Medicinal uses of Onion (*Allium cepa* L.): An Overview

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Abstract: Medicinal value of onion is known since ancient civilizations. Onion is the part of our daily diet and it holds many properties that can help with numerous health issues because it is anti-allergenic, anti-inflammatory, cardio-protective, vasodilatory, anti-carcenogenic, antioxidant, antibacterial and antifungal. Quercetin is main element that gives onion these properties. The extracts of onion are seen to resist the growth of many microbes and are more effective against gram positive bacteria. The ethanolic and essential oil extracts of onion are able to fight pathogens more effectively than aqueous extracts. There are no drug interactions known with onion consumption that's why its usage is safe.
[Sijjil Shafiq, Mehak Shakir and Qurban Ali. **Medicinal uses of Onion (*Allium cepa* L.): An Overview.** *Life Sci J* 2017;14(6):100-107]. ISSN: 1097-8135 (Print) / ISSN: 2372-613X (Online). http://www.lifesciencesite.com. 15. doi:10.7537/marslsj140617.15.

Keywords: onion, medicinal value, anti-allergenic, anti-inflammatory, cardio-protective, vasodilatory, anti-carcenogenic, antioxidant, antibacterial, antifungal.

Introduction

Onion is a well known vegetable which is used in our daily meals for its nutritional values. Onions are actually native to Asia and red, white, yellow varieties of onion are commonly used. Onion contains organic sulphur compounds and allinase enzyme which is responsible for lacrimatory effect (Pizzorno & Murray, 2012, Platt, 2003). Onion also contains flavanoids like kampeferol and quercetin that are beneficial as they exhibit antiallergenic, anti-inflammatory, cardio-protective, vasodilatory, anti-carcenogenic and antioxidant properties antibacterial and antifungal properties (Shon *et al*., 2004). Red onion has more flavanols in its outer layer then white onion (Benmalek *et al*., 2013). The antibacterial activity of onion juice can be attributed to the presence of flavonoids and polyphenols which has been reported to have broad spectrum of antibacterial activity (Hendrich, 2006) thatswhy onions can be considered as a good source of natural additives to retard food deterioration (Navas *et al*., 2006). Onion extracts are very effective antimicrobial against bacteria. Gram positive bacteria are more sensitive to onion extract response then gram negative bacteria as it is resistant to onion extract. (Benmalek *et al*., 2013). The purple onion extract exhibited a strong antimicrobial activity against Vibro cholerae which is gram negative bacteria. The antimicrobial activity increases with the concentration of extracts. The highest antimicrobial activity is shown by the non aqueous solvent extracts against many microbes then aqueous solvent extracts (J. Bakht *et al*, 2014). Onions have been observed to have antimicrobial, antioxidant activities which are key to cure many diseases. The current review details the onion's ability to fight bacteria and fungus for the treatment of infections. The onion extract abilities can be used to make new drugs that are natural and have fewer side effects on human health. Onion is the well renowned vegetable which is famous for its benefits and flavour. It is consumed daily by human beings in their diet in many forms. The biological name of onion is Allium cepa. They are cheap and available in every region of earth in different varieties thatswhy they differ in shape, size and color. (Pizzorno & Murray, 2012, Platt, 2003) They are native to Asia and are found their way to Egypt through trade. (Pizzorno & Murray, 2012, Platt, 2003) Onions can be perrenials or biennials herbs and are cultivated worldwide. They are used for their fleshy bulb mostly (Pizzorno & Murray, 2012, Platt, 2003).

Common varieties of onions

Onion is usually grown with three common color varieties, white onion, red onion and yellow onion. The onions have pungent taste and flavour (Pizzorno & Murray, 2012, Platt, 2003).

Chemical composition

Onions like garlic contain various organic sulphur compounds, including, S-methyl cysteine sulfoxide, Trans-S-(1-propenyl) cysteine sulfoxide, S propyl cysteine sulfoxide and Dipropyl disulphide. Onions also contain the enzyme allinase, which is released when in cut or crushed, causing the conversion of Trans-S-(1-propenyl) cysteine sulfoxide to the so called lacrimatory factor (propanethial-S-oxide) (Pizzorno & Murray, 2012, Platt, 2003). It also has other constituents involved flavonoids (primarily quercetic acid), phenolic acids (e-g, caffeic, sinapic and p-coumaric), sterols, saponins, pectin and volatile oils. Onion is known for being a good natural source of flavonoids mainly represented by the flavonols

quercetin and kaempferol, which are present as their glycosides (Fossen *et al*., 1998).

