

## R E V I E W

# The antioxidant properties of the medicinal fruits: a pivotal mechanism of their nutritional, pharmacological, and cardioprotective effects

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**Summary.** *Background and Purpose:* The pharmacological properties of the medicinal fruits are insufficiently elucidated and the mechanisms remain to be clarified. The purpose of this article is to describe the antioxidant properties of the medicinal fruits. *Materials and Methods:* Pertinent literature of the medicinal fruits, *Lycium barbarum*, mulberry, kiwifruit, and avocado were comprehensively screened for analysis. *Results:* The medicinal fruits are also rich in antioxidative components, especially the phenolic ingredients, with significant antioxidant capacities in addition to the nutrients contained. By decreasing the reactive oxygen species and promoting the levels of superoxide dismutase, catalase, and glutathione peroxidase, they play an important protective effect against deoxyribonucleic acid damage and myocardial, hepatic, and other organ damages. Based on the antioxidant mechanism, modifying the storage conditions with low O<sub>2</sub> and low temperature may prevent fruit ripening and control lipid oxidation. *Conclusions:* The medicinal fruits are not only nutritious foods, but also healthcare and medical agents as well. The underlying mechanisms responsible for the protective effects are via antioxidative properties.

**Key Words:** Antioxidants; fruit; myocardial ischemia.

## Introduction

Reactive oxygen species is a crucial element triggering oxidative stress and eventually leading to cell apoptosis by breaking down matrix metalloproteinase. In contrast, the antioxidant defense enzymes, such as glutathione peroxidase (GSH-Px), catalase, and superoxide dismutase (SOD), are playing a protective part against oxidative stresses (1). It has been suggested that antioxidants might protect against oxidative stresses by reducing lipid peroxidation and promoting the activities of antioxidant defense enzymes (1).

Fruits and vegetables are rich in antioxidants, which may account for the beneficial effects of fruits on human health and help in lowering the incidence of degenerative diseases, such as cancer, arthritis, arteriosclerosis, heart disease, inflammations, brain dys-

function, and ageing process (2). Fruits and vegetables contain a lot of antioxidants that can reduce the level of deoxyribonucleic acid (DNA) oxidation, which to some extent can reduce the oxidative damage of DNA and enhance the repair ability of the damaged DNA. The most abundant antioxidants in fruits and vegetables are polyphenols and vitamin C, but vitamins A, B and E and carotenoids are less (2). The physiological functions of the natural products are attributed to the antioxidative property of the phenolic ingredients (3). Among fruits, berries carry a higher antioxidative capacity, which are considered to be due to the abundant contents of phenolics, anthocyanins, total flavonoids, and ascorbic acids (4). In spite of sporadic reports describing the antioxidant property of fruits, there is still a lack of comprehensive description of the characteristics of the medicinal fruits in relating to the antioxi-

tive capacities. This review aims to give a comprehensive description in this respect.

## *Lycium barbarum*

### *Ingredients and mechanisms*

Fruits of *Lycium barbarum*, also named *Fructus lycii* when dehydrated, are well-known in traditional Chinese medicine for longevity, vision, wellness, and headaches (2). *Lycium barbarum* is rich in nutrients, including *Lycium barbarum* polysaccharides, fats, proteins, amino acids, taurines, betaines, vitamins, and trace elements (iron, zinc, phosphorus, and calcium). These components can maintain normal cell development, improve the repair ability after gene damage and accelerate the reverse of aging process. *Lycium barbarum* has many physiological effects, such as enhancing immunity, reducing blood fat, protecting liver, anti-tumor, antiaging, and antistress effects and so on (5). *Lycium barbarum* polysaccharide is one of the most important active components. It has multiple biological and pharmacological properties, such as anticancer, antifatigue, neuroprotective, antioxidant, hypoglycemic, fertility-protective, and immunomodulating functions (6). In recent studies, it has been found that the flavonoids from the fruits of *Lycium barbarum* protect the blood cells and mitochondria against oxidative damages (7). In the experimental studies, *Lycium barbarum* has been shown to have antioxidant, immunoenhancing, radioprotective, and antiaging effects (2). The antioxidant activity was measured by using 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging method showed that the antioxidant capacity of *Fructus lycii* was higher than that of the fresh fruits, in line with the results obtained for total phenolic contents (2). The antioxidant capacities detected by Folin-Ciocalteu, DPPH and Fenton methods showed similar results. However, the extracts of the non-defatted *Fructus lycii* had stronger antioxidant activities than that of the defatted under the same extraction condition (8).

