

Overview of the Black Garlic Movement in the Fields of Research and Marketing

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Abstract: Newly developed black garlic had made a sensational debut with a strong anti-tumor potency proved by the mouse tumor model in 2006 from our laboratory. At that time few researches on it have been conducted due to less popularity of the products even among the researching field. Since then some of the bio-functional works of the black garlic gradually appeared along with gaining of its popularity. Representative bio-activities reported up to now are: (1) enhancement of anti-tumor potency in the mouse tumor model; (2) immune system enforcement, and suppressive act against allergic symptoms caused by decreasing IL-4 cytokine production; (3) bacteria killing potency; (4) anti-oxidant activity; (5) reduction of carcinogenic potency; (6) lowering cholesterol level and preventive work against obesity; (7) controlling high blood pressure; (8) beneficial effect against diabetics; (9) regenerative effect to the burned skin (*Clinical study case*) et al. On the black garlic business (marketing), the Aomori Black Garlic Union (Association) had been established in Aomori Prefecture to offer the citizen high quality, high safety and high security black garlic (products) aiming at contribution for health improvement. All union members are now exerting themselves to the most to attain the high quality production of the black garlic. The quality proving certification seal will be issued to the products that passed the quality approval test by the third party inspections to place it on the their products. This system is now effectively working to guarantee the garlic quality and differentiate the Union member's products from others at the markets.

Key words: Black garlic, anti-tumor potency, anti-oxidant activity, anti-bacterial act, black garlic union, quality approval test.

1. Introduction

Citizen's upsurge of interest is now toward the functional foods with possible expectation to decrease incidence of the lifestyle-related diseases by the functions of the foods. The Ministry of Health and Welfare in Japan has lately stated that the modification of the daily diet style can lower the incidence of variety of lifestyle-related diseases, eventually large reduction of the government annual budget.

In 1999, the miracle vegetable with multi-biological functions "Black garlic" was created by Japanese Mr. Kamimura in Mie prefecture Japan [1], being characteristic with sweet taste as a fruit, no pungent odor, and directly edible just after peeling off outer

coat. It was really a revolution in the field of vegetable and food world.

The number of the black garlic companies now reaches over 500 just in Japan, and some of them expand their business in building of black garlic making plants in foreign countries. The black garlic is easily creating just by controlling of temperature and humidity with no use of additives in the conditioned circumstances.

In 2006 we had first demonstrated presence of the strong anti-tumor potency in the black garlic using a mouse tumor model (Fig. 1). This report had much accelerated the people's healthy preference with hope that they could control their health conditions just by ingesting this miracle vegetable—black garlic.

Almost ten years have passed since the black garlic function had been introduced in the newspaper, the author overviewed the worldwide movements of the

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Fig. 1 Anti-tumor activity of the black garlic was reported in Newspaper on the Mutsu Shinpo, March 22, 2006.

black garlic from both aspects of researches and new business in this paper.

2. Historical Background of the Black Garlic

Concerning history of the black garlic appeared on the home page of Web site [2], it is described likely

“Black garlic has gained popularity in Japan after a research showing its health benefits was published in 2006 (Fig. 1). Researcher, Jinito Sasaki, a professor at Hirosaki University. The research showed that black garlic reduced cancer cells in mouse. When the same research was conducted using white garlic, it didn’t have the same result”.

In the first edition of Wikipedia, the black garlic was introduced likely that “Japanese had developed black garlic in 2005”.

However in the revised edition this part of descriptions was completely deleted, and started likely “In Korea, black garlic was introduced as a health product”. People therefore believe that the black garlic was created by Korean. This incorrect information is now spreading worldwide.

Black garlic creation was attained by Japanese Mr. Kamimura in Mie Prefecture in 1999 as introduced above, and he had acquired the manufacturing patent of the black from the Japan Patent Office.

