

Functional Sesame

Young sesame leaves cultivated on black volcanic ashes from the Satsuma Peninsula and grown in its temperate climate.

Young sesame leaves

Young sesame leaves which contain acteoside.

Over a period of approximately 100 days starting in June when sesame seeding starts, sesame plants grow to be more than one meter high and have an abundance of fresh green leaves. It has recently been discovered that these sesame leaves have strong oxidation properties and a number of other health promoting benefits that cannot be found in other green juices. At present, several tons of young sesame leaves are carefully being cultivated every year in Kagoshima and Shimane prefectures without the use of pesticides or chemical fertilizers.



■ Comparison of components between young sesame leaves and other green juices

Young sesame leaves are rich in minerals and nutrients, especially in iron, folic acid, potassium, calcium, magnesium, and β carotene. In addition, radical oxygen scavenging activities by SOD (Superoxide Dismutase) were confirmed in young sesame leaves.

Table comparing the components of young sesame leaf powders to other powders

(Values shown below are per 100 grams except for the value of super-oxide scavenging activities)

Analysis test items	Young sesame leaf powders	Barley young leaf powders	Kale powders
Moisture	8.0 g	5.4 g	4.5 g
Iron	16.6 mg	20.6 mg	5.5 mg
Folic acid	760 μ g	290 μ g	540 μ g
Calcium	1360 mg	429 mg	1530 mg
Potassium	4900 mg	1430 mg	2170 mg
Magnesium	477 mg	142 mg	248 mg
Vitamin A (amount of retinol)	187 μ g	72 μ g	206 μ g
α -carotene	40 μ g	Not detected	Not detected
β -carotene	2220 μ g	864 μ g	2470 μ g
Riboflavin (vitamin B)	1.40 mg	0.85 mg	0.81 mg
Vitamin E (α -tocopherol)	4.2 mg	3.4 mg	8.7 mg
Lutein	11.3 mg	9.17 mg	9.25 mg
Superoxide scavenging activity	1500 points /g	80 points/g	630 points/g
Polyphenol	1300 mg	600 mg	860 mg

Interview with Mr. Omagari, President

It takes about 40 minutes by ferry, passing Sakurajima Island to reach Shikanai. Shikanai is the second largest production area for young sesame leaves in Japan.

We conducted an interview with Mr. Shuji Omagari, the president of the company. Here at Shikanai, Mr. Omagari manages the production, drying and powdering processes of young sesame leaves.

■ It is said that sesame production only makes up 0.1% of all domestically produced crops and that it is quite difficult to produce sesame seeds and young leaves. Is that true?

Generally speaking, sesame is a difficult crop for farmers to make a profit on, both domestically and abroad. However, in recent years, an added value of sesame is beginning to be recognized by people since it is produced without the use of pesticides and chemical fertilizers. We are encouraged by this market trend as the care we take when cultivating sesame is so important to us.

■ The amount of polyphenol peaks when the plant reaches a height of 30 to 90 centimeters.

Another important point in cultivating sesame is that young leaves should be harvested at a certain time before the seeds bear fruits.

From the beginning, we have harvested young sesame leaves before the stems become thick and stiff. Overtime it became known that the amount of polyphenol (Acteocide) peaks when sesame plants attain a height of 30 to 90 centimeters. This was found out through the research conducted by universities and companies with whom we are jointly developing sesame.

Depending on the temperatures for a particular year, we usually start seeding around June, the plants grow until they reach a height of 70 to 90 centimeters after two and a half months. We pay a lot of attention to the height of plants for harvesting.