Benefits of onion use

In recent years, many publications have reported evidence of beneficial health effects attributed to flavonoids including antiallergenic, antiinflammatory, cardioprotective, vasodilatory, anticarcenogenic and antioxidant properties (Shon *et al*., 2004). Several epidemiological studies have also associated the consumption of flavonoids with a reduction of the risk of chronic diseases including, cancer, diabetes and coronary heart problems (Hirvonen *et al*., 2001; Kosmider & Osiecka, 2004). In addition, many flavonoids have been reported to posses antibacterial and antifungal properties (Rauha *et al*., 2000). This has increased the interest of the food industry in these natural compounds as components to improve food stability against microbiological spoiling agents (Taguri *et al*., 2004; Sofia *et al*., 2007).

Pharmacology

Onions are rich in quercetin which are very good antioxidants. The consumption of onions in an experimental group was observed and noted that it prevents DNA damage and breakage. The consumption of onion increased the flavanoid glucosides (quercetin-3-glucoside and isorhamnetin-4-glucoside) and this elevation caused the lymhocyte DNA to be increased in resistance against DNA damage. There was significant decrease in the level of urinary 8 – hydroxy -2-deoxyguanosine (Bio marker for Radiation-Induced Oxidative DNA Damage) which was increased after 4 hours of ingestion. If tomatoes were also consumed with onions then only quercetin was detected in plasma and the endogenous base oxidation was decreased but strand breakage was unchanged. So onions and tomatoes both decreased the bio markers of oxidative stress transiently (Pizzorno & Murray, 2012, Platt, 2003).

Cardiovascular effects

Onions and its extracts are known to decrease the blood lipids levels, increase fibrinolysis and decrease platelet aggregation and also lower the blood pressure. Onion oil has more inhibitory power as comared to garlic oil for the enzyme cyclooxygenase and lipoxygenase, which mediate eicosanoid metabolism (prostaglandins, thromboxanes and leukotrienes). Onion and garlic comsumption was also associated with lower levels of cholestrol and triglycerides. Onion consumption may also reduce the risk cardiovascular diseases due to its quercetin content. The high quercetin levels in blood affect the signaling of platelet aggregation resulting in decrease of the cardiovascular diseases (Pizzorno & Murray, 2012, Platt, 2003).

Diabetes

Onions were shown to have significant oral hypoglycemic action. This is because of the presence of allyl propyl disulphide mainly but other constituents like quercetin and anthnocyanidin also play significant role. Allyl propyl disulphide lower glucose by competing with insulin for degrading sites, thereby increasing the half life of insulin (Pizzorno & Murray, 2012, Platt, 2003).

Antiasthmatic action

Onions have historically been used as antiasthmatic agents. Their action on asthma, as well as in other conditions associated with increased lipoxygenase derivatives (leukotrienes), such as psoriasis and atopic dermatitus appear to be greater than garlic. The net effect is of like cortisol, which inhibits all eicosanoid metabolism via inhibition of phospholipase. Inhibition of leukotriene formation and onion's quercetin and isothiocyanate content are probably the primary factors responsible for onion's antiasthmatic effects. These effects have been confirmed in experimental coducts (Pizzorno & Murray, 2012, Platt, 2003).

Antitumor effects

An onion extract was found to be cytotoxic to tumor cells in vitro and to arrest tumor growth when tumor cells were implanted on rats. The onion extract was shown to be unusually non toxic because a dose as high as 40 times that of cytotoxic dose for the tumor cells had no adverse effect on host. One human study was conducted on the evaluation of onion consumption and stomach cancer more then in 120,000 men and women between 55 and 69 years of age, and researchers found strong inverse association between onion consumption and stomach cancer incidence, but no association with the use of leeks or garlic (Pizzorno & Murray, 2012, Platt, 2003).

Clinical application and dosage

Onion has medicinal values that even modern medicine acknowledges. It can be used for cardiovascular diseases, diabetes mellitus and inflammatory conditions. Onions are and should be literally part of our daily nutrition. The therupatic dosages in the various forms are typically equally ro 50 to 150 g per day of raw onion (Pizzorno & Murray, 2012, Platt, 2003).