### *Pharmacology*

In patients taking fruits of *Lycium barbarum*, the DNA repair capacity in human lymphocytes and the activities of SOD and catalase were remarkably in-

creased and the lipid peroxidase activity was significantly decreased (9). A study revealed that treatment with a longer duration and higher doses of *Lycium barbarum* polysaccharide (100 and 200 mg/kg) decreased the apoptotic rate fully and significantly (6). The effect of *Lycium barbarum* polysaccharide extracted from *Lycium barbarum* were also investigated on the proliferation rate, cell cycle distribution, and apoptosis in the human hepatoma QGY7703 cell line, by which it was discovered that *Lycium barbarum* polysaccharide treatment caused inhibition of QGY7703 cell growth with cycle arrest in the S phase and apoptosis induction (10). *Ginseng-Lycium barbarum* Decoction (formula: *Ginseng* 10 g, *Lycium barbarum* 10 g, longan pulp 10 g, and jujube 9 pieces) that were prepared by frying *Ginseng* for 20 minutes and boiling 10 minutes by adding other drugs showed satisfactory effects for the treatment of chronic heart failure. With one dose per day for a 5-day treatment course, the total effective rate was 95.8% for the experimental group and 87.6% for the control (11).

### *Food therapies*

At present, there are at least 60 kinds of *Lycium barbarum* diet recipes, which are top grade tonifying substances for the liver, kidney, and lung, such as medlar broth (pork tenderloin 200 g and *Lycium barbarum* fruit 50 g), medlar chicken juice corn soup, and *Lycium barbarum*-Chinese yam milk soup, and *Ginseng-Lycium barbarum* wine, etc.

### *Product development*

*Lycium barbarum* and its extract are suitable for the development of daily chemical and nursing products. They can be used as a supplement of hair cosmetics for preventing alopecia, maintaining the color and nutrition of hair and promoting hair melanin. As a supplement of facial cosmetics, they nourish the skins and keep facial skin smooth and delicate. They also serve as infant care products (12).

## **Mulberry**

### *Ingredients and mechanisms*

The mulberry belongs to the *Morus* genus of the *Moraceae* family. Mulberry contains nutrients necessary