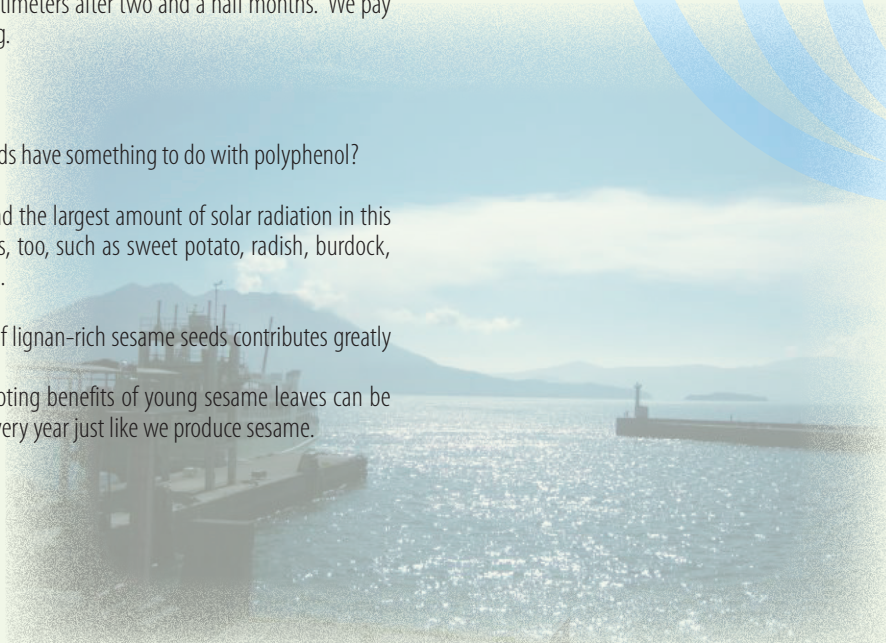
■ Synergetic effects of lignan-rich sesame and soils

Do the components of the soil and cultivation methods have something to do with polyphenol?

The black volcanic ashes of Kagoshima prefecture and the largest amount of solar radiation in this area are quite suitable for growing other vegetables, too, such as sweet potato, radish, burdock, carrot, cabbage, taro, spinach, onion and green onion.

In recent years, it has also been confirmed that use of lignan-rich sesame seeds contributes greatly to production of high quality young leaves.

We do hope that more and more new health promoting benefits of young sesame leaves can be found in the future and that we can cultivate them every year just like we produce sesame.



Sesame produced in Kagoshima and Shimane prefectures is lignan-rich sesame produced in the temperate zones.

Sesame can be divided into two categories: one is sesame produced in tropical zones and the other is that produced in temperate zones.

The sesame produced in Japan belongs to the latter group. If we try to produce the tropical type of sesame in Japan, the crop will fail. The plant will keep growing higher and higher, and will eventually wither without many flowers. For the cultivation of young leaves we now use lignan black sesame as the raw material. Within one month of seeding, young plants grow to a height of 30 centimeters. Around August, their growth rate accelerates to between two and three centimeters per day.

(The picture on the right shows young sesame leaves grown organically in Shimane prefecture.)

Dry powders are carefully produced after the cultivation of young sesame leaves.

1) Leaves fresh from harvest
(★Sample①)



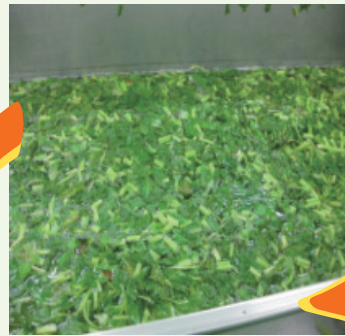
2) Cleaning with cold water



3) Cutting



5) Soaking in cold water
(color fixing)
(★Sample k)



4) Smothering process



6) Dehydration



7) Dry process



※ During the dry process, the utmost care is taken to prevent the amount of polyphenol from decreasing or decoloration from occurring in the leaves.

Anti-oxidant properties of young sesame leaves

It has been confirmed that the young sesame leaves contain polyphenol with strong anti-oxidant properties.

An 80% ethanol extraction liquid was prepared from each powder sample in order to evaluate their anti-oxidant properties in relation to three radical scavenging methods (DPPH radical scavenging method, ABTS radical scavenging method, and WST-1 method based on super-oxide anion radical scavenging.)

In the results, it was found that in every evaluation method, mulberry leaves came top in terms of the highest level of anti-oxidant properties followed by sesame leaves, then kale leaves, and finally burley leaves.

