



Evaluating Cucumber Fruit as a Health-giving Vegetable

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(Received: 21.11.2018, Accepted: 02.05.2019, Published Online: 30.06.2019)

Keywords

Functional food,
 Medicinal plant,
 Folk medicine,
 Anti-aging,
 Cucurbitacin

Abstract: Cucumber vegetable (*Cucumis sativus* L.) is one of the very widely cultivated agricultural crops not only in Turkey but in the World as well. Cucumber has become a very popular fruit especially, in the Western Countries due to its high water and low calorie contents. The vegetable has been using in traditional medicine in India and China since ancient times. The fruit cosmetically used for nourishing the skin. The fruit has a soothing effect against skin irritations, swellings and sunburns. The fruit also carries refrigerant, haemostatic and tonic properties. A number of bioactive compounds have been found in cucumbers including cucurbitacins, cucumegastigmanes I and II, cucumerin A and B, vitexin, orientin, etc. This review explores phytochemical and pharmacological facts of cucumber fruits and points out some their therapeutic potential.

Hıyar Meyvesinin Şifalı Bir Sebze Olarak Değerlendirilmesi

Anahtar Kelimeler

Fonksiyonel gıda,
 Tıbbi bitki,
 Halk hekimliği,
 Yaşlanma geciktirici,
 Kukurbitasin

Özet: Hıyar sebzesi hem dünyada hem de Türkiye’de oldukça yüksek miktarda üretilen tarımsal ürünlerden bir tanesidir. Hıyar yüksek su içeriği ve düşük kalori değeri ile Batı Ülkeleri’nde popüler bir sebze haline gelmiştir. Sebze Hindistan ve Çin’de uzun zamandır halk hekimliğinde kullanılmaktadır. Kozmetik olarak, hıyar meyvesi özellikle cilt besleyici olarak kabul görmektedir. Hıyar meyvesi tahriş/kaşıntı, şişme ve güneş yanıklığına karşı deride rahatlatıcı bir etkiye neden olabilmektedir. Hıyar ayrıca serinletici, tonik ve kanama durdurucu etkiye sahiptir. Hıyarlardan kukurbitasin, cucumegastigman I and II, cucumerin A and B, vitexin, orientin gibi çok sayıda biyoaktif bileşenler izole edilmiştir. Bu derleme ile hıyarın fitokimyasal ve farmakolojik özelliğini incelenmiş ve terapötik potansiyeline dikkat çekilmiştir.

1. INTRODUCTION

The therapeutic value of the cucumbers has been known in India and China from ancient times [1,2]. In India, the fruit is generally used for arresting skin aging, and for several skin problems such as swelling under eyes and sun-burns [2,3]. In China, cucumber leaves, stems or roots are used for anti-diarrhea and anti-gonorrhoea agent, and detoxification [4].

Pharmacological studies of cucumbers have revealed that cucumber carries a potential of antimicrobial, antidiabetic and hypolipidemic agent traits [2]. Moreover, the vegetable may suppress the activities of elastase and hyaluronidase enzymes, which increases its cosmetic values [5]. A number of bioactive compounds have been isolated from cucumbers including

cucurbitacins, cucumegastigmanes I and II, cucumerin A and B, vitexin, orientin etc.

This review aims to explore phytochemical and pharmacological potential of cucumber fruits and to point out some their therapeutic effects.

2. CUCUMBER PLANT

Cucumber plant is the only species bearing only 7 chromosomes in Cucurbitace family, and the plant is thought be evolved a 12-chromosome karyotype [6]. The plant is thought be originated from Northern India, Himalayas [7]. In India, two types of cucumber are cultivated; the first one creeping form is grown during the hot season, and the second one climbing form is grown during the rainy season [2]. Cucumbers have also

been cultivated in China for 2000 years and cover the second largest area among vegetables after Chinese cabbage [8]. Cucumber cultivars may be divided into 4 categories: (1) exotic group cultivated in Europe and America, (2) xerophytic group from Northern India, (3) Chinese group with long fruits and shiny skin, (4) Himalayan group with rusty skin [7]. In Turkey, the vegetable is annually grown and its cultivars are usually climbing types when grown for fresh consumption.

The cucumber leaf is consisted of three to five lobes and bears prickly hairs. The plants bear both male and female flowers which are yellow in color. Cucumber fruit varies in size and shape ranging from compressed, elongated, ellipsoid, dorsoventrally, convex and laterally ridged type. Seeds are cream or white in color and the testa hard and smooth [2].