for the human body, including protein, polysaccharides, alkaloids, cardiac glycosides, anthocyanins, lipids, free fatty acids, alcohols, volatile oils, tannins and cyanidin, essential amino acids, vitamins, and minerals (13). Mulberry fruits are also rich in organic acids, such as malic, citric and tartaric acids. The essential fatty acids, vitamins, and polyphenols that contain in the fruits are potent antioxidants (14). When the experimental diets of mulberry fruits were fed to Sprague-Dawley rats, hepatic GSH-Px, catalase, and 3-hydroxy-3-methylglutaryl-coenzyme A (HMG-CoA) reductase activities were increased in all experimental groups comparing with those with normal diets (15). The cytoprotective effects of cyanidin-3-glucoside (C3G) isolated from mulberry fruit against pancreatic  $\beta$ -cell apoptosis caused by hydrogen peroxide ( $H_2O_2$ )-induced oxidative stress showed that the C3G-treated cells were associated with a significant dose-dependent increase of intracellular reactive oxygen species-scavenging activity, 19.4% and 33.8% at 50 and 70  $\mu\text{g}/\text{mL}$  C3G, respectively, and C3G exerted protective effects against oxidative stress-induced apoptosis in MIN6N  $\beta$ -cells by inhibiting DNA fragmentation, and protected pancreatic  $\beta$ -cells against cell death by inactivating caspase-3 and by regulating the phosphorylation of extracellular signal-regulated kinase (ERK) and p38-mitogen activated protein kinase (MAPK) (16). A polysaccharide purified from mulberry fruits was found to stimulate murine macrophages to release chemokine and pro-inflammatory cytokines (17). After hydrogen peroxide treatment, apoptosis-like morphologic changes, such as shrinkage, detachment, and cytoplasmic condensation, were observed, and were inhibited in the presence of mulberry extract (18). Mulberry polysaccharide treatment at appropriate concentrations significantly increased the proliferation of splenocytes via modulating the proapoptotic protein Bak and antiapoptotic protein B-cell lymphoma 2 (Bcl-2) expression ratios, suggesting that mulberry polysaccharide protects primary immune cells from apoptotic cell death. Polysaccharides isolated from strawberry and mulberry juice modulated Bak and Bcl-2 protein levels in murine primary macrophages. Furthermore, a negative correlation between the cytokine secretion levels and Bcl-2 protein levels suggested that proinflammatory interleukin (IL)- $1\beta$  and IL-6 decreased Bcl-2 levels in

the lipopolysaccharide-stimulated macrophages. The results showed that IL-4, -5, -10 and -12 and tumor necrosis factor- $\alpha$  levels secreted by the mulberry polysaccharide-treated splenocytes significantly increased in a concentration-dependent manner (19).

#### Pharmacology

- 1) Antioxidant: Mulberry polysaccharide can eliminate free radicals, playing antioxidant and antiaging roles. Mulberry polysaccharide has an obvious hypoglycemic activity, and it keeps blood sugar in normal range. The antiaging effect of mulberry is carried by mulberry anthocyanins, which show enhanced antioxidant capacity to *Drosophila* in inhibition of lipid peroxidation (13). Both *Panax Notoginseng* suspension and mulberry extract improve activities of SOD and GSH-Px, and reduce malondialdehyde (MDA) content in the serum and liver of mice. The effect of mulberry extract was obvious on GSH-Px, while *Panax Notoginseng* suspension had more apparent effect on SOD. Therefore, both *Panax Notoginseng* and mulberry extract had antioxidant and antiaging functions (20). In *D*-galactose-induced aging mouse model, the serum and liver SOD, GSH-Px activities, and MDA content were investigated after oral mulberry extract of different doses (2, 4 and 6  $\text{g}/\text{kg}/\text{day}$ ) for 40 days. As a result, the mulberry extract could improve liver SOD and the GSH-Px activity, and reduce MDA content. Low-dose mulberry extract increased the serum SOD and GSH-Px activity, and MDA content decreased significantly (21).
- 2) Blood lipid regulation and anti-arteriosclerosis: The New Zealand white rabbit hyperlipidemia model was given mulberry sarcocarp extract by intragastric administration at low-dose (1  $\text{g}/\text{kg}$ ), middle-dose (5  $\text{g}/\text{kg}$ ) and high-dose (10  $\text{g}/\text{kg}$ ). The serum lipid was determined 0, 2, 4, 6 and 8 weeks after administration. Compared with the control animals, the serum levels of total cholesterol and triglyceride of the experimental group with extract from mulberry sarcocarp significantly decreased. The serum levels of low-density lipoprotein and apolipoprotein B of the middle- and high-dose mulberry sarcocarp extract groups also significantly decreased. The levels of high-density lipoprotein

and apolipoprotein A<sub>1</sub> of middle- and high-dose mulberry extract groups increased (22). An immunohistochemical study also revealed that with low- and middle-dose mulberry extract, expressions of intercellular cell adhesion molecule-1 (ICAM-1) were downregulated somewhat in the rabbit aorta and coronary artery, but weak positive staining in the high-dose rabbits, indicating the role of the extract in inhibiting atherosclerotic process (23).