3. Survey of Black Garlic Researches and the Related

Since the anti-tumor potency of the black garlic had been introduced in the Newspaper 2006 (Fig. 1) and published in journal 2007 [3], the citizens and researchers have fascinated to the black garlic with miracle bio-functions. Especially the post-operative cancer patients have started to ingest expecting metastasis prevention due to enforcement of NK cells activity that had been reported in the animal test.

Currently the average people are making their own black garlic as a hobby by using the electric-rice cooker.

3.1 What’s the Black Garlic? Ugly but Delicious with Beneficial Bio-functions

Here in a brief introduction of the black garlic’s profile appeared at the black garlic home page [4].

“It is learned that the fermented black garlic was made of selected fresh and high-quality raw garlic, using Japanese unique professional approach and carefully processed required for a month which improve the nutrition of the garlic and eliminate the unpleasant odor of garlic to make it easy to accept. Fermented black garlic was researched by Mie



Fig. 2 Black garlic filled with multibio-functions.



Fig. 3 Feature of the high quality Japanese Garlic called “White Six Cloves” (right) developed by Japanese researcher, and Chinese garlic as reference (left). Japanese one is easily recognizable by its size and number of cloves inside.

Prefecture, Japan in 2003. Professor Sasaki Jin-Ichi, the famous Japanese physician in School of Medicine of Hirosaki University, proved through a mice experiment that the active ingredient of black garlic can improve immunity which has a strong inhibitory on cancer cells”.

3.2 Bio-functions of the Black Garlic

Beneficial bio-functions of the black garlic were briefly introduced below for understanding true characters.

3.2.1 Tumor Therapeutic Potency Reported by the Hirosaki University

The first report of the bio-functions on the black garlic was independently issued in 2007 from the two universities in Japan, the Hirosaki University [3] (Table 1) and the Fujita Hoken Eisei University [5]. The Hirosaki University’s work was on the tumor

therapeutic act and the other was on the anti-carcinogenic potency by the Fujita Hoken Eisei University that was briefly introduced in the following 2-2-2 section in this text.

The boiled water extracts of the black garlic attained 50% cure rate in the mouse model and average tumor size of the non-cured mice was 47.5% to that of control. By contrast the fresh garlic extracts failed in deletion of transplanted tumor as shown in Table 1, implying surely the presence of therapeutic ingredients in the processed black garlic.

An osteopathic physician Dr. Joseph Mercola introduced the experimental results in his home page [4].

“Another little-known anecdote is that black garlic, which is basically fermented garlic, may be even healthier than other forms. In 2009 mouse study, Japanese researchers found that black garlic was more effective than fresh garlic in reducing size of tumors, for instance. The study was published in the journal *Medicinal and Aromatic Plant Science and Technology* [3]. In another study, black garlic was found to have twice the antioxidant levels as fresh garlic-the aging/fermenting process appears to double the antioxidants”.

3.2.2 Anti-carcinogenic Report from the Fujita Hoken Eisei University in Japan

In 2007 another report on the anti-carcinogenic activity of the black garlic was issued in the journal by the Fijita Hoken Eisei University (Prof. Shimpo’s research group) using the 1,2-dimethyl hydrazine (DMH)-induced premalignant lesion model in the rat colon [5]. The outcome was:

Table 1 Tumor therapeutic potency of the back garlic (extracts) against Meth AFibrosarcoma of Balb/c mouse.

Sample	Dosage	No cured/No mice used	Tumor size of the non-cured against that of control
Black g.	1 mg	5/10	47.5%
Control	(-)	0/5	100
(Reference)			
Fresh g.	5 mg	0/5	64%
Control	(-)	0/5	100

*Tumor transplanted mouse was treated by the test samples 3 times injection as therapy after tumor cells transplantation, and left three weeks without further therapy till anti-tumor evaluation.

“In the 5% black garlic-fed group for 6 weeks, numbers of premalignant lesion decreased compared with those in the control group given DMH alone. Feeding 5% black garlic to rats did not affect hematological and serum biochemistry parameters in the tested rats”.

The author presently considers that one of the major ingredients for cancer therapeutic and anti-carcinogenic activities is the SAC (S-allyl-L-cysteine) that was created during the garlic processing. This speculation does not necessarily deny other elements association to fight cancer cells.