Drug interactions

There are no confirmed drug interactions with onion consumption. Theroretically, because onion consumption may improve the blood sugar control, patients with type 2 diabetes taking oral hypoglycemic drugs need to monitor glucose levels because dosage level of medication might need to be changed (Pizzorno & Murray, 2012, Platt, 2003).

Antimicrobial acitivity

Onion exhibit antibacterial anti fungal, anti bacterial and anthelmintic activity but it is not as potent as garlic (Allium sativum). Garlic can fight infection much better then onion. But onion can also be potent in its anti microbial activity, if consumed in large quantities. The antibacterial activity of onion juice can be attributed to the presence of flavonoids and polyphenols which has been reported to have broad spectrum of antibacterial activity (Hendrich, 2006). Onions has also been seen to have antifungal activities against Gram-negative and Gram-positive bacteria (Whitemore & Naidu, 2000). The antibiotic activity of 1 mg of allicin, which is a (+)-S-methyl-l-cysteine sulfoxide, has been equated to that of 15 IU of penicillin (Han, Lawson, Han, and Han 1995). Onions have inhibitory effect by aqueous and essential oils extracts on numerous bacterial and fungal species (Sivam, Lampe, Ulness, Swanzy, & Potter, 1997; Phay *et al*., 1999; Hsieh, Mau, & Huang, 2001; Ward, Fasitsas, & Katz, 2002). The antimicrobial activity of onion (red, yellow and green varieties) and garlic essential oil extracts against these bacteria The antimicrobial activities of different varieties has also been experimented and observed against different micro- organism stains which include bacteria and fungus.

Antifungal activity of onion and protection of food

Protection of food from pathogens and spoilage organisms has been traditionally achieved by chemical methods, but during recent years there has been an increase in consumer interest in developing foods which contain a low level or are free of chemical preservatives (Viuda Martos *et al*., 2008). Onions can be considered as a good source of natural additives to retard food deterioration (Navas *et al*., 2006). However, the application of thiosulfinates and volatile compounds for food preservation is limited due to their strong flavour and their biochemical instability (Benkeblia, 2004). These properties focus attention on the more stable flavonoids as additives to enhance food shelf-life by inhibiting microbial spoiling and oxidative deterioration, due to their antimicrobial and antioxidant properties (Ramos *et al*., 2006; Naz *et al*., 2008).

Antimicrobial activity of onion against bacteria

One study also reported the medicinal uses of Illicium verum (badiane or star anise), Crataegus oxyacantha ssp monogyna (hawthorn) and Allium cepa (onion). Antibacterial activity of the plant extracts was evaluated in vitro against four bacterial test species known to cause humans infections which were Eschericia coli, P.aeruginosa, and two types of S.aureus. It was observed through results that outer layer of onion is rich in flavonols in red variery then white variety. The flavonols contents for Crataegus oxyacantha ssp monogyna leaves were greater then its berries Illicium verum. Anthocyanins showed highest content in Crataegus oxyacantha ssp monogyna in its berries), while, inner and outer layers of white onion had the lowest contents of anthocyanins. Flavonols extracts presented high antioxidant activity as compared with anthocyanins and standards antioxidants (ascorbic acid and quercetin). Allium cepa and Crataegus oxyacantha ssp monogyna exhibited the most effective antimicrobial activity (Benmalek *et al*., 2013). Extracts of *A. cepa* L and *C. oxyacantha* ssp *monogyna* were the most effective. The largest inhibition zone was observed with flavonols of the inner layer of *A. cepa* L "Red Onion" (40 mm), inhibiting the Gram-negative *Escherichia coli*. Flavonols extracts from *I. verum* and *C. oxyacantha* ssp *monogyna* were slightly effective against *Escherichia coli* with an inhibition zone of 18 mm and 12 mm, respectively. Extracts of *C. oxyacantha* ssp *monogyna* berries and sheet of *C. oxyacantha* ssp *monogyna* (flavonols and anthocyanins) were also effective (30mm), but only inhibited the growth of *Pseudomonas aeruginosa*. None of the extracts from *C.oxyacantha* ssp *monogyna* and *I.verum* inhibited *S.aureus*.(Benmalek *et al*., 2013)

Antibacterial activity of onion against clinical isolates of *Vibrio cholerae* in vitro