- 3) Hematological functions: Pharmacological research confirmed that mulberry has immunoenhancing function by strengthening the phagocytic function of animal macrophages, promoting T lymphocyte maturation, and participating in the killing effect of T cells on the target cells. It might decrease the sodium-potassium adenosine triphosphatase (Na<sup>+</sup>-K<sup>+</sup>-ATP) activity of erythrocyte membrane, promoting the growth of hematopoietic and granulocyte progenitor cells, promoting lymphocyte transformation, and increasing peripheral white blood cells (24). Mulberry xanthan gum showed good effects for the treatment of chronic idiopathic thrombocytopenic purpura (13).
- 4) Treatment of alopecia areata: By using the plum blossom needle combined with mulberry *Shengfa* Decoction for the treatment of alopecia areata, 42 patients were cured with significant effects (13).

#### Food therapies

The recipes of food products include: 1) Concentrated mulberry jam, which is good for *yin* deficiency, thirsty throat, dizziness, and constipation; 2) Mulberry honey cream, which is prepared by the use of mulberry and proper amount of honey, by which the mulberry decoction is simmered to boil cream, honey is then added and mixed, to drink, 10-15 g each time, 2-3 times a day. It is suitable for nourishing the blood, *yin* deficiency caused by premature graying, dizzy, women's menstruation, and amenorrhea; 3) Mulberry-*Linearstripe Rabdosia* granules, which is composed of mulberry, *Linearstripe Rabdosia*, *Herba Artemisiae Scopariae*, *Schisandra*, and other herbs, is effective for clearing away the *heat* and detoxification, and is indicated for patients with *dampness-heat*-induced hypochondriac pain, jaundice, acute and chronic hepatitis, and liver damage; 4) Mulberry *Cistanche* Decoction, which is prepared with

dried mulberries 20 g, *Cistanche deserticola* 15 g, black sesame 10 g, and fried fructus 6 g, cooked together for 1 hour. To take it with proper amount twice daily, and it is good for nourishing the kidney and intestine and for the treatment of constipation; 5) Mulberry nut porridge, which is prepared with mulberry 75 g, raisins 50 g and *Semen Coicis* 50 g, cooked together into porridge, suitable for the treatment of chronic nephritis and cardiac edema; and 6) Mulberry consumptive thirst juice: Mulberry 15 g, and *Rehmannia glutinosa*, *Radix Scrophulariae*, and *Ophiopogon japonicus* 20 g each, are decocted for juice with supplement of crystal sugar, one dose daily. It can nourish *yin* and increase fluid, and suitable for the treatment of thirst due to insufficiency of body fluid, lung dryness due to *yin* deficiency, and consumptive thirst.

#### Product development

Mulberry vinegar drink green tea, one of the mulberry products, has been developed and it showed superior antioxidant DPPH-scavenging capacities (25). Mulberry can also be processed into other health care products, such as canned mulberry, mulberry beverage, mulberry wine, dried mulberry fruit, mulberry juice, mulberry jam, mulberry dew, mulberry pigment, mulberry jelly, and mulberry ice cream, *etc.* (26).

Mulberry extract can also be used in hair care cosmetics. The products include mulberry hair oil, mulberry mousse, mulberry shampoo, mulberry hair tonic, mulberry hair cream, mulberry hair conditioner, and mulberry dyeing shampoo, *etc.* (26).