It was assumed that the variation in anti-oxidant properties had resulted from the amount of polyphenol contained in each sample, and so it was decided to calculate the amounts of polyphenol in each sample, using the Folin-Chiocalteu method. As shown in table 2, the order for the amount of polyphenol matched perfectly the extent of each sample's anti-oxidant properties. In other words, mulberry leaves came top and contained the largest amount of polyphenol. These were followed by sesame leaves, kale leaves, and finally burley leaves. We also compared the anti-oxidant properties per amount of polyphenol. The result showed that, in this respect, sesame leaves and mulberry leaves were almost equal or in some cases the sesame leaves had greater anti-oxidant properties than those of the mulberry leaves.

Table 1. Solubility to 80% EtOH(%)

Sesame	15.93 ± 0.83
Burley	6.84 ± 0.10
Kale	9.64 ± 0.28
Mulberry	19.07 ± 1.29

Table 2. Content of polyphenol (%)

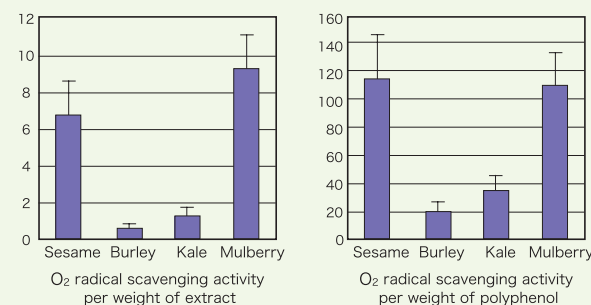
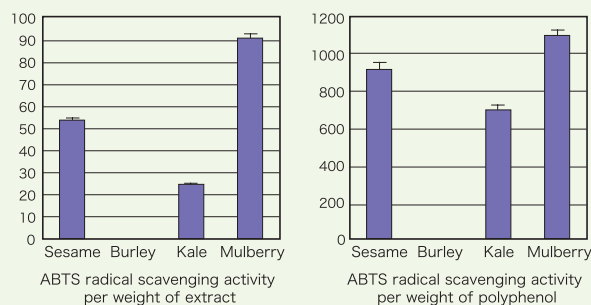
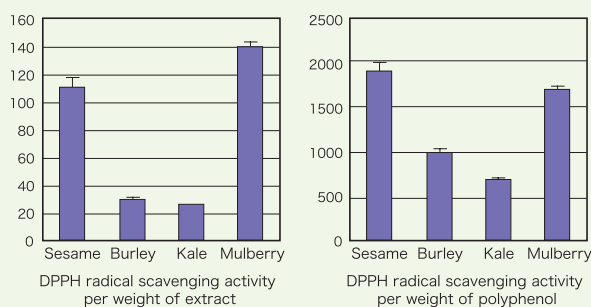
Sesame	0.939 ± 0.046
Burley	0.204 ± 0.005
Kale	0.361 ± 0.006
Mulberry	1.593 ± 0.006

■ Anti-oxidant properties of young sesame leaves are compared against those of other vegetables and fruits. (The values based on the DPPH method refer to intensity of radical scavenging activities.)

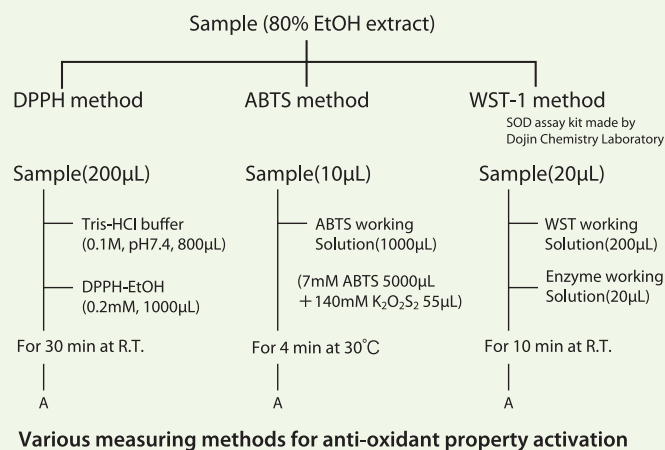
Fruits, vegetables, seaweed, rice	μmol Trolox equivalent/g
Fig	22.0
Japanese persimmon(Maekawa Jiro: brand name of persimmon)	12.6
Japanese persimmon(Rendaiji: name of a variety)	26.5
Plum(Shira kaga: name of a variety)	30.6
Large purple-black grape	68.4
Unshu mandarin orange	19.3
Spinach (Asajiri: name of a variety)	14.9
Molokheiya (leaves, leaf stem, stem)	84.7
Gumbo	68.4
Takana (Red large leaf)	22.9
Tomato (House Momotaro: name of a variety)	13.3
Japanese basil (leaf and leaf stem)	343.4
Forbidden rice (Brown rice)	6.5
Hijiki seaweed	188.4
<i>Sesame young leaf powders</i>	<i>70.7</i>