Vibrio cholerae, the causative organism of cholera is a gram negative bacterium responsible for severe morbidity and mortality in developing countries of the world including Pakistan. It has caused seven pandemics of the world (Hannan *et al*., 2010). Cholera can be treated with oral rehydration solution and antimicrobial agents like tetracycline, ampicillin, nalidixic acid, erythromycin and furazolidone. Antimicrobial resistance has developed against these antibiotics. (Rawalpindi, 2004). Resistance to more than one antibiotic is now common among the clinical isolates. There are reports of multi drug resistant *V.cholerae* appearing with increasing frequency. So it is necessary to find new antimicrobials which are natural then synthetic. (Scrascia *et al*., 2003). Hannan *et al*., reported antimicrobial activity against Vibrio chlore by using ethanolic fractions of purple and yellow types of onion. Both the extracts exhibited antibacterial activity against *V. cholerae.* The antibacterial activity of purple type of *Allium cepa* extract was found to be better as compared to yellow type of *Allium cepa* extract. Antibacterial activity of both extracts has been increased by increasing their concentration (Hannan *et al*., 2010).

Antimicrobial activity of red onion essential oils

The essential oils antimicrobial activity was observed in one study which include stains of bacteria which are *Staphylococcus aureus, Salmomella Enteritidis,* and these three fungi*, Aspergillus niger,*

Penicillium cyclopium and Fusarium oxysporum (Benkeblia, 2004). The stains of S.Enteritidis were strongly inhibited to grow by the red variety of onion. The stain of S. Enteritidis was also observed to be inhibited by the garlic essential oils. *A. niger* and *P. cyclopium* were significantly inhibited particularly at low concentrations of onion essential oils (Benkeblia, 2004). However, some of the stains was inhibited by onion essential oils but showed less sensitivity towards it. The bacteria *S. aureus* showed less sensitivity towards Essentisl oil extracts and the fungus *F. oxysporum* showed the lowest sensitivity towards essential oil extracts (Benkeblia, 2004).

Antimicrobial activity of ethyl acetate fractions of onion bulb

A large number of naturally derived antimicrobial compounds are found in different medicinal plants and their essential oils. These compounds are known to be safe, possessing varying degree of antimicrobial activity, and could prevent growth of food borne pathogens and spoilage bacteria. The different ranges of antimicrobial activity of different concentrations of onion dry bulb extracts were studied in Institute of Biotechnology and Genetic Engineering, the University of Agriculture Peshawar KPK Pakistan. It was reported by the team of Pakistani scientists that Ethyl acetate fractions of dried onion bulbs showed inhibitory activities against all tested microbes including bacteria and a fungus while chloroform fractions inhibited all the microbes except *Pseudomonas aeruginosa.* Butanol fractions showed second highest activity at both lower and higher concentrations. Among Gram positive microbes, *Staphylococcus aureus* was the most susceptible bacteria and the most resistant Gram negative bacteria were *Pseudomonas aeurginosa* and *Salmonella typhi*. Ethanol and water fractions were not so effective against other microbes as compared to other extracts (Bakht *et al*., 2014).

It was seen that the antimicrobial compounds of *Allium cepa* are soluble in ethyl acetate and chloroform followed by butanol as compared to other solvents. Also crude ethanol extract and other fractions showed effective antifungal activity suggesting a potential use of this plant as antifungal agent. There were six solvents (ethyl acetate, water, butanol, chloroform, ethanol and petroleum ether) for extraction of onion (Bakht *et al*, 2014). Lower concentration (1mg disc) and higher concentration (2 mg disc) were used against eight microbes which are seven gram positive and negative bacteria and one fungus and the following observations were noted in this research (Table 1).