#### Kiwifruit

##### Ingredients and mechanisms

Kiwifruits contain a variety of bioactive ingredients including ascorbic acid, carotenoids, dietary fiber, minerals, and phenolic compounds. The bioactive compounds contained in kiwifruits differ depending on cultivar, genotype, growing place, and degree of maturity of the fruits. The correlation coefficients between the total phenolics and the antioxidant capacity of kiwifruits measured by using the 2,2-azinobis (3-ethyl-benzothiazoline-6-sulfonic acid) (ABTS), DPPH, and the oxygen radical absorption capacity



(ORAC) methods suggested that the phenolic compounds contribute more than flavonoids to antioxidant capacity. Among various ripe kiwifruits, 'Bidan' had the highest total phenolics and antioxidant capacity, but the lowest total flavonoids; whereas 'Chiak' had the highest level of total flavonoids, but the lowest antioxidant capacity (27). The methanolic extracts contain significantly lower amount of polyphenols than the hydrolyzed extract with the solvent with combined methanol and acid (28). The antioxidant activities varied among the kiwifruit samples as determined by various used assays: the highest was with ferric reducing antioxidant power (FRAP), intermediate with DPPH, and the lowest with ABTS (29). The results of the determined antioxidant activities of the investigated kiwifruit samples varied greatly. The data depended on the extraction procedure of the kiwifruit: solvent used (acetone, methanol, and water), duration, and the temperature of extraction (29).

Kiwifruit extracts have potent fruit-derived antioxidant capacities showing a preventive effect against certain cancers and cardiovascular disease. *In vitro* experiment revealed that aqueous, 70% ethanol, and linoleic acid emulsion kiwifruit extracts at 50 mg/mL showed antioxidant activities of 72.31%, 70.75%, and 96-98%, respectively. The inhibitory activity against angiotensin I-converting enzyme of kiwifruit extracts was 21-26% at 10 mg/mL, and was 46-49% at 50 mg/mL, and that against HMG-CoA reductase was 13-14% at 10 mg/mL and was 19-30% at 50 mg/mL, indicating that the cardiovascular protective effects of kiwifruit relied on the oxidative components, including vitamins, carotenoids, polyphenols, and flavonoids (30). Consumption of the fruit may decrease oxidative DNA damage in human cells owing to its potential antioxidant properties, and its effectiveness at decreasing oxidative DNA damage has been proved by *in vivo* and *in vitro* experiments, which proved it to be more potent than vitamin C in protecting DNA from damage (31).

### Pharmacology

Kiwifruits are rich in vitamins, especially vitamin C. It also contains a variety of amino acids, actinidine, proteolytic enzymes, tannin, and trace elements. It contains cellulose and pectin, which promotes in-

testinal peristalsis. Researches revealed that kiwifruit can be used as an antidote to mercury, which reduces blood mercury and improves liver function (32). Kiwifruit showed protective mechanisms by antagonizing against chromium-induced cytotoxicity, cyclophosphamide-induced mutations and lipid peroxidation, reducing nitrite toxicity, and improving immune functions (33). Pharmacological studies have shown that kiwifruit and juice products can prevent carcinogens from forming in the body and lower blood lipids. In general, Kiwifruit has preventive and therapeutic effects on cancer, hypertension, hyperlipemia and coronary heart disease (32).

It has been reported that H<sub>2</sub>O<sub>2</sub>-induced DNA damage could be abated and the antioxidant capacity was significantly improved after taking a large amount of kiwifruits, thereby reducing the mutagenic effects in relation to carcinogenesis (34). Motohashi et al. (35) found five fractions of kiwifruit H<sub>1</sub>, H<sub>2</sub> (hexane extract), A<sub>1</sub>, A<sub>2</sub> (acetone extract), and M<sub>2</sub> (methanol extract) showed selective cytotoxic activity against human oral tumor cell lines. Kiwifruit polysaccharide has an anti-tumor effect, and it can inhibit the growth of cancer cells and induce apoptosis of cancer cells via the signaling pathways related to gastric cancer, including epidermal growth factor receptor/Ras/MAPK, protein kinase C, phosphatidylinositol 3-kinase, and transforming growth factor- $\beta$  signaling pathways (36).

