total microbial population in fresh brine) to 80 % after a few days).

Indigenous lactic acid bacteria (LAB) change spontaneously during natural fermentation, and at the end of the process, participating Lactobacillus species, mainly Lactobacillus plantarum (Rodríguez et al., 2009) at a rate of 39.9% of the total (Sanchez-Gomez et al., 2006), although other LAB species such as Lactobacillus pentosus and Leuconostoc mesenteroides, among many others, have also been isolated (Rodriguez et al., 2009). During the initial stage of fermentation, gram-negative bacilli are the most characteristic microorganisms, their mechanism leads to the generation of CO2, hydrogen, acetic acid, lactic acid, ethyl alcohol, etc. as end products. During the second phase, as a result of a decrease in pH (a pH decrease to 4.5), a vigorous growth of Lactobacilli begins; they only produce lactic acid as the end product of glucose fermentation. During the third stage, when the pH reaches 4.0 or lower, acid formation is stopped (Minguez-Mosquera et al., 1989), and when the sugar is depleted, the fermentation period can be considered. end and start storage time.

Lactic acid fermentation takes place spontaneously as soon as the organic matter is encased in a restricted space for oxygen penetration. Therefore, as microorganisms grow, oxygen is consumed and CO2 is created. This change in gaseous environment is the first environmental factor to control the local micro-flora (microflora) on the odor of LAB. Organic acid production and pH reduction contributes to the altered gas environment, and becomes extremely important for microbial control. In addition to these primary environmental control mechanisms, antibacterial compounds in addition to organic acids, such as hydrogen peroxide (Price and Lee, 1970; Gilliland and Speck, 1977), and nitrogen oxide (Kelley et al., 1995 Malawista et al., 1992), or antibacterial protein or peptides can be produced by LAB (Daeschel and Nes, 1995).

To enhance the selective pressure of the natural lactic acid fermentation, salt can be added or the activity of the water is reduced. A more subtle way to enhance control of lactic acid fermentation is to add a starter culture or purebred seed source Lactobacillus plantarum (according to modern industrial methods). The primary goal of lactic acid fermentation is to increase product shelf life. From experience, mankind has known that this is a safe way of preserving food and also has a significant nutritional quality, even improving in many respects (odor). Sometimes, lactic acid fermentation has other advantages such as improved taste and consistency of the product. In addition, lactic acid fermentation is also recognized to have beneficial effects on human health possibly due to consumption of live LAB (live LAB) (Mehta et al., 2012).

4.2. The role of fermentation in enhancing bioactive substances in the human body

Some strains of Lactobacillus have the ability to induce or enhance bioactive compounds in fermented foods, eg L. acidophilus, L. delbrueckii, L. helveticus, L. lactis, L. plantarum, L. rhamnosus, ... LAB's outstanding proteolytic activity is caused by proteinase binding to the cell wall and some intracellular peptidases, including aminopeptidase, dipeptidase , endopeptidase, and tripeptidase. Some peptides are biologically active, for example, antioxidant, anti-mutagen, immunomodulatory. The release of biologically active peptides is highly dependent on strain selection ensuring a balance between product integrity and the appropriate level of proteolytic activity required to release active peptides. this biology (Mehta et al., 2012).

Folate can be produced by certain microorganisms in certain foods. With few exceptions (L. acidophilus, L. plantarum), Lactobacilli is known to be unable to synthesize folate rather than to consume folate (Mehta et al., 2012).

4.3. Nanotechnology in food technology

Nanomaterials are materials with a physical and chemical structure in sizes larger than the atom / molecular dimension but less than 100 nm (exhibiting physical, chemical and / or biological properties related to nanostructures. of nanomaterials). In fact, nanotechnology involves substances that have novel properties due to their size, and if based on the structure of a natural molecule (for example, a biomolecule after being fabricated) then function. They differ from function in nature (Linkov and Steevens, 2008; Narlikar and Fu, 2010; NRC, 2006).