(Dry food per gram)

The values for vegetables and fruits are cited from Mie prefecture Science Technology Promotion Center, Industrial Research Department Report No.31 (2007) and No. 32 (2008). *The values for young sesame leaves were calculated based on the value per powder weight, 0.0177 mg trolox equivalent/mg.



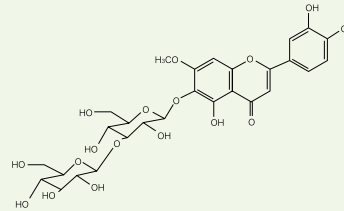
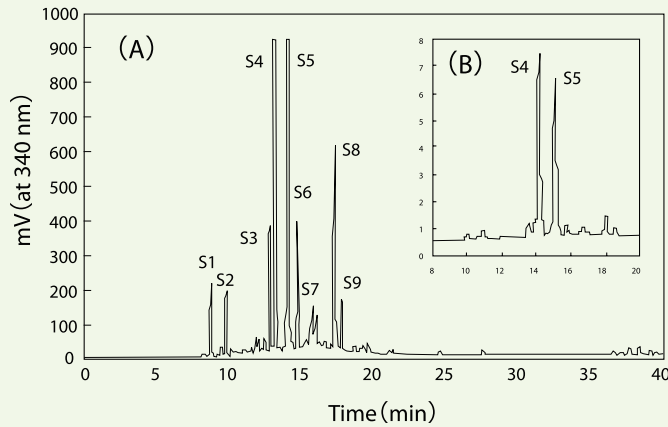
■ Comparison of anti-oxidant activities of sesame, burley, kale and mulberry as per weight of polyphenol



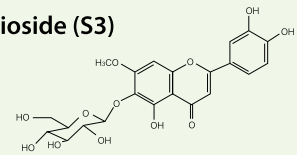
Polyphenol in young sesame leaves

So far, seven types of polyphenol have been confirmed to exist in young sesame leaves. Major polyphenols confirmed are acteoside (S5) and pedalitin (S4).

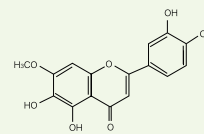
Polyphenol contained in young sesame leaves (sterilized and pulverized leaves)



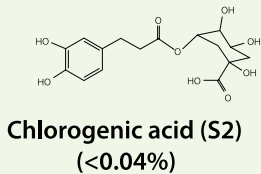
Pedalitin-6-O laminaribioside (S3)
(0.06%)



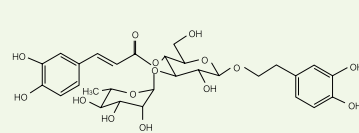
Pedalitin-6-O glucoside (Pedalitin)(S4)
(0.67%)



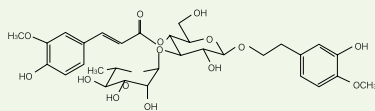
Pedalitin (S8)
(0.09%)



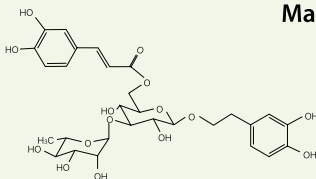
Chlorogenic acid (S2)
(<0.04%)



Acteoside (S5)
(1.16%)