3.3 Immune System Boosting and Suppression of Allergic Symptoms

In previous studies of the tumor therapeutic action of the black garlic results suggested that anti-tumor action could be led via an enhancement of the immune system. To ascertain the presumption an additional experiment was designed, and immune system enhancement was surely confirmed in the black garlic-fed mouse certainly raised as shown in Fig. 4, along with increasing generation of the cytokine IFN,

TNF, NO, and IL-2 (not shown here) [6].

However cytokine IL-4 took different behavior by decreasing its production in the black garlic-fed mouse. Cytokine IL-4 promotes the proliferation and differentiation of B-cells that eventually result in enforcement of allergic symptoms by increasing production of allergic antibody IgE. Lowering of IL-4 production (amount) probably represents the allergic disease suppression. The experimental results in mouse model were well corresponded with the humans clinical cases. It is known that daily taking of the black garlic improved the allergic symptoms in the patients. Additional experiments should be designed to answer this question.

3.4 Bacteria-Killing Potency

Anti-bacterial potency was admitted in the extracts of the black garlic against MRSA (Methicillin-Resistant *Staphylococcus aureus*), enterohemorrhagic *E. coli* O157, *Pseudomonas spp.* (a causative agent of opportunistic infection), *Candida albicans*. However bacteria killing potency was less than that of general fresh garlic. Difference in its activity between them

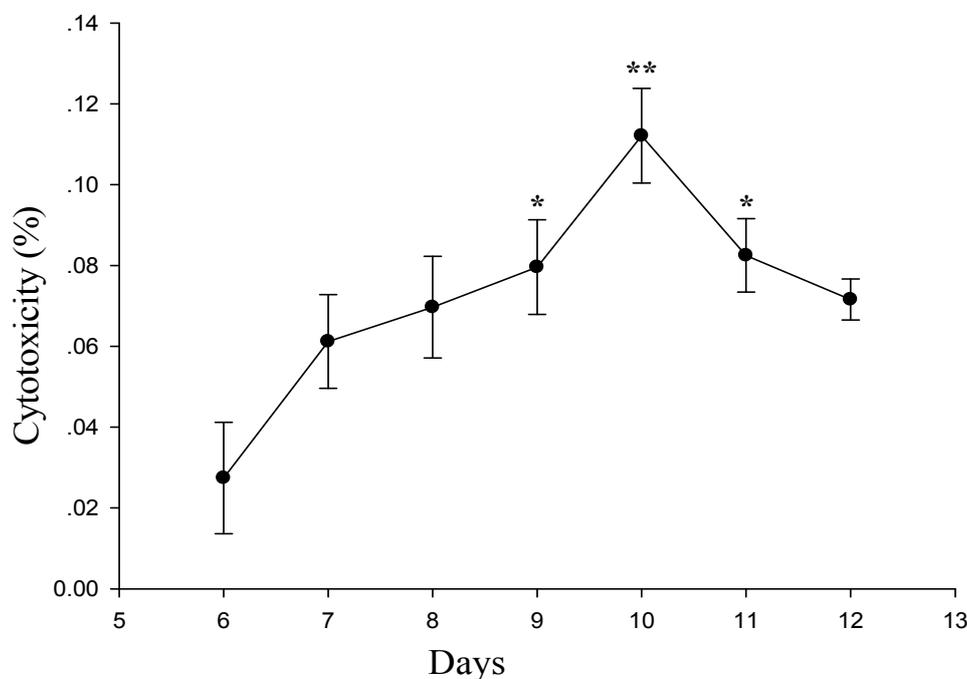
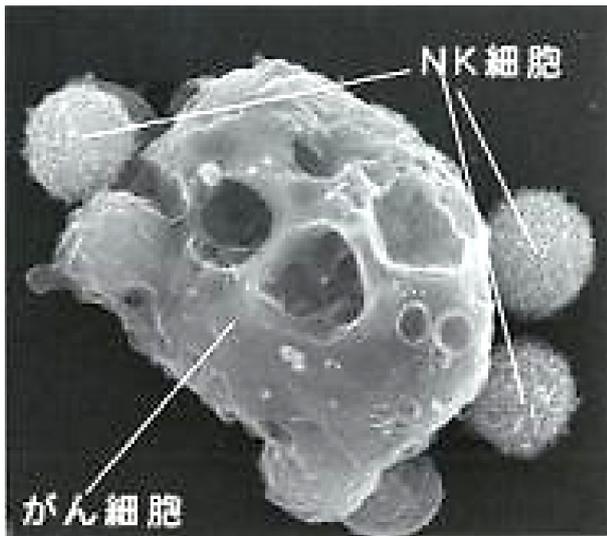