Kiwifruits showed obvious anti-myocardial ischemia effect. They could reduce the myocardial infarction area of the rat myocardial ischemia model made by coronary artery ligation. They could also increase the coronary blood flow in isolated guinea pig hearts and to decrease the heart rate and myocardial contractility (37). Experiments revealed kiwifruits contained arginine and glutamic acid salts, which were helpful in dilating the arterioles as what the vascular dilating agents did, thereby improving blood circulation and preventing thrombus formation. They could be used as a supplement to the human body for magnesium deficiency caused by cardiac diseases, such as myocardial infarction and hypertension.

Clinical observations revealed that *Actinidia chinensis* juice syrup (30 mL, three times daily, taken for 12 months) could prevent atherosclerosis and cardiovascular diseases by lowering blood cholesterol, triglyc-

eride, and low-density lipoprotein, and increase blood high-density lipoprotein level of patients with hyperlipidemia (38).

#### *Health care*

Nutritional effects: Kiwifruits contain a lot of vitamin C and minerals. Therefore, they are especially suitable for supplementing the electrolyte loss due to physical exercise. Meanwhile, kiwifruit juice contains 5% carbohydrate, which is conducive to keep the glucose level stable during strenuous exercise. The investigations showed that kiwifruit beverage could enhance the physical fitness of the athletes, increase blood cell density, maintain blood glucose within normal limit after a 2.5-hour exercise, and improve the insulin and vitamin C levels as well.

As a natural sugar alcohol, inositol contained in kiwifruit has a positive effect on glucose metabolism, and the supplement of inositol can improve the nerve conduction speed. As a second messenger in cell signal transduction, inositol serves as a regulator of hormones and nerve conduction in the cells.

Kiwifruits also contain healthful carotenoid (carotene, lutein, and yellow pigment), phenolic compounds (anthocyanins), and antioxidants, thereby capable of supplementing sufficient vitamin C for those working in a high temperature environment and in plateau pastoral areas, and for patients of extensive burn and vitamin deficiency. Kiwifruits are beneficial for the occupational diseases poisoned with lead, mercury and other materials, and also show preventive and curative effects for radioactive damages (39).

#### *Product development*

The pertinent products that have been under production include kiwifruit wine and low sugar preserved kiwifruit, *etc.*

## **Avocado**

#### *Ingredients and mechanisms*

Avocado is a widely grown and consumed fruit. It is rich in nutrients but low in calories, sodium, and fats. Besides, it contains a large amount of potent antioxidants (monounsaturated fatty acids, fiber, vitamins B

and E, and phytosterols), essential nutrients (monounsaturated, oleic acid, and polyunsaturated fats linoleic and linolenic acids), and potentially cancer-preventing phytochemicals (polyphenols, proanthocyanidins, tocopherols, carotenoids,  $\beta$ -sitosterol,  $\beta$ -carotene, lecithin, minerals, and vitamins A, C, D, and E).

#### *Pharmacology*

Medical and health care effects: Avocado oil contains a lot of unsaturated fatty acids, which can reduce blood lipids as evidenced by clinical observations. After the rat hyperlipidemia models were treated with avocado fruit pulp (2 mL/rat/day, orally) for 10 weeks, the serum hepatic enzymes, bilirubins, and liver and heart MDA levels were significantly reduced in a dose-dependent manner (40).

Avocado fruit is a high energy, low sugar food for people with diabetes. Avocado peel tea drinking plays a certain role in the remission of diabetes. The avocado fruits can also reduce blood lipid and is effective for scleroderma, periodontitis, and spinal epiphysis, *etc.* Professor Paul Spagnuolo from the University of Waterloo has discovered a lipid in avocados may eliminate the source of acute myeloid leukemia by targeting leukemia stem cells (41).