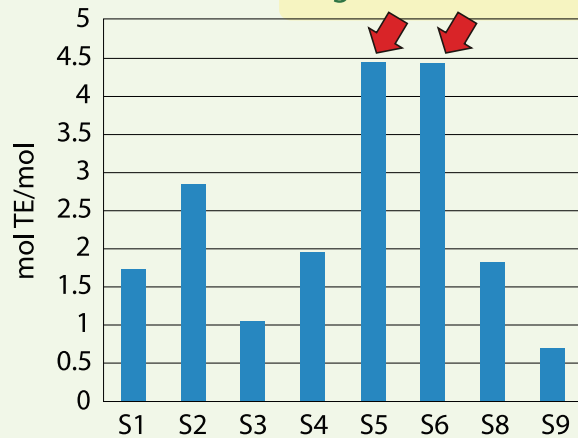


Martinoside (S9)
(0.03%)



Isoacteoside (S6)
(0.09%)

S5 and S6 show high anti-oxidative activity

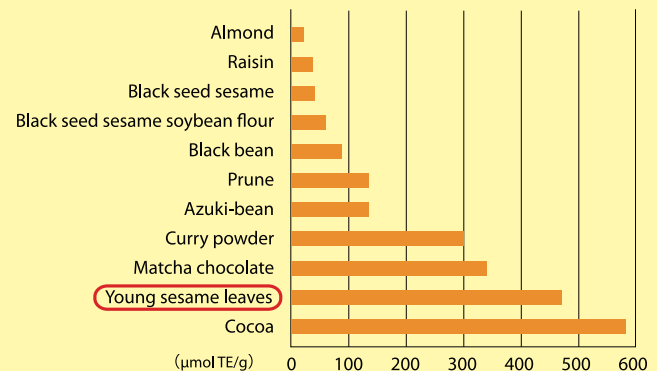


DPPH anti-oxidative activity of polyphenol contained in young sesame leaves

■ **ORAC (Oxygen Radical Absorption Capacity) values that represent anti-oxidative property.**

* Please refer to the graph on the right.

Young sesame leaves show 470 $\mu\text{mol TE/g}$, a higher ORAC value than that of many other food products. The values on the graph show the absorption capacity of radical oxygen.



* All values except for those of young sesame leaves and matcha chocolate powders cited from "Starch and food items, Issue No. 37."

* Young sesame leaf production lot 110125, produced in Shimane prefecture, was used. Analysis organization: Japan Food Analysis Center Foundation. No. 11101576001-01

The polyphenol called Acteoside

Acteoside is a polyphenol contained in olives and other fruits. Acteoside has an antioxidant effect 15 times stronger than that of resveratrol, another polyphenol contained in red wine. Acteoside also has an antioxidant effect five times greater than that of vitamin C. In addition Acteoside is said to suppress the activity of α glucosidase, an enzyme that affects the absorption of carbohydrate, and so may help in the reduction of blood-sugar levels.

What are the health benefit of Acteoside?

- ◆ Anti-oxidant effects
- ◆ Tonic effects, prevention of impotency
- ◆ Improvement of sexual functions which have been negatively affected by stress
- ◆ Ability to block cyclooxygenase (COX)-2 related to inflammation
- ◆ Anti-tumor effects
- ◆ Recovery effects of learned behaviors
- ◆ Improved fertility in women
- ◆ Promotion of the production of collagen

L. Li et al., Food Chem., 108, 702-710 (2008). 2000-302797

■ Acteoside

An extremely small amount of acteoside is contained in a variety of herbal plants. Acteoside has various physiological effects.

■ Functions

Anti-oxidant properties
Liver protective effects
Anti-inflammatory effects
Anti-nociceptive effects (pain-relieving effects)
Improvement of sex functions
Sedative effects
Phospholipase A2 blocking effect
5-lipoxygenase blocking effect

■ Future expectations

It is expected to be used in the application of immune suppressors, anti-allergic drugs and antidiabetics.

■ Challenges

Unable to be synthesized in the laboratory
Only extremely small amounts are available in nature.

High expectations exist for the functions and effective utilization of young sesame leaves.