Fig. 4 Increasing NK cells activity in the cell culture system constructed from the black garlic-fed mouse.



(米国法人蓮見国際研究財団)

(HASUMI International Research Center in USA)

Fig. 5 NK cells fighting against tumor cell to create holes that led tumor cell to death.

might be caused by different amount of volatile *allicin* contained, which was powerful bacteria killing agent. Great benefit of the black garlic is to have worked to the drug resistant MRSA [3].

3.5 Antioxidant Act

Antioxidant either in the form of natural material extracts or chemical constituents are very effective to prevent the destructive process caused by oxidative stress [7]. It is worth noting that the black garlic had the strongest antioxidant properties among a large number of medical plants and vegetables that effectively work as anti-aging and anti-carcinogenic to protect body from harmful chemical attacks (Table 2).

3.6 High Content of GABA in Black Garlic; Improvement of Brain Disorder?

Lately the Aomori Prefectural Industrial Technology Research Center in Japan had found the high content of the GABA (γ -aminobutyric acid) at 8-70mg/100gr in the processed black garlic. It exceeded amount of the germinated brown rice known as the highest content of the GABA at 10mg/100gr.

The compound GABA serves as a neurotransmitter

Table 2 Anti-oxidative potency of black garlic (*RS50%)

Sample	Black Garlic	Fresh Garlic
Japanese	4.1 mg	114.9 mg
Chinese	7.3	88.5

*Milligram used to reduce 50% of 1.1-diphenyl-2-picrylhydrazyl.

in central nervous system in humans, and deficiency of it can cause various brain disorder such as Parkinson disease et al [8]. Beneficial bio-functional effects of the black garlic will be expected against the central nervous disorder with no therapeutic or disease preventive ways. Yet the common belief among scientists is that GABA will not cross the blood brain barrier, and not be carried in the brain. This kind of urgent and critical important tasks will soon start at the above center under the financial support of the local government.

Additional new finding was that the pyroglutamic acid that has amnesia-preventive action in rats, improvement of learning in age-associated and alcohol-induced memory loss [9] increased in the black garlic by processing. These new information provided encouraged the black garlic manufacturing companies to do their best for their business.

3.7 Additional Major Bio-functions Reported up to Now

- Detoxification activity (Japan 2008);
- Anti-fatigue effect in mouse experiment (Pharmaceutical company Japan 2008)
- Effect against acute alcohol-induced hangover and chronic alcohol-induced liver injury (Korea 2009)
- Decrease the cholesterol level and obesity of body (Korea 2009)
- Control high blood pressure (Australia 2010)
- Regenerative of therapy of burn damaged skin (Clinical study case Malaysia);
- Liver protective effect (Korea 2010);
- Control of diabetics and sugar disease (Korea 2010, India 2013).