Table 1. Activity of gram positive and negative bacteria against onion extract

Microbe	Effect	Order of inhibition
Bacillus subtilis	All of the solvent extracted samples were ineffective against this gram positive bacteria at low concentration except ethyl acetate and chloroform extracted samples had most inhibitory action against it at both concentrations	At both concentration ethyl acetate>chloroform>butanol
Candida albicans	Ethyl acetate and chloroform extracted samples were effective against this fungus in both concentrations while other solvent extracted samples were only effective in highest concentration with ethyl acetate and chloroform extracted samples having highest inhibition effect followed by butanol.	At both concentration ethyl acetate>chloroform>butanol
Erwinia carotovora	Chloroform and butanol extracted samples showed most effective inhibition against this gram negative bacteria at both concentration while ethyl acetate was more effective then butanol at higher concentration	At higher concentration chloroform>ethyl acetate>butanol
Escherichia coli	Only Ethyl acetate,chloroform, water were effective against this gram negative bacteria and in both concentrations while other solvent based extractions showed zero zone inhibition	At both concentrations ethyl acetate>chloroform>water
Kleibsiella pneumoniae	Chloroform and butanol was most inhibitory in both concentrations against this gram negative bacteria while all other solvent extraction showed zero zone inhibition in lower concentations	At higher concentration Chloroform,butanol >ethyl acetate
Salmonella typhi	All the extractions except ethyl acetate and chloroform showed zero inhibition in both concentrations against these gram negative bacteria. Chloroform being most effective in both concentrations while ethyl acetate was second but it has inhibitory effect at higher concentration	At higher concentration Chloroform>ethy acetate
Pseudomonas aeruginosa	Ethyl acetate was only solvent whose sample extraction have inhibitory effect against this gram negative bacteria but only in higher concentration	
Staphylococcus saureus	Ethyl acetate and chloroform were most effective in both concentrations against this gram postive bacteria.	At higher concentration Ethylacetate>chloroform> petroleum ether

Similar results were also reported by Hughes and Lawson (1991), Bekenblia (2004), Santas *et al*. (2010) whose results are also mentioned in this review and Chathradhyunthi *et al*. (2009).

Antimicrobial activity of methanolic spanish onion extracts

J.Santas *et al*. (2009) were evaluated for the methanolic extracts of Spanish onions were evaluated for their antimicrobial activity for the ethyl acetate and water subfractions. Flavonoids were mainly found to be present in ethyl acetate subfraction with sufficient antioxidant activity and antimicrobial activity which was only showed by this subfraction. No significant inhibitory effect of the water subfraction of the extracts was observed. Three different Spanish onion varieties (*A. cepa* L.) were purchased in a local market white skinned onion variety. 'Fuentes de Ebro'(FE), white skinned onion variety 'Calc¸ ot de Valls' (CV) and yellow skinned onion variety 'Grano de Oro' (GO).

Table 2. Antimicrobial activity of methanolic spanish onion extracts

Flavanols	**Microbe**	**Effect**
1. Quercetin 2. Kaempferol	Gram positive bacteria	Bacteria was sensitive to both flavanols
	Gram negative bacteria	Bacteria resistant to both flavanols
	C.albicans	Yeast showed resistance to both flavanols.
	L.monocytogenes	It is sensitive to both extracts
Ethyacetate fraction	**Microbe**	**Effect**
1. Calc¸ ot de Valls 2. Grano de Oro	Gram positive bacteria	Extracts were efficient in inhibiting gram positive bacteria
	Gram negative bacteria	Gram negative bacteria is resistant to both onion extractions types
	C.albicans	C.albicans is resistant to both onion extractions types
	L.monocytogenes	It is sensitive to both extracts.
Fuentes de Ebro	L.monocytogens	This extraction of onion type is only efficient in inhibiting L. monocytogenes which were the most sensitive bacteria.