***Cistanche salsa* has been designated as a Class No.2 protected plant in China. However it has become difficult to collect *Cistanche salsa*, so *Cistanche tuberosa* is now used as an alternative.**

■ Desert Ginseng (*Cistanche tuberosa*) is a fleshy stalked plant belonging to the same family as *Cistanche salsa*, Orobanchaceae. It lives on the roots of host Tamarix species, which can grow even in scorching deserts.

■ *Cistanche salsa* had long been treasured and eaten for its health promoting benefits. (*Cistanche salsa* contains 4.8 ~ 15.2mg/g of acteoside.)

■ It was in 2009 that young sesame leaves were found to contain acteoside-approximately 1.28% of the amount found in *Cistanche tubulosa*.

■ *Cistanche deserticola* has been used to cure impotency, infertility, menstrual irregularities such as reduced flow or flooding, and waist and knee psychroalgia. It has also been clinically prescribed as a dietary supplement and to strengthen the kidneys.

■ Which plants contain acteoside?

Acteoside is a phenylpropanoid compound. It is widely known that acteoside is found in variety of plants, especially in herbal plants. It has been reported that acteoside is found in *Conandron ramoidioides*, *Proboscidea louisianica*, *Leucoseptrum japonicum*, *Cistanche herba*, *Stachys sieboldii*, *Plantago asiatica*, *Plantago depressa*, *Rehmanniae radix*, *Olea europaea*, etc.



Cistanche tubulosa



Young sesame leaves



Leucoseptrum japonicum

Dietary effects of sesame leaves

Sesame leaves are often mixed with perilla leaves which are commonly used in Korean cooking. Historically, however, sesame leaves have seldom been eaten. According to the Dictionary of Chinese Medicine (called Chuyaku Daijiten), it is said that if one drinks sesame leaves as a beverage, they are effective in the treatment of diarrhea. In addition, sesame leaves are used in the treatment of paralysis caused by cold, which is often accompanied by muscle pain, arthrosis, uterine hemorrhaging, and hematemesis. The medical effects of sesame leaves are stated therein:

1760 ゴマヨウ

胡麻葉 hu ma ye[神農本草經集注]
【異名】青囊(セイジコウ)・巨勝苗(キョシヨウビョウ) [神農本草經], 蔓(マン)・夢神(ムシン) [吳普本草], 胡麻苗(ゴマビョウ) [壽親養老新書]
【基原】ゴマ科の植物, 脂麻(シマ: 和名ゴマ)の葉。

原植物の詳細は黒脂麻(→1618)を参照。

【成分】乾燥した葉は, 0.3%のペダリンを含む1。

【薬理】葉は植物ゴム質を含み, 水に入れると粘滑剤を形成し, 下痢や痢疾の病人が飲料として用いると刺激を緩和する作用がある1。

【性味】甘, 寒。1[神農本草經] 味は甘, 寒。2[図経本草] 甘, 滑。

【薬効と主治】風寒湿痺, 崩中, 吐血, 外陰搔痒症を治す。1[神農本草經] 五臓の邪氣, 風寒湿痺を治す。氣を益す, 脳髓を補う, 筋骨を堅くする。長く服用すると耳や目が鋭敏になる。2[薬性論] 崩中や血凝が長く続いているものは, 新鮮なものは1升とってつき, 熱湯に入れ, 汁を半升絞り取り服用する。3[千金・食治] 暑気あたりによる発熱を主る。4[図経本草] 大腸を利す。5[本草綱目] 風を去り解毒する, 腸を潤す。また, 糸のようなものがのどに飛び込んだものを治すには, これをかむ。

【用法と用量】<内服>煎じて服用するか, つき汁を服用する。<外用>研って粉末にして乾燥させ塗布する。

【処方例】1 吐血の治療 胡麻の若い茎と葉を煎じ, 砂糖を混ぜて服用する [湖南薬物志]。2 外陰搔痒症の治療 胡麻葉, 朝陽花朱砂(→2448)をとともに研って粉末にし塗布する [湖南薬物志]。

■中薬大辞典より

Medical effects and treatment

■ Sesame leaves can cure various symptoms resulting from disorders of the bowels and other internal organs, as well as problems resulting from the body getting cold. They increase mental toughness, promoting healthy function of the brain and nerves. They also strengthen muscles and bones. However, if taken for a prolonged period, they can damage hearing and vision.