Nanotechnology approach to supporting material development in the processing process, allows manipulation of matter at nanoscale. This involved the spontaneous automatic assembly of multiple molecules into naturally occurring nanostructures, and the assembly of multiple molecules into the supermolecular structure aided by the inducing process. changes on material. The term "nanotechnology" describes an approach to manipulating matter at the molecular size resulting in the creation of new materials and / or products. The nanomaterial development process is supported by new analytical tools and techniques (e.g., atomic force microscope, AFM; scanning transmission electron microscope, TEM; secondary nanatomic mass spectrometry , nano-SIMS; small angle neutron scattering and X-rays, SANS and SAXS) can be used to identify and describe nanostructures. This helps to understand the relationship between the macroscopic properties of materials and their nano-, micro- structures.

Nanotechnology is of considerable importance in the food industry. The nanotechnology approach promises many new opportunities to create novel structures to improve the taste, texture and quality of food (e.g. food with palatability), new equipment (e.g. for example, nanosensors, nanotechnology-based packaging materials, nano-markers), bioactive capsule encapsulation systems (food drug preparations, nutraceutical) (e.g., omega oils 3, probiotics, polyphenols, lycopene) through new food and processing have the potential to significantly affect food production, safety and security (Chaudhry et al., 2008; Farhang, 2007; Sanguansri and Augustin, 2006; Sozer and Kokini, 2009). Many of these approaches due to advances in the fundamental fields (e.g. chemistry, biology, mechanics, processing, colloidal science and materials science) are the foundation of real science. traditional products.

Fabrication of nanomaterials can be approached by a "top-down structure", "a bottom-up structure" or a combination of the two. In a top-down structure, a nanomaterial is created from a material of a larger suitable dimension using a downsizing process (eg, milling, micro-liquefaction, homogenization). In the bottom-up structure, nanomaterials arise from the self-assembling of pre-existing components, such as molecules and atoms. Examples of bottom-up structures include micell formation through the self-aggregation of both hydrophilic and hydrophobic (amphiphilic) molecules, the two-dimensional aggregation of cellulose fibers in the plant cell wall, and protein-polysaccharide coacervate formation through bio-polymer interactions.

Recent research combines top-down and bottom-up structures to fabricate nanomaterials. For example, Lesmes et al. (2008) used a double source high-pressure homogenizer to generate single helical glucose and promote amylose formation consisting of multiple complexes with stearic acid (bottom-up structure). Similarly, McClements (2010) coat the nanoparticles by emulsifying large amounts of oil to form dispersed oil droplets (top-down structure) that are then coated with a bio-polymer layer (bottom-up structure).).

Various processes aimed at achieving top-down size reduction (e.g. mixing, grinding, spray-drying, relying on supercritical fluids), the most promising top-down technologies are pulping (e.g. , crushing, micro-liquefaction, homogenization) and spraying route (eg, electrostatic spray, spray drying).

Extraction is the process by which a compound (dissolved or solid) changes from one phase to another by contacting two phases to separate the essential compounds from impurities. Extraction methods include enzyme-assisted or microwaves, ... In which, extraction with ethanol or water solvents is a simple, inexpensive, easy to implement and safe method. in functional food processing.

a Process of size reduction

Various processes can be used to reduce the size of food ingredients across a range of length sizes and this makes it possible to adjust their functional properties, to adjust hierarchical self-aggregation and further self-organization of food ingredients.

Mechanical process: Mechanical downscaling approach in the food industry often uses grinding, homogenization or ultrasonic techniques.

Crushing: particle size is greatly related to function; an increase in the total surface area of the food ingredient corresponds to both an increase in the rate and extent of hydration (e.g., improved solubility and dispersion) and can also lead to an increase increased surface reactions (eg, enzyme digestion, oxidation), improved processing performance, improved product quality, and improved nutrient digestibility and bioavailability (Acosta, 2009) .