**黒ニンニク 強い抗がん作用に加え
ストレス抑制成分含有**

青森県内の 研究者団体の 研究成果生かし販売

ニンニクを熟成・発酵させた「黒ニンニク」に、脳の代謝を促したり、ストレスを軽減する効果を持つ「GABA（γ-アミノ酪酸）」や「セサミン」などの有効成分が含まれていることが、青森県産業技術センター 農産物加工研究所の研究で明らかになった。強い抗がん作用に加え、体に良い多様な成分が確認されたことで、消費拡大の期待が高まっている。

黒ニンニク製造業者 徳島大学研究員が、ニンニクの製造過程で、10団体でつくる黒ニンニク1年産から採れた「GABA」や「セサミン」の含有量を分析した結果を発表した。GABAはストレス抑制作用だけでなく、抗酸化作用や、免疫力向上、抗がん作用など、さまざまな効果があることが明らかになった。

徳島大学農学部長と中村 分を名乗る。黒ニンニクは「ストレス抑制成分が豊富に含まれていることが確認された」「青森の黒ニンニク」

また、メタボリック症候群にも有用な可能性もあり、今後、研究を進めるといふ。一方、免疫力を高めたり、成長ホルモンの分泌を促進したりするアルルニンが、黒ニンニクに豊富に含まれていることが確認された。GABAの成分量は、乾燥によって大きく減少するが、原料や製造方法で変わる可能性があるという。

青森県産の黒ニンニクは、熟成が進むと低下する水素イオン指数（pH）を、9前後を目安にして製造するが、今回の調査で、黒ニンニクは「まず、健康食品として、規格化を目標とする。健康食品としての機能を高める」とも話している。

同協会は「青森の黒ニンニク」をブランドとして地域内外の産地を支援する。徳島大学は「黒ニンニク」の研究を進めるといふ。研究成果を生かして、黒ニンニクの販売促進につなげたい」と期待を込めた。

Fig. 6 Higher content of GABA (γ -aminobutyric acid) in the black garlic that works to reduce stress (March 28, 2014).

4. Clinical Case Reports from Clients

CASE 1: Oil painter Choo Keng Kwang, 81, has been eating around half a bulb of black garlic for the past few months. Mr. Choo who suffers from psoriasis-a skin disease which results in itchy red patches or flaky scales, decided to give the herb a try after seeing a newspaper advertisement for it. He says in Mandarin: “The effect was obvious. After three to four days of consuming black garlic, the red patches disappear. Previously, I’ve tried many skin creams given by doctors and they were not effective”. (www.hardwarezone.com.sg)

CASE 2: Singapore General Hospital dietitian Tan Ai Shan says “Unlike fresh garlic, black garlic is sweeter in taste. The pungent smell and spiciness in fresh garlic is removed during the fermentation process. She pointed to experiments conducted by Japanese researchers in 2007 which suggest that black garlic is more effective in reducing the size of tumor in laboratory mice. The study was published in a

Global Science Book Journal about medicinal plant science”.

(www.sgh.com.sg > Home > About Us > Newsroom)

CASE 3: Fermented garlic has greater health benefits than the common varieties, says nutritionist Velumani Deepapriva of the Singapore Nutrition and Dietetics Association. “Especially in improving blood circulation and increasing antioxidant levels in the body”. She adds. (beforeitsnews.com/.../aged-black-garlic-a-new-superfood)

CASE 4: Business consultant and part-time marathon runner Edward Goh, 50, started eating black garlic last June to lower in cholesterol level. His cholesterol was high at 250 mg/dL. According to the Singapore Heart Foundation’s guide lines, an average adult should maintain his total cholesterol level at less than 200 mg/dL.

(www.sgh.com.sg > Home > About Us > Newsroom)

CASE 5: Mr. Kondoin Guatapara Brazil made the black garlic at home just to distribute his acquaintance prepared by an electric rice-cooker. Local newspaper introduced the black garlic as “Alho Negro” and currently restaurant and supermarket have started to deal in the black garlic. Mr. Kondo recently appears to start business as the black garlic dealer (Fig. 7).

(www.nikkeishimbun.com.br/nikkei/html/show/120719-61colonia.html)

Headline; Kondo’s black garlic in Guatapara Brazil showed ten times more of anti-oxidative activity than that of general garlic.