■ For women who have genital disorders or who suffer from chronic melena, it is advised to pick one measure of fresh sesame leaves, put them into hot water and make a hot infusion. Drink it half a dose at a time.

■ Sesame leaves reduce high body temperatures caused by heat.

■ They also have a beneficial effect on the large intestine.

■ They have a warming effect when one is cold, and further moisten the intestine. Also when you feel you have something stuck in your throat, chewing sesame leaves can relieve this.

■ There are some examples where young sesame leaves are used as an ingredient in processed food in China.



History overseas

There are some reports from overseas which show the sesame leaf is used as a vegetable.

INTRODUCTION

Sesamum indicum is an annual plant belonging to the Pedaliaceae family. It is one of the world's most important oil crops grown in developing countries by small holders (FAO, 1993). Its oil, seed and other desirable properties and **young shoots are used as vegetables in soups** (Bokhari and Ahmed, 1999). *S. indicum* grows flamboyantly with good seeding property. It is grown as leafy vegetable in family home gardens and contributes to house hold food security. It also serves as a source of income to families (Rubahaiyo, 1994).

(Reference)

Kubmarawa, D., Andenyang, I. F. H. and Magomya, A. M., Amino acid profile of two non-conventional leafy vegetables, *Sesamum indicum* and *Balanites aegyptiaca*. *Af. J. Biotechnol.*, **7**, 3502-3504 (2008).

■ Sesame leaves from species such as *S. Indicum* and *S. radiatum* are used in Africa and Asia as a traditional and indigenous medicine for the treatment of stomachache, bruising, rashes, catarrh, and sore eyes.

(Reference)

Ahmed, T., Shittu, L. A. J., Bankole, M. A., Shittu, R. K., Adesanya, O. A., Bankole, M. N. and Ashiru, O. A., Comparative studies of the crude extracts of sesame against some common pathogenic microorganisms, *Sci. Res. Essay*, **4**, 584-589 (2009).

Ogunlesi, M., Okie, W. and Osibote, A., Analysis of the essential oil from the leaves of *Sesamum radiatum*, a potential medication for male infertility factor, by gas chromatography – mass spectrometry, *Af. J. Biotechnol.*, **9**, 1060-1067 (2010).

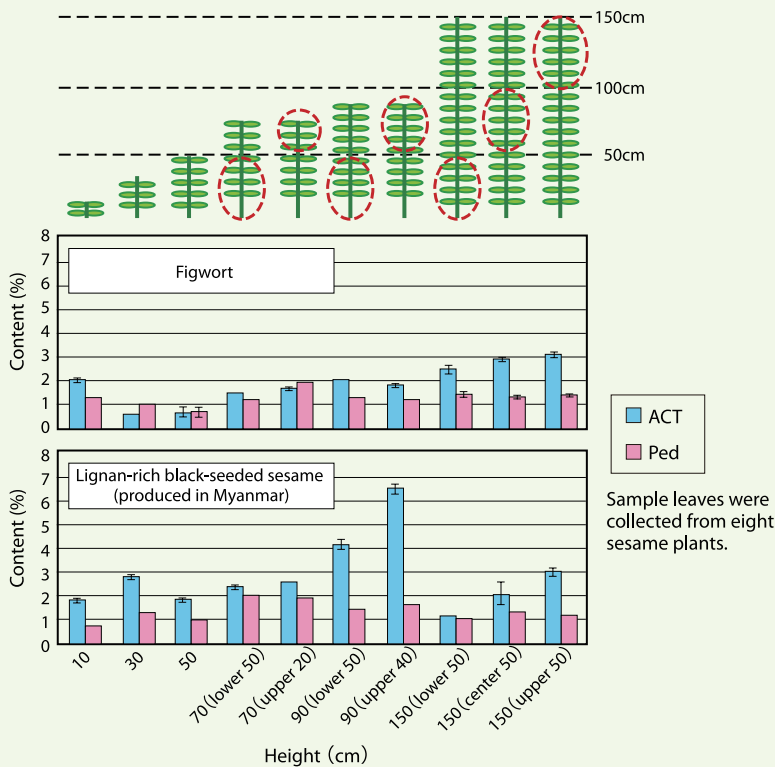
Auwalu, B. M. and Babatunde, F. E., Analyses of growth, yield and fertilization of vegetable sesame (*Sesamum radiatum* Schum). *J. Plant Sci.*, **2**, 108-112 (2007).