Ultrafine grind refers to the particle pulverization of the material. A wide range of different ultrafine grinding methods (e.g. ultrasonic flow jet grinding, cryogenic crushing, high pressure expansion, roll mill, high speed airflow dust crushing) are available to create material diversity with many distinctly different attributes (de Castro and Mitchell, 2002; Wang and Forssberg, 2007; Zhao et al., 2009).

Homogenization: A typical homogenization process depends on dispersion and suspension to high strain stress. Although homogenization is commonly used to reduce oil drop size and thus improve emulsion stability. Zhong and Jin (2009a) used a rotor-stator homogenizer to produce zein nanoparticles (maximum diameter 200 nm). Zein is dissolved in 55-90% aqueous ethanol solution, and then the solution is deformed in a large amount of water, causing zein precipitation and forming nanoparticles.

b The process of creating nanoparticles for the structure of biological materials

Biopolymers (proteins, polysaccharides, lipids) are the building blocks of the basic structure in food. During food processing, biopolymers are exposed to a variety of stresses (eg, heating, deformation, pressure) which can change their physical and chemical properties. This is another lever in food nanostructures, and hence macroscopic qualities, which can then be redesigned.

Heating: The effects of heat on the structural and functional characteristics of spherical proteins (eg, whey protein) have been extensively studied (Damodaran, 1996; Oakenfull et al., 1997). The physical and chemical properties of proteins can also be altered by heating in the presence of reducing sugars to form covalent, co-polymer masses through the spontaneous Maillard reaction (Oliver et al., 2006). Under controlled conditions, the amphiphilic co-polymer block (eg, casein-polysaccharide conjugate) is capable of self-assembling into micell with a hydrophobic core and a hydrophilic shell. Co-polymer blocks can be used to construct nanoparticle encapsulation systems. Pan et al. (2007) reported that the simultaneous formation of nanoparticles based on casein-dextran (diameter 170-300 nm, pH dependent) and hydrophobic bioactive capsule encapsulation, □-carotene. The capsule core is formed by the hydrophobic interaction between □- carotene and □-casein. Hydrophilic Dextran attached to the □-casein shell is formed, improving the stability and dispersion of the particles over a wide pH range (pH 2-12). The modification in this approach is to first form Maillard conjugated nanoparticles and follow a heating process that causes (at a temperature above denaturation temperature, Td, of the protein) to form the core-shell nanogel (diameter 100-200 nm) (Li and Yao, 2009; Li et al., 2008).

Alginate has been widely used for its exceptional physical and chemical properties. They are commonly used to create particles (nano or micro-size) and thick gel (Gombotz and Wee, 1998; Khotimchenko et al., 2001; Tønnesen and Karlsen, 2002; Shilpa et al., 2003; George and Abraham, 2006; Zimmermann et al., 2007; Zimmermann et al., 2007; D'Ayala et al., 2008; Murtaza et al., 2011; Goh et al., 2012; Lee and Mooney, 2012). Alginate is non-toxic, biodegradable, low cost and readily available in the market. Alginate is also considered a drug that can stick to the intestinal wall and release the drug (mucoadhesion), biocompatibility (biocompatibility) and non-immunogen. Alginate is a negatively charged polymer produced from brown algae and bacteria, consisting of α-L-guluronic acid and reduced form β-D- mannuronic acid, linearly linked by 1 bond, 4-glycosidic. The composition and sequence of the α-L-guluronic acid and the reduced β-D-mannuronic acid depend on the origin of the algae used and they influence the alginate properties. Alginate can also be chemically modified to modify its specificity (Yang et al., 2011; Pawar and Edgar, 2012). In addition, nanoaggregates, nanocapsules and nanospheres are nanosystems with a particle diameter of about 10 to 100 nm. These systems may contain enzymes, drugs and various compounds by dissolving or trapping them or by attaching (clamping) them to a particle matrix. For polymer circuits, the alginate will curl up or "roll" to confine the compounds inside.