5. Establishment of the Aomori Black Garlic Union to Manufacture High Quality and High Secure Black Garlic in Japan

On March 2006, the black garlic had made a sensational debut in the field of foods via the Japanese Newspapers and TV. Thereafter an increasing number of companies started to manufacture the black garlic as a new business using advantage of news reported on the black garlic. Some companies had shifted their black garlic plants from Japan to the oversea seeking after inexpensive garlic and low-cost of labors.

発酵黒にんにくをどうぞ！ =グアタパラ近藤さんが生産・販売 中 =抗酸化作用は生の10倍

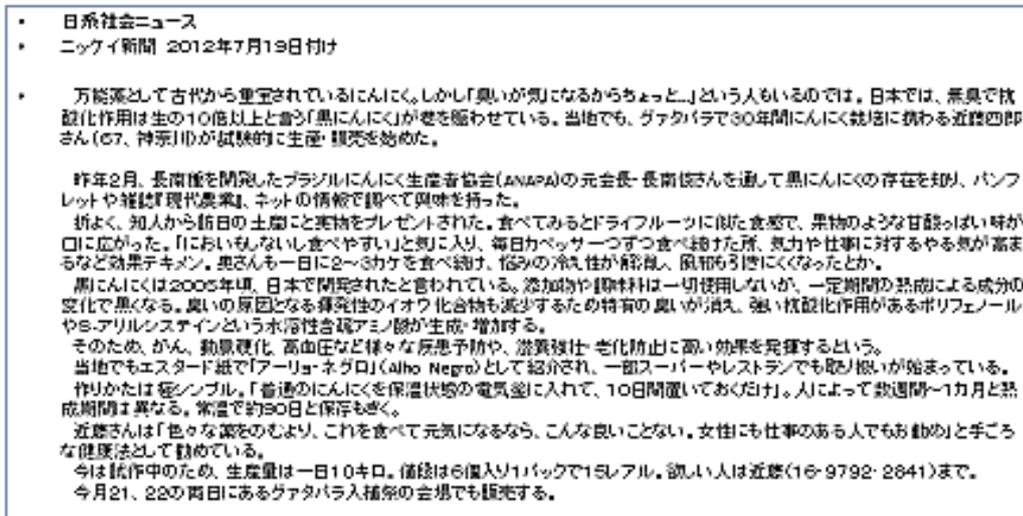


Fig. 7 Japanese-Newspaper in Brazil reported black garlic production by the emigrant Mr. Kondo.

In connection with increase of companies, the product-related troubles had occasionally occurred likely to have used illegally agricultural chemicals that were strictly controlled in our country. Japanese are especially sensitive to these kinds of problems that directly affect family member's health. When purchasing agricultural products at the supermarket they first confirm the country of origin, and read carefully data of chemical analysis placed on for safety. Actually Japanese had experienced in the past severe intoxication affair due to high contamination of the illegal chemicals in the imported products.

Since then, the black garlic companies in Aomori prefecture were considering establishment of “the Aomori Black Garlic Union” to supply the safe products to the citizens [10]. The member's companies in Union were making more of exertions to fulfill the Union's demands to gain citizen's credit. When their products are passed the Union's inspection organized by the third party examinees, the certificate seal below will be given to the company to place on their products (Fig. 8).

The quality inspection system is now effectively working to guarantee the Aomori black garlic quality, along with differentiation of the Union member's products from others. Home-made products currently prevailed among citizens are heterogeneous in quality, color, testy, and they are likely to be a half-raw material (Fig. 9) due to the incomplete processing manners. These sorts of the defectives are hard to eat with the remained pungent odor, lacking of sweetness, and will result in loss of the black garlic customers.



Fig. 8 “Authorized Warranty Emblem” issued by “Black Garlic Society of Aomori”. This seal secures “Safety and Security of the black garlic”.



Fig. 9 Insufficient processing manners created this sort of defective (by Caroline Hatchett).

