

*Special Paper***A REVIEW ON CHEMICAL AND MEDICINAL ASPECTS OF ALLIUM CEPA**

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Allium cepa (piyaz or onion) is very commonly used throughout the world and specially in India and Pakistan, as a condiment in daily cooking and as a vegetable salad; but very few people realize that it has many useful medicinal properties. Recent findings about its beneficial effect in heart troubles have revived a great interest and investigations are going on in Pakistan and many other countries to find out the constituents responsible for its beneficial effects. In this article an attempt is made to bring out the medicinal properties of onion and to give a review of the chemical, pharmacological and clinical investigations carried out so far.

Allium cepa (Liliaceae), onion or piyaz, is a bulbous, biennial herb, bearing linear, hollow, fleshy, cylindrical leaves and umbels of small white flowers. The flowers mature into 3-celled capsular fruits containing small, black seeds. The flower heads also, sometimes, bear bulbils. The underground bulbs, which constitute the crops, vary in size, colour (white, yellow, red, brown), shape (round, flat, conical), firmness, keeping quality, period of maturity and strength of flavour. It is cultivated throughout the world in tropical and subtropical countries and is grown from seeds, bulbs or bulbils.¹

Onions² are largely used as an article of food and condiment. These are often eaten raw, flavoured with lemon juice, pepper, salt, etc., to enable the body to get the maximum amount of the vitamins, minerals and other useful constituents present. Mostly the onions are used as condiment after roasting, in which case the vitamins, volatile constituents, etc., are destroyed. The medicinal properties of onion are mostly destroyed after roasting. Bulbs are useful in fever, dropsy, catarrh and chronic bronchitis. Mixed with common salt, onions are a domestic remedy in colic and scurvy. Roasted or otherwise, they are applied as poultice to indolent boils, bruises, wounds etc. Onion juice is used like smelling salts in faintness, in infantile convulsions, epileptic and hysterical fits. Slightly warm juice is put into the ear to relieve earache; and is applied hot to the soles of feet in convulsive disorders. It is applied to eyes in dimness of vision and locally to allay irritation of insect bites, scorpion stings and also in skin diseases. It is given as an antidote in tobacco

poisoning. Mixed with mustard oil in equal proportions, it is a good application for rheumatic pains, other inflammatory swellings and in skin diseases.

Cooked with vinegar they are given in jaundice, splenic enlargement and dyspepsia. In malarial fevers, they are eaten twice a day with two or three black peppers, with remarkable relief. Roasted onions mixed with cumin, sugar candy and cow's ghee is a nice demulcent of great benefit in piles.

Chemical Constituents of Onion

Two Colombian varieties of onion have the following composition³: Moisture 87.46-87.77, fat 0.26-0.37, proteins 1.03-1.63, sugars 5.45-6.04, cellulose 1.30-1.50, pectin 2.0-2.16, mucilage 2.61-3.38, allyl isothiocyanate 1.50-1.59, total ash 0.492-0.741, acid sol. ash 0.344-0.521, sodium and potassium 0.1128-0.1928, iron 0.00083-0.0015, calcium 0.04234-0.0736% and traces of cobalt and copper. These also contain vitamin B₃₅-50%, and vitamin C, 0.91823-1.01853 mg/100 g. The individual sugars are arabinose 1.0%, rhamnose 0.69%, xylose 0.67%, ribose⁴ 0.45%, glucose 2.05%, fructose 0.20%, sucrose 3.23% and polyfructosan⁵ 1.45%. Also present are malonic acid⁶ (0.5 mg/g of fresh material) malic, citric acid and propionaldehyde.

Onions contain a precursor⁷ identical to allinin (+)-*S*-allyl-*L*-cysteine sulfoxide, which is responsible for releasing pyruvic acid enzymatically in the fresh juice of onions. The bulbs⁸ contain *p*-coumaric acid, caffeic acid and ferulic acid. The coloured outer skin⁹ contains quercetin(I), spiraeoside(II) (quercetin-4-mono-*D*-glucoside), protocatechuic acid(III), phloroglucinol (IV) phloroglucinol carboxylic acid(V) and pyrocatechol(VI) beside two unknown quercetin glucosides m.p. 224-6°C(VII) and m.p. 196-8°C(VIII): fleshy onion scales contain I,II,III, IV,VI,VII, VIII and ferulic acid, while leaves contain I,II, ferulic acid and caffeic acid.