Nanomaterials display different sizes, shapes, structures and properties, which can be formed depending on the fabrication process, manufacturing conditions, environmental conditions, component properties and any Pretreatment (eg, microphone liquefaction, high-pressure process, injection, ultrasound) is performed to correct many properties of components.

Nanoparticles are a form of nanomaterials. A nanoparticle (typically 1-100 nm thick) consists of two or more layers of materials with nanoscale dimensions (bound physically or chemically). The commonly used approach to make the blades is layer-by-layer electrostatic deposition (LBL). This method is based on the principles of direct self-assembling of polyelectrolytes to build multilayer films. One of the great advantages of the LBL technique is that it allows precise control of the thickness and properties of the adjacent film (McClements, 2009; 2010).

The market for nanostructured materials is predicted to exceed $ 20 billion in the year 2000 (Anonymous, 2009). The application of nanotechnology in the food industry worldwide has the potential to impact across many food sectors including manufacturing, processing, packaging and safety.

The properties of food depend on the formation, preparation, and processing used in production. Many functional ingredients are available in relation to their unique composition and chemical structure. However, processing that causes modification of food ingredients affects the properties of the individual ingredients in their formation and on how they assemble into nan- and micro- structures, and ultimately organized macro-structure. The texture, storage, conversion and destruction of food significantly affect the physical and chemical properties of food materials. Food texture also affects nutritional quality, chemical and microbiological stability, and organoleptic value (Aguilera, 2005). The understanding of the relationship between food properties and structure allows for enhanced design of nano-sized food materials and food products (Aguilera and Lillford, 2008)

a Food structure to modulate odor dispersion: Food viscosity affects odor perception by delaying the dispersion of odor and flavor compounds (reducing overall odor perception) (Taylor, 2009). Advanced texture modification of food products provides a means of controlling odor dispersion. For example, the structure of an emulsion influences the dispersion of odor and flavor compounds. The odor dispersion of the hydrophobic ester (eg, geranyl acetate) from the emulsion can be increased by reducing the emulsion droplet size while maintaining the oil content of the emulsion, although this has not been observed. with many hydrophilic esters (eg, ethyl butanoate) (Weel et al., 2004). In another study, the perception of acidity (from citric acid) of an emulsion pair (water in oil in water) containing a fixed amount of citric acid was found to decrease with an increase in the volume of the aqueous phase (Malone). et al., 2003). Using different emulsion structures to change odor dispersion states has the potential for low fat food product application. Phan et al. (2008) showed that the dispersion state of lipophilic odor compounds from 5% lipid nanostructured emulsions (with monoglycerides) was similar to that of conventional 10% lipid oil in water emulsion stabilized with sodium caseinate.

b Food structure to control texture: Food texture is an important element to induce the appetite (mouthfeel) of the food, among other properties such as appearance, and sound. during handling and oral consumption (Wilkinson et al., 2000). The rheological properties of the original food and how to change it upon chewing (e.g., the fracture of a solid food, the breakdown of starch by amylase in the saliva, the agglomeration of the grain leading to an increase viscosity) affects the sensory properties of foods (van Aken et al., 2007).

c Food Structure for Stability Adjustment: Food products are required to remain stable over the time of storage. Controlling the structure of food microorganisms is one way in which harmful chemical reactions and microorganisms are delayed (Aguilera, 2005).

The physical stability of an emulsion is, in part, influenced by the crystal of the fat phase, and a change in the fat droplet size in the emulsion can change the crystallinity of the fat within the droplet range. bridge. This indicates that the melting and crystallization temperature of trilaurin (glycerin trilaurate) in an oil-in-water emulsion (diameter 40-120 nm) is decreased compared to that of trilaurin in the bulk phase (Higami et al., 2003). . These operations are expected to influence the structure and stability of the emulsion.