3. NUTRITIONAL VALUE OF CUCUMBER FRUIT

Cucumber fruit contains water (96%), protein (0.4%), fat (0.1%), carbohydrate (3%), mineral (0.3%), calcium (0.01%), phosphorus (0.03%), iron (1.5 mg 100 g⁻¹) and vitamin B (30 IU 100 g⁻¹) [2]. The fruit also carries crepsin, proteolytic enzyme, ascorbic acid, oxidase, succinic and malic dehydrogenase [9]. The fruit mesocarp is rich in ascorbic acid while its peel in lactic acid [10]. More than 35 volatiles have been isolated from cucumber fruit, and nonenol and its derivatives the more prominent aromatic substances are among the volatiles [10,11]. Some of the major fatty acids isolated from cucumber fruits are linoleic, lauric, oleic, stearic, palmitic and myristic [12,13].

4. PHYTOCHEMICAL PROFILE OF CUCUMBERS

More than 30 phytochemicals have been extracted from cucumber fruit, leaf or seed (Table 1). Cucurbitacins, well-known for bitterness and toxicity, their derivatives are the leading compounds in cucumbers [14]. All forms of cucurbitacins have been isolated from cotyledons of cucumber seedlings [15]. Cucurbitacins in fruits are hydrolyzed by elaterase enzyme during maturation. Thus, bitterness fades away with fruit maturity [16]. *Bt* gene promotes cucurbitacin formation while *bi* gene suppresses [17]. Ecological factors can affect the activity of elaterase; such as cool temperatures restrict the activity, thereby, causing a bitter fruit formation [18].

Table 1. Phytochemicals isolated from cucumbers [2].

No	Phytochemicals
1	Cucurbitacin A
2	Cucurbitacin B
3	Cucurbitacin C
4	Cucurbitacin D
5	Cucurbitacin E
6	Cucurbitacin I
7	Cucumerin A
8	Cucumerin B
9	Vitexin
10	Isovitexin

11	Orientin
12	Isorientin
13	Cucumegastigmanes I
14	Cucumegastigmanes II
15	(+)-Dehydrovomifoliol
16	Indole-3-aldehyde
17	Indole-3-carboxylic acid
18	Isovitexin 2''- O - (6'''-(E)-p-cou maroyl) glucoside
19	Isovitexin 2''- O - (6'''-(E)-p-cou maroyl) glucoside-4'-O-glucoside
20	Isovitexin 2''- O - (6'''-(E)-feruloyl) glucoside-4'-O-glucoside
21	soscoparin 2''- O - (6'''-(E)-p-cou maroyl) glucoside
22	Isoscoparin 2''- O - (6'''-(E)-feruloyl) glucoside-4'-O-glucoside
23	Isovitexin 2''- O - (6'''-(E)-feruloyl) glucoside
24	Isoscoparin 2''- O - (6'''-(E)-feruloyl) glucoside
23	Saponarin
26	Saponarin 4-O-glucoside
27	Vicenin-2
28	Apigenin 7- O - (6''-O-p-coumaroyl)glucoside
29	Quercetin 3- O -glucoside
30	Kaempferol - 3 - O - glucoside
31	Kaempferol 3- O - rhamnos

5. PHARMACOLOGICAL PROPERTIES

Cucumber fruits have been traditionally used for various skin ailments and for nourishing the skin. Cucumber fruit contains an abundant amount of water, ascorbic acid and caffeic acid, which creates a soothing effect on the skin and alleviates swellings [2]. Cucumber fruit has been reported to suppress elastase and hydroxyacid enzyme activities in the skin, which proves it might carry a potential role on the skin care, especially preventing wrinkles [5]. Fruit is rich in lactic acid which is a member of alpha-hydroxy acid family. The cosmetic use of alfa hydroxyl acid includes healing or reducing several skin ailments including xeroderma, keratosis, etc [10,19,20].

The cucumber fruit pulp is also used for curing warts, xerosis and chemical peeling of the skin [21]. Cucumber fruit extract demonstrated a sun protective factor (SPF) value of 0.06 to 100 at a concentration of 100 µg ml⁻¹, thus, can be used in skin care products [22]. Fresh cucumber extract contains cucurbitacin D, 23, 24-dihydrocucurbitacin D and rans cis-2, 6-nonadienal that can subdue tyrosine and melanin synthesis, which may have a potential to inhibit darkening on the skin [23,24]. Cucumber fruit bears an abundant amount of fiber, and a variety of valuable minerals such as silica, potassium and magnesium, which depicts cooling effects on the skin, hence, it may be used as anti-wrinkle agent in cosmetic products [5].