Antimicrobial activity onion essentail oils

The antimicrobial activity of onion in its essential oil form has been reported by using onion extract. The gram negative (*Escherichia coli, Klebsiella pneumonia, Pseudomonas fluorescens* and *Serratia rhadnii*) and positive (*Bacillus anthracis, Bacillus cereus, Micrococcus luteus* and *Staphylococcus aureus*) bacteria that were used was generally the Gram-positive bacteria were more sensitive to onion oil than Gram-negative bacteria. The onion oil was highly active against the four Gram-positive bacteria tested and only one isolate of Gram-negative bacteria *(Klebsiella pneumoniae) (Zohri et al., 1995)*. Effect of onion oil at three concentrations (100, 200 and 500 ppm) on the growth of different isolates of dermatophytic fungi (*Chrysosporium carmichaelii, C. indicum, C. keratinophilum, C. queenslandicum, C. tropicum, Microsporum canis, M. gypseum, Trichophyton* simii and Trichophyton *mentagrophytes*) was studied and found that onion oil was highly effective against all the isolates of dermatophytic fungi tested. Onion oil completely inhibited mycelial growth of *Microsporum canis, M. Gypseum* and *Trichophyton simii* and highly reduced the growth of *Chrysosporium queenslandicum* and *Trichophyton mentagrophytes* when added to the solid Medium at 200 ppm (Zohri *et al*., 1995). The growth of *Chrysosporium queenslandicum* and *Trichophyton mentagrophytes* was completely inhibited in the presence of 500 ppm of onion oil. The mycelial growth of the other four dermatophytic fungi tested *(Chrysosporium carmichaelii,* C. *indicum,* C. *keratinophilum* and C. *tropicum)* was gradually decreased by increasing the concentrations of onion oil (Zohri *et al*., 1995). The fungal growth and mycotoxin production by *Aspergillus versicolor* 1M1 16139 which was produced by produced sterigmatocystin and *Penicillium rubrum* IMI 136127 which was produced by rubratoxin A were completely inhibited by the addition of onion oil at 200 ppm to the medium. Even in the presence of 100 ppm of onion oil fungal growth and toxin production by the two organisms were markedly reduced (Zohri *et al*., 1995). The same response was also observed by antibacterial activity of onion or garlic components in the studies conducted by the investigators (Buck and Suter 1944; Cavalli to *et al.* 1945; Rao 1946; Abdou *et al.* 1972; Lewis *et al.* 1977). The essential oils of red onion at concentration of 20, 40, 60 mg/dl showed inhibition of all the stains but the *S. typhimurium* was more sensitive as observed by their zones of inhibition. *A. niger* was not more susceptible against red onion at concentration of 20, 40, 60 mg/dl. The 60 mg/dl concentration of onion essential oil was most active against the bacterial stains. (Abdel-Salam *et al*., 2014).

Comparision of Antimicrobial activity of different solvents onion extracts in different studies

Bakht *et al*. reported that petroleum ether, ethyl acetate and chloroform extracts of *Allium cepa* inhibited the growth of *Staphylococcus aureus* at both lower and higher concentration. In contrast, it was resistant to fresh *Allium cepa* extracts, also Butanol, ethanol and water extracted amples were ineffective to control the growth of *Staphylococcus aureus* at any concentration. (Bakht *et al*., 2014). It was also reported that petroleum ether, methanolic and aqueous extract of bulbs of *Allium cepa* was found to be inactive against *staphylococcus aureus* (Grover *et al*., 2011). Hexane, diaxon, ethanol extracts of scale leaves of *Allium cepa* at a concentration of 1000µg/ml showed an inhibition zone of 8 mm against gram positive bacteria *Staphylococcusaureus*, where is the aqueous, isopropyl alcohol and n Butanol extract of the same plant showed no effect (Vamshi *et al*., 2010). Eltaweel *et al*., (2013) investigates antimicrobial activities of *Allium cepa* (onion) extract against tested bacteria (Staphylococcus aureus). The antibacterial activities of the methanolic suspension shows high effect at all concentration in comparison with the aqueous suspension as reported by other studies especially. Salam *et al*., (2014) whose study is also mentioned in this review. Boiled water extracts of onion oil were also reported to cause inhibition of *Alternaria tenuis, Helminthosporium* sp. and *Curvularia perniseta* (Shekhawat and Prasada 1971). In a study by Rehan Irkin, in Turkey, onion extract with ethyl alcohol has inhibited *Aspergillus* (Irkin & Korukluoglu, 2007). The lachrymatory factor has been identified as thiopropanol-S-oxide, extractable in diethyl ether (Brondnitz and Pascale 1971; Bandyopadhyay and Tewari 1973). The inhibition of *Tryptophyton gypseum* and *Microsporom audouini* caused by different homologues of synthetic thiosulfinates (Small *et al*. 1949).

Conclusion

So, onions are miracle vegetable that can be used to make new therupatic medicines as it has high antimicrobial and antioxidant activities that are considered to be a boon for the treatment of many diseases. Onion also contains flavanoids like kampeferol and quercetin that are beneficial as they exhibit anti-allergenic, anti-inflammatory, cardioprotective, vasodilatory, anti-carcenogenic and antioxidant properties antibacterial and antifungal properties. The onion consumption prevents DNA damage and breakage due to presence of quercetin which acts as good antioxidant. Onion extracts have effectively inhibited gram positive bacteria than gram negative bacteria. The non aqueous extracts of onion have greater tendency to inhibit bacterial growth than aqueous extracts. There is no evidence of drug interaction by the consumption of onion thus onion can also be use as a safe therupatic drug in addition to a natural remedy.

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6/22/2017