Gas liquid chromatography¹⁰ of its steam-volatile fractions gave 16 different peaks, out of which Pr₂S₂, MeSSPr and Me₂S₂ were identified. Onion juice contains MeCHO, EtCHO and MeCH₂CH=CMe.CHO which were identified as dinitrophenyl hydrazones. The three varieties

of American onion, namely Southport White Globe, Southport Yellow Globe and Southport Red Globe, contain quercetin-4'-glucoside, -3,4'-diglucoside, -4,7'-diglucoside and 3-glucoside.¹¹

Hypoglycemic Agent

The presence of hypoglycemic principle in *A. cepa* was confirmed by several workers. Brahmachari¹² carried out further investigation to pin-point the fraction responsible for the above property. Ground dried onions were extracted with various solvents. These extracts were dried and the powder fed to groups of fasting normal male rabbits weighing 2 kg and having a fasting 18 hr: blood sugar level of 100–120 mg/100 ml. Only light petroleum (60–80°) extract of the powder possesses hypoglycemic property, which was compared with that of tolbutamide. Its hypoglycemic activity is 62.1% of tolbutamide. These findings were substantiated by a group of Egyptian workers,¹³ who found that the total extract of dried onions has a potent and prolonged hypoglycemic effect on artificially induced diabetes in rats and rabbits. Similar observations were made by Sharef and his coworkers,¹⁴ who found that onion tops are effective antidiabetics. They used alloxan diabetic rats and determined fasting blood sugar and adrenaline hyperglycemia.

Antibacterial and Fungicidal Agent

Onion is very commonly used in almost every family and specially during the cholera epidemics, when people are advised to take onion with vinegar. It has been experimentally proved that onion has useful antibacterial and fungicidal properties. Lesnikov¹⁵ has proved that onion juice stops the growth of geotrichoid cultures, when a cotton wad soaked with fresh onion juice was placed near the culture for a few minutes. It inhibits the growth¹⁶ of *E. coli*, *Salmonella typhosa*, *Shigella-paradysenteriae*, *staphylococcus* species, *Proteus vulgaris*, *Serratia marcescens* and vibris comma. Gupta¹⁷ and co-workers observed that oil obtained from *A. cepa* inhibited mycobacterium tuberculosis at 10 ml. Fresh onions¹⁸ when homogenised have strong antimicrobial effect, 50–100 mg/ml completely inhibiting *Staphylococcus aureus* growth in nutrient solution. Two active constituents are OS(Me)-CH₂CHNH₂CO₂H and OS (Pr) CH₂CH NH₂-CO₂H.

Hair Tonic

Onion juice contains some constituents that are useful for hair growth and, due to this reason, it is used for hair growth in folklore medicine. According to Klosa¹⁹ extract of onion with 55% alcohol, prepared in the cold, contains pyrocate-

chol, which was found to increase hair growth 20–30% on application to shaved parts of the scalp. A French patent²⁰ describes a prescription for hair tonic which contains onion juice 15%, garlic juice 1%, egg yolk 20%, alcohol 24%, petroleum 20% and castor oil 20% by volume. It revitalizes the hair, stops hair loss and encourages regrowth. The alcohol (5–10%) can be replaced by an equivalent amount of marine alginate.

Antioxidant

Sethi²¹ and his coworkers have observed that onions exhibited the antioxidant property on fat. In order to test this property, turmeric, dried ginger, onions, garlic, cinnamon leaves and pepper were extracted with various solvents, and these various extracts, oils, phenols etc were added to lard, which had been refined with decolorising carbon and activated earth. The time required to attain a peroxide value of 20 mg/kg was determined and used to calculate a stability index. A yellow solid extracted from onions exhibited the most antioxidant activity of the group, but it was not of high order. Similarly Janicki²² observed the influence of the seeds of onion, *Raphanus sativus*, *Solanum lycopersicum*, *Juglans regia* etc. on the stability of fat. He showed the presence of antioxidant substances in the fat-soluble portion of the seeds. The antioxidant activity of the substance was not related to fat content. Onions had a marked restraining influence on the development of acidity in lard²³ the effect lasting from three to six months.