In the mesocarp tissues, C7 sugars and particularly mannoheptulose, play a major antioxidant role. Cowan (42) proposed that C7 sugars have various important functions, among which is protection of certain key enzymes essential for fruit growth and development from damage by reactive oxygen species. Vinokur and Rodov (43) reported on the lipophilic versus hydrophilic radical scavenging activity of avocado. Certain C6 sugar alcohols (sorbitol and mannitol) act as antioxidants (44). *In vitro* and *in vivo* studies illustrated that the avocado nonsaponifiable fraction was a very potent antioxidant with 3-fold higher DPPH radical scavenging capacity and 20-fold higher ferric iron reducing ability, comparing with the fat soluble vitamin,  $\alpha$ -tocopherol (45). When avocado extract (1 mL/kg body mass, for 30 days) was employed to the diethylnitrosamine-treated rats, the liver tumor necrosis factor- $\alpha$ , cyclooxygenase-2, lipoxygenase, caspase-3, DNA fragmentation, nitric oxide, MDA, and total protein decreased remarkably to the levels of the diethylnitrosamine-untreated control rats (46).

Low O<sub>2</sub> atmospheres could influence post-harvest physiology and quality of fruit. Avocados that were treated with combined 1-methylcyclopropene and low O<sub>2</sub>, and stored under low temperature conditions showed lowered peroxide levels and increased iodine levels and SOD activities, by which lipid oxidation and ripening were effectively controlled (47). The control treatment with refrigeration maintenance showed increased antioxidant capacity and total phenolic compound content over the storage (48). However, the effects of 1-methylcyclopropene on oxidative features of avocado fruit were limited to a study of polyphenol oxidase and peroxidase activities associated with low temperature-induced mesocarp browning (49).

#### Food therapy

Avocado, a favorite food and fruit with high energy and low sugar, is an important raw material for food and beverage industry. Nutritional experts recommended that eating half an avocado fruit daily could enhance the short-term memory. In addition to be a fresh food, avocado can be made into salad, fruit juice, jam, and powder, *etc.* In the Canary Islands, Spain, there have been dozens of avocado food formulae, including 5 kinds of salads, 12 kinds of vegetable muds and jams, and 16 kinds of dishes. The formulae of guacamole amount up to 53, such as the Asian guacamole, *Asparagus officinalis* L. guacamole, broccoli guacamole, grilled onion guacamole, sweet pea guacamole, and bean curd guacamole. In South Africa, avocado pulp is also used as a baby food.

#### Product development

Avocado oil is a widely used high-quality raw material for cosmetic products owing to its ingredients of unsaturated fatty acids and vitamins, especially vitamin E and carotene, with strong ultraviolet radiation absorbing and sunscreen capacities. Avocado oil, because of its deep color, is not applicable for a direct use as cosmetics until proper decolorization. Avocado oil is non-toxic and non irritating to the skin. In addition to the general grease compositions, avocado oil also contains the effective components of plant sterol, ergosterol, folate, inositol, phosphoric acid, and lecithin, *etc.* Therefore, it has better lubricity, mildness, emulsification, and stability. The permeability of the skin by ap-

plying it is stronger than that by using lanolin. It also has a certain effect on inflammation and acne. At present, in the United States, Japan, and China, avocado oil is widely used for cosmetic product developments, such as skin cream, cleansing cream, nutrition cream, and sunscreen cream, *etc.* (50).

#### Conclusions

The medicinal fruits are rich in antioxidative components, especially the phenolic ingredients, with significant antioxidant capacities in addition to their high nutritional values. By decreasing the reactive oxygen species and promoting the levels of SOD, catalase, and GSH-Px, *etc.*, they play an important protective effect against DNA damage, and myocardial, hepatic, and other organ damages. Based on the antioxidant mechanisms, modifying the storage conditions with low O<sub>2</sub> and low temperature may prevent fruit ripening and control lipid oxidation. The medicinal fruits are not only nutritious foods, but also healthcare and medical agents as well.

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