At that time of the Fukushima Nuclear Power Plant explosion, the radioactive contamination assessment

standard on foods had not enacted in Japan. After plants explosion the rumor damages rapidly grew and the citizens hesitated to purchase the agricultural and fisheries products shipped from Fukushima and neighboring prefectures [11]. Foreigners living in Tokyo and around had evacuated immediately to the home countries, and some of them never came back again. To clear up the rumor damages of radioactive pollution on foods the public inspection center started to measure all foods before shipping to offer people security with “the Radiological Testing Inspection Certificates”. The black garlic was also not exception



ドイツ、フォルクスワーゲン
本社工場のある街、
ヴォルフスブルクにある最高級ホテル
リッツカールトンホテル。



運河に面しているので
レストランの名前も「水」を
意味する「Aqua:アクア」で

Fig. 10 “Takko Shoji’s products” are served at cuisine of the 3 Star Hotel in German.



Fig. 11 Nuclear power plant explosion due to disorder of cooling system caused by Tsunami.

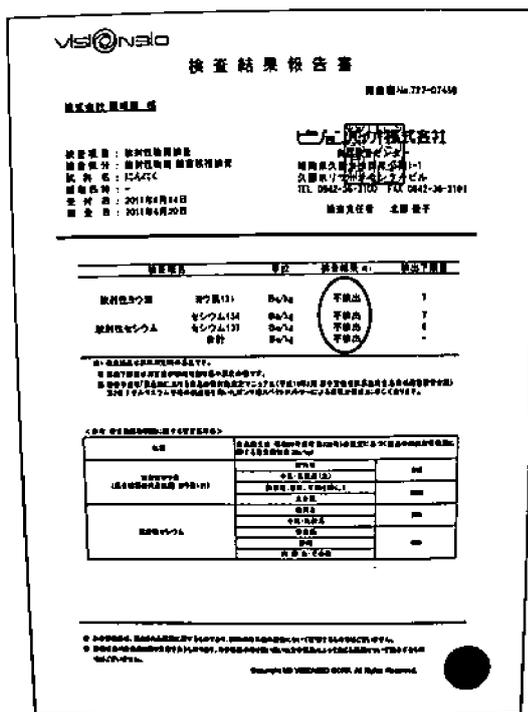


Fig. 12 Safety proof certificate issued by the government authorized inspection center in Japan against the radioactive pollution of the black garlic.

even in Aomori prefecture, where was located in 500 km north from Fukushima plants. The Union member’s companies voluntarily measured radioactivity on their products, and shipped to the markets along with the safe certificate as shown in Fig. 12.

6. Discussion

The novel type of vegetable, the black garlic, rose up its name among the citizens in both domestic and foreign countries because of plenty of beneficial bio-functions as listed in the text along with the personal experiences. At the moment the black garlic is less recognizable even among the scientific researchers, and most of them know nothing about it.

However its popularity is increasing among the citizens and scientists, and some scientists are initiating experiments on the black garlic currently. One of the latest new findings was the higher content of the GABA (γ -amino-butyric acid) in the processed black garlic.

This compound is critical important as a neurotransmitter in central nervous system as described above. Alzheimer and Dementia are representative brain disorders at the aged. Deficiency of GABA in brain causes various mental diseases as anxiety disorders likely to be panic attacks, headaches, Parkinson disease, and can also cause depression, insomnia, and epilepsy. Japanese researchers lately initiate bio-functional works of the black garlic for restoration of the damaged nervous systems.

Researchers in broad areas should co-work to try to find new functional ingredients in the natural product [12] to overcome the intractable diseases such as cancer, brain disorder et al.

Additionally ubiquitous urgent requirement in the black garlic is the organization of the national and/or international association to establish the safety guideline of the products to avoid the unexpected problems.

7. Conclusion

Present state of the novel vegetable “Black Garlic” was reviewed from both aspects of scientific and business fields. An increasing number of the black garlic companies are now growing to cultivate their market places around the world repeating the heat competition. Excessive competition eventually resulted in sales at low price of the defective products in the markets by ignoring of safe and security of the products. To avoid this kind of the problems experienced in the past, the black garlic related companies have to perform their duties conscientiously to contribute to the nation’s health promotion.

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