Some clinical studies have shown that cosmetic products containing cucumber fruit extract may be used for skin care and alleviating various skin problems. A topical skin-care cream carrying hydro-alcoholic extracts of cucumber has been reported to decrease skin moisture loss and melatonin amount [25]. Skin massage agents bearing cucumber fruit extract have demonstrated to be

potentially beneficial for skin aging and improving skin elasticity [26-28].

Besides against skin ailments, few studies related to their pharmacological activities exist and summarized as follows: Clinical works have indicated that cucurbitacins exerted cytotoxicity and anti-cancer activity [2]. Cucurbitacin B has been found to suppress prostate cancerous cell growth in vivo [29]. Cucurbitacins have also wielded wide ranges of pharmacological effects including being a purgative, anti-inflammatory and anti-fertility agent [30]. Cucumber leaf and stem MeOH extracts have been reported to suppress melanin production in B16 cancerous cells [31,32].

Aromatic compounds isolated from cucumbers have been found to effective against some gram-negative bacteria including *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumonia* and *Enterobacter cloacae*; against some gram-positive bacteria including *Staphylococcus epidermidis* and *Staphylococcus aureus*, and against some fungi including *Candida tropicalis*, *Candida albicans* and *Candida glabrata* [10]. Furthermore, (*E*)-2-nonenal and (*E*, *Z*)-2, 6-nonadienal chemical substances extracted from cucumbers have shown to exert antibacterial properties against some deadly pathogens such as *Salmonella typhimurium*, *Listeria monocytogenes* and *Bacillus cereus* [33].

Extract from cucumber leaves showed that it might be used against encephalitis [34]. Cucumber may be used against burning sensation, constipation, tonic and intermittent fevers [35].

To conclude, cucumber fruit and plant including root, stem, leaf, seed and especially leaf possess important therapeutic value especially for the skin. However, farther clinical studies are required to optimize the application of cucumbers for skin care or cure other ailments.

REFERENCES

- [1] Franco P, Vittorio S, Robert A. Plants in cosmetics. Press-Council of Europe; 2002.
- [2] Mukherjee PK, Nema NK, Maity N, Sarkar BK. Phytochemical and therapeutic potential of cucumber. *Fitoterapia*. 2003;84:227-236.
- [3] Mukherjee PK, Maity N, Nema NK, Sarkar BK. Bioactive compounds from natural resources against skin aging. *Phytomedicine*. 2011;19:64-73.
- [4] Chuyaku-Daijiten. Shanghai Technology. Tokyo: Shogakukan Press; 1985.
- [5] Nema NK, Maity N, Sarkar B, Mukherjee PK. *Cucumis sativus* fruit potential antioxidant, anti-hyaluronidase, and anti-elastase agent. *Arch Dermatol Res*. 2011;303:247-52.
- [6] Renner SS, Schaefer H, Kocyan A. Phylogenetics of *Cucumis* (Cucurbitaceae): cucumber (*C. sativus*) belongs in an Asian/Australian clade far from melon (*C. melo*). *BMC Evol Biol*. 7: 1–11.