Emulsions containing unsaturated head seeds oxidize easily, which can cause a rancid odor. Both the junction zone and the junction essence of the emulsion droplet can be expected to contribute to oxidative stability. This does not seem to be a consensus on the effect of oil drop size on the oxidation stability of the oil. While some authors found that the rate of oxidation in the oil-in-water emulsion was stabilized bovine serum albumin increased as a function of the reduction of the oil drop size (Lethuaut et al., 2002), but some Another author found that oxidation and oil drop size are not related (Shimada et al., 1996). Dimakou et al. (2007) investigated the effect of surfactants on oxidation stability; Stable emulsions Tween are more susceptible to oxidation than protein stabilized emulsions. This is probably due to the difference in structure of the junction. However, many other factors, such as protein's antioxidant properties, may not be assessed as contributing factors.

5. Conclusion

Garlic products (Allium sativum L.) can open up the direction of using garlic more to meet the health needs and prevent diseases for users. Black garlic or fermented garlic exhibits powerful antioxidant effects and a milder flavor than fresh garlic. Besides, the convergence of nanotechnology with other technologies will also have a great impact on garlic production, processing and preservation. Therefore, studying the impact of processing, preserving techniques, and building kinetic models for the transformation of important active ingredients in garlic products with nanotechnology is applied to maintain and enhance quality. product quality for a higher and more efficient use.

Garlic tubers harvested at the age of 130-135 days after sowing have the highest quality and low respiratory intensity. The 0oC temperature provides the best storage conditions to ensure the quality of garlic bulbs up to 180 days stored in mesh cloth packaging.

In black garlic processing, both blanching and freezing of whole garlic have higher levels of bio-compounds than fresh garlic. Carrying out the process of freezing garlic for 36 hours at -18oC is an effective pretreatment measure for the high content of biological compounds and high antioxidant capacity. The temperature of 70oC creates favorable conditions for the processing of black garlic, specifically, the polyphenol content increases by 6.5 times compared to fresh garlic. The optimum parameters are achieved when drying black garlic at 58.78oC for 12.25 hours. In addition, black garlic products have good ability to store at cool temperatures (5oC) in aluminum packaging. Under these conditions, the content of biological compounds in the product is maintained at the highest level.

In lactic fermentation, garlic cloves are blanched at 80oC for 90 seconds, showing the lowest loss of these compounds. During lactic acid fermentation, the content of total polyphenols and flavonoids, garlic's antioxidant activity significantly increased. Meanwhile, thiosulfinate content decreased gradually after 6 days of fermentation in a solution with 1% NaCl salt concentration and Lactobacillus plantarum density of 106 CFU / mL. In addition, lactic fermented garlic products still retain biological compounds (polyphenols, flavonoids, and thiosulfinate) and antioxidant properties when stored at temperatures of 4-6oC in the fermentation solution coincide within 2 months.

References

i. *Nicoli, M.C., M. Anese, L. Manzocco, and C.R. Lerici, 1997. Antioxidant properties of coffee brews in relation to the roasting degree. Food Science and Technology-Lebensmittel-Wissenschaft & Technologie, 30: 292-297.*

ii. *Noureddine, B. and Virginia, 2007. Allium Thiosulfinates: chemistry, biological properties and their potential utilization in food preservation. Food, 1(2): 193-201.*

iii. *Nuevo, P.A. and O.K. Bautista, 2001. Morpho-anatomical features and postharvest changes in garlic (Allium sativum) harvested at different maturities. Acta Horticulturae, 555: 195–206.*

iv. *Oakenfull, D., D. Pearce, and R.W. Burley, 1997. Protein gelation', in Damodaran , S. and Paraf , A. (eds), Food Proteins and their Applications , New York: Marcel Dekker, pp. 111-142.*

v. *Oliver, C.M., R.A. Stanley, and L.D. Melton, 2006. Creating proteins with novel functionality via the Maillard reaction - a review. Critical Reviews in Food Science and Nutrition, 46: 337-350.*