Acteoside of young sesame leaves and sesame lignan

It has been confirmed that young sesame leaves contain a large amount of acteoside. The reason for their strong anti-oxidant properties is no longer a mystery.

More interestingly, it has also been found that young sesame leaves cultivated from the lignan-rich black seeded sesame contain higher amounts of acteoside.

Patent applied: (Name of invention) Dried young sesame leaves which contain higher amounts of acteoside, and the extract powders which can be obtained from those leaves.(Patent application No. 2009 248744)
Changes in polyphenol content and thermal stability during the growth of young sesame leaves. Japan Food Science Society 58th Convention (September, 2011)



Changes in the amounts of acteoside and pedalitin contained in the leaves during the growth of figwort.

Lignan as a phenylpropanoid compound

A phenylpropanoid chemical compound is biosynthesized from phenylalanine or tyrosine. Phenylpropanoid is a collective term for chemical compounds with the basic structure C6-C3. They are biosynthesized through the shikimic acid pathway. Those compounds which form lactone with side chains and aromatic rings are called coumalin. If two C6-C3 compounds are condensed, lignan will be created, whereas, if multiple C6-C3 compounds are condensed, lignin will be created.

In particular, Lignin is a component of lignifying cell membranes and is contained in all woody plants. Plants absorb moisture and nutrient elements through their roots and synthesize required components. Flavonoid is another chemical compound belonging to the phenylpropanoid group (cinnamic acid, red portion) that contains benzene ring. It is synthesized using the aromatic amino acids phenylalanine or tyrosine with shikimic acid a raw material.

Category of compounds	Compounds (origin of plants)
Polyphenol	Catechins such as EGCG (green tea, etc.), flavonoids such as quercetin and luteolin (many kinds of fruits and vegetables), isoflavonoids such as genistein and daidzein (soy bean, etc.), dianisidine and anthocyanin (many kinds of vegetables and fruits), and resveratrol which is present in fruits such as grapes.
Phenylpropanoid	Coffeic acid (many kinds of fruits and vegetables), ACA (greater galangal), auraptene (citrus fruits), and sesaminol (sesame)
Terpenoid	Limonen (citrus fruits), perillyl alcohol (citrus fruits), zerumbone (wild ginger), ursolic acid (plants of lamiaceae and rosaceae family), various types of carotenoid (many kinds of fruits and vegetables)
Curcuminoid	Curcumin (turmeric, etc.)
Sulfur-containing compounds	Sulforaphane (plants of the brassicaceae family), many kinds of sulfides (plants of liliaceae family and of the genus allium such as garlics)
Nitrogen-containing compounds	13C (brassicaceae family)
Others	Anti-oxidant vitamins, tannins, and dietary fibers

Cited from "Aiming at Preventing Cancer through Dietary Change", an article contributed to *The Japan Complementary and Alternative Medicine Institute Magazine* by Dr. Hajime Daito. (Vol. 5 No 1: 19-26, 2008)

■ Safety of young sesame leaves

Results of acute oral toxicity tests using male mice

Acute oral toxicity tests, using male mice were conducted. 2,000 mg/kg of the specimen was administered to the mice. During the observation period, no abnormalities were found in the mice and no deaths were reported. Therefore, the LD50 value resulting from a single oral administration of the specimen to the male mice is presumed to be more than 2,000mg/kg.

Mutation tests

The mutation tests were conducted to observe the mutagenic potency of the young sesame leaf powders, using *Salmonella typhimurium* TA100, TA1535, TA98, and TA1537, as well as *Escherichia WP2uvrA*. Results confirmed that reverse mutation colony increases were less than double in all strains, regardless of whether or not metabolic activity had occurred.