- [7] Peter KV, Abraham Z. Biodiversity in horticultural crops. New Delhi. Daya Publishing House; 2007.
- [8] Whitaker TW, Davis GN. Cucurbits - Botany, Cultivation, Utilization. New York: Interscience Publication; 1996.
- [9] Kapoor LD. CRC Handbook of Ayurvedic Medicinal Plants. Florida: CRC Press LLC; 1990.
- [10] Sotiroidis G, Melliou Sotiroidis E, Chinou I. Chemical analysis, antioxidant and antimicrobial activity of three Greek cucumbers (*Cucumis sativus*) cultivars. *J Food Biochem*. 2010;34:61-78.
- [11] Kemp TR, Knavel DE, Stoltz LP. Identification of some volatile compounds from cucumber. *J Agric Food Chem*. 1974; 22:717-718.
- [12] Peng AC, Geisman JR. Lipid and fatty acid composition of cucumbers and their changes during storage of fresh-pack pickles. *J Food Sci*. 1978;41:859-862.
- [13] Zhou WA, Mcfeeters RF. Volatile compounds in cucumbers fermented in low-salt conditions. *J Agric Food Chem*. 1988;46:2117-2122.
- [14] Hideki H, Hidekazu ITO, Katsunari I, Keiko A, Yoshiteru S, Isamu I. Cucurbitacin C-bitter principle in cucumber plants. *Jpn Agric Res Q*. 2007;41:65-68.
- [15] Chen JC, Chiu MH, Nie RL, Cordell GA, Qiu SX. Cucurbitacins and cucurbitane glycosides: structures and biological activities. *Nat Prod Rep*. 2005;22:386-99.
- [16] Enslin PR, Joubert FJ, Rehm S. Bitter principles of the cucurbitaceae. III.-Elaterase, an active enzyme for the hydrolysis of bitter principle glycosides. *J Sci Food Agric*. 1956;7:646-55.
- [17] Peerce LK, Wehner TC. Review of gene and linkage groups in cucumber. *HortSci*. 1990;25:605-615.
- [18] Pittenger DR. California master gardener handbook, Volume 3382. California: University of California. Division of Agriculture and Natural Resources Publication; 2002.
- [19] Scott EV, Yu R. Hyperkeratinization, corneocyte cohesion and alpha-hydroxy acid. *J Am Acad Dermatol*. 1984;5:867-879.
- [20] Scott EV, Yu R. Alpha-hydroxy acids: procedures for use in clinical practice. *Cutis*. 1989;43:222-228.
- [21] Murad H, Shamban AT, Premo PS. The use of glycolic acid as a peeling agent. *Dermatol Clin*. 1995;13:285-307.
- [22] Hogade MG, Patil BS, Prashant D. Competitive sun protection factor determination of fresh fruit extract of Cucumber vs marketed cosmetic formulation. *Res J Pharm Biol Chem Sci*. 2010;1:55-59.
- [23] Fernando GH, Mercedes JN, Juana C, Francisco GC, Josefa E. Tyrosinase inhibitory activity of cucumber compounds: enzymes responsible for browning in cucumber. *J Agric Food Chem*. 2003;51:7764-7769.
- [24] Jian CC, Ming C, Rui LN, Geoffrey AC, Samuel XQ. Cucurbitacins and cucurbitane glycosides: structures and biological activities. *Nat Prod Rep*. 2005;22:386-399.

- [25] Akhtar N, Mehmood A, Khan BA, Mahmood T, Muhammad H, Khan S, Saeed T. Exploring cucumber extract for skin rejuvenation. *Afr J Biotechnol* 2011;10:1206-1216.
- [26] Su CJ. A skin massage agent containing Succus Cucumidis sativi, lemon, and Eupolyphaga Seu Steleophaga juice for preventing skin aging and improving moisture retention and preparation method thereof. Repub. Korean Kongkae Taeho Kongbo; CODEN: KRXXA7 KR 2003005078; 2003.
- [27] Hwa CJ. Method for preparing massage pack containing plant extracts for preventing skin keratin trouble. Repub. Korean Kongkae Taeho Kongbo; CODEN: KRXXA7 KR 2007121272 A 20071227; 2007.
- [28] Yeong YJ. Method for preparing cosmetic pack containing minerals and extracts from mulberry and cucumber. Repub. Korean Kongkae Taeho Kongbo; CODEN: KRXXA7 KR 2010026644 A 20100310; 2010.
- [29] Gao Y, Islam MS, Tian J, Lui, VW, Xiao D. Inactivation of ATP citrate lyase by Cucurbitacin B: A bioactive compound from cucumber, inhibits prostate cancer growth. *Cancer Lett* 2014;349(1):15-25.
- [30] Guha J, Sen SP. The cucurbitacins: a review plant. *Biochem.* 1975;2:12-28.
- [31] Kamkaen N, Mulsri N, Treesak C. Screening of some tropical vegetables for anti-tyrosinase activity. *Thai Pharm Health Sci J.* 2007;2:15-19.
- [32] Cho MJ, Buescher RW, Johnson M, Janes M. Inactivation of pathogenic bacteria by cucumber volatiles (E, Z)-2, 6- nonadienal and (E)-2-nonenal. *J Food Prot.* 2004;67:1014-1046.
- [33] Kai H, Baba M, Okuyama T. Inhibitory effect of *Cucumis sativus* on melanin production in melanoma B16 cells by downregulation of tyrosinase expression. *Planta Med.* 2008;74:1785-1788.
- [34] Jevtic B, Djedović N, Stanisavljević S, Gašić U, Mišić D, Despotović J, Samardžić J, Miljković D, Timotijević G. Anti-encephalitogenic effects of cucumber leaf extract. *J Func Foods.* 2017;37:249–262
- [35] Warriar PK, Nambiar VPK, Ramamkuty C. Indian medicinal plants: A Aompendium of 500 Species. Chennai: Press Orientlongman; 1994.