vi. *Olmsted, S.S., J.L. Padgett, A.I. Yudin, K.J. Whaley, T.R. Moench, and R.A. Cone, 2001. Diffusion of macromolecules and virus-like particles in human cervical mucus. Biophysical Journal, 81: 1930-1937.*

vii. *Orlov, N.P., I.Y. Kutlina, and O.Y. Didenko, 1991. Changes in chemical composition of onion and garlic during fermentation. Tovarovedenie, 24: 27-29.*

viii. *Pan, X., P. Yao, and M. Jiang, 2007. Simultaneous nanoparticle formation and encapsulation driven by hydrophobic interaction of casein- graft -dextran and β –carotene. Journal of Colloid and Interface Science, 315: 456-463.*

ix. *Park, J.H., Y.K. Park, and E. Park, 2009. Antioxidative and antigenotoxic effects of garlic (Allium sativum L.) prepared by different processing methods. Plant Foods for Human Nutrition, 4: 244–249.*

x. *Park, S.H., S.H. Kim, H.S. Kim, Y.K. Jung, Y.R. Kim, and H.Y. Lee, 2010.*

xi. *Research of S-allyl-(L)-cysteine content changes in aged garlic. In Proceedings of the 2010 ASABE annual international meeting. Pittsburgh, USA. pp. 4506-4512.*

xii. *Paul, C., M. Louis, S. Jean-Bosco, J.V. Arnold, and V.B. Dirk, 2005 . Bioassay for antibacterial and antifungal activities. Laboratory for Microbiology, Parasitology and Hygien, Faculty of Pharmaceutical,*

xiii. *Biomedical and Veterinary Sciences, University of Antwerp, Belgium: 1- 13.*

xiv. *Pawar, S.N. and K.J. Edgar, 2012. Alginate derivatization: a review of chemistry, properties and applications. Biomaterials, 33: 3279–305.*

xv. *Pederson, C.S. 1960. Sauerkraut. In: Chichester, C.O., E.M. Mrak and G.F. Stewart (Editors). Advances in Food research. Academic Press, NewYork, 233-291.*

xvi. *Pham Xuan Phong, 2015. Black garlic has cancer prevention effects on experimental human liver cancer model. Vietnamese Medicine, May (2): 39-42.*

xvii. *Pham Xuan Phong and Ho Anh Son, 2015a. Study on the effects of black garlic programmed cell death on colon cancer cell lines. Vietnamese Medicine, April (1): 4-8.*

xviii. *Pham Xuan Phong and Ho Anh Son, 2015b. Study on cancer inhibitory effect of black garlic in mice with human liver cancer Vietnamese Medicine, April (2): 14-17.*

xix. *Phan, V.A., Y.C. Liao, N. Antille, L. Sagalowicz, F. Robert, and N. Godinot, 2008. Delayed volatile compound release properties of self-assembly structures in emulsions. Journal of Agricultural and Food Chemistry, 56(3): 1072-1077.*

xx. *Põldma, P., T. Tõnutare, A. Viitak, A. Luik, and U. Moor, 2011. Effect of selenium treatment on mineral nutrition, bulb size, and antioxidant properties of garlic (Allium sativum L.). Journal of Agricultural and Food Chemistry, 59(10): 5498–5503.*

xxi. *Polinati, R.M., A.L.K. Faller, and E. Fialho, 2010. The effect of freezing at - 18oC and -70oC with and without ascorbic acid on the stability of antioxidant in extracts of apple and orange fruits. International Journal of Food Science and Technology, 45(9): 1814-1820.*

xxii. *Prasad, K., V.A. Laxdal, M. Yu and B.L. Raney, 1996. Evaluation of hydroxyl radical-scavenging property of garlic. Biochemistry, 154: 55–63.*

xxiii. *Price, R.J. and J.S. Lee, 1970. Inhibition of Pseudomonas species by hydrogen peroxide producing lactobacilli. Journal of Milk and Food Technology, 33: 13-17.*