Miscellaneous Properties

It has been noticed²⁴ that excessive and prolonged use of onion causes a grave irreversible anemia in dogs, goats and rabbits. Similarly, when white leghorn hens²⁵ were fed on onion (200 g day) for 11–53 days, their weight was reduced by 7–10%, hemoglobin reduced by 5–12% by 11th day and 58% by 53rd day red cells diminished. Oxygen consumption was rapidly reduced by 24–72%. Consumption of allium species may contribute to the prevalence of goiter in endemic areas.²⁶ This was proved by testing a few sulphides, which are major constituents of volatile fractions of onion. Thus allyl monosulphide administered by gastric intubation into rats was well-tolerated even at 350 ml, but allyl disulphide, methyl disulphide and allyl alcohol were toxic at 100, 50 and 30 ml respectively. Allyl alcohol and methyl disulphide significantly inhibited thyroid function, reducing I¹³¹ uptake in female rats to 0.52 and 0.87% at 25 and 30 ml respectively as compared with 1.56 and 1.74% that was taken up by control tissue. Methanolic²⁷ extract of dry onion scales gave a flavone complex

with diuretic properties. Total amount of flavone glycosides was 6.74% (quercetin 4.81, spireoside 1.13 and other heterosides 0.8%). By administering onion, garlic, etc., to the healthy human, the thiamine contents in faeces and in urine increased.²⁸

An infusion of the outer skins of *A. cepa* inhibits the root growth of onion.²⁹ An aqueous solution of *A. cepa* skins was fractionated into four fractions and only one out of these completely inhibits the growth of onion roots, the second partially inhibits, whereas the third and fourth are ineffective. On further investigation, two compounds, namely, quercetin and protocatechuic acid, were detected in the skin of onions. Protocatechuic was found to inhibit the growth of onion roots, whereas quercetin has no effect.

Onion is used throughout the year, but the difficulty is that it cannot be preserved fresh, and it starts sprouting after two or three months. The only commercial method of preserving it is to dehydrate it, and use it as such or in powder form. The drawback in this method is that the volatile constituent are mostly eliminated and it can only be used as a condiment in daily cooking. Investigations have been carried out in various parts of the world to prevent sprouting by various methods, but the methods have not been used commercially.

Onions exposed to increasing γ -radiations³⁰ showed best storage-stability after the application of a dosage not exceeding 7000 r.e.p. Irradiation of food with X-rays does not induce radioactivity and the germination power of onions is quickly destroyed.³¹

Various chemical compounds have been tried to control the sprouting of onions amongst these only maleic hydrazide found effective. Wittwer *et al.*³² sprayed onions with sodium salt of 1-naphthaleneacetic acid (I), 2,4,5-trichlorophenoxyacetic acid (II), sodium salt of 2-naphthoxyacetic acid (III), 2-benzothiazoleoxyacetic acid (IV) and maleic hydrazide (V), when tops are still green one third of the way up. Maleic hydrazide in concentration of 2500 p.p.m. at 75 gal/acre completely stopped the sprouting, whereas I and II increased sprouting. Cliferi³³ applied 0.2% solution of sodium salt of maleic hydrazide to foliage of onion before harvesting, which prevented sprouting during 8-month storage and reduced the loss of moisture. He also used³⁴ (IPC) isopropyl-phenyl carbamate (200 mg for 1 kg of bulbs) or a mixture of IPC and methyl naphthalene acetate (100 mg each for 1 kg of onions) which prevented sprouting of onions. Maleic hydrazide not only prevented sprouting but also increased the yield of onions due to increase in fruit set, although it has no marked effect on the general growth of onions.

Terabun³⁵ observed the physical and chemical changes in onion by applying various plant har-

mones. Indole-3-acetic acid, naphthaleneacetic acid, 2, 4-D, kinetin, 2,3,5 triiodobenzoic acid and maleic hydrazide (MH) were applied by foliar means to onions. Only MH produced a swelling of basal sheaths. MH-induced swelling was followed by an increase in sugar content in leaf sheaths and blades. Both the leaves and roots ceased to develop soon after treatment of MH. It was assumed that MH-induced swelling was caused mainly by inhibition of meristematic activity in the bud and secondly by accumulation of sugar in the sheaths.

It is evident that the chemical constituents of onion responsible for hair growth, antioxidant, antibacterial and fungicidal properties have been isolated and identified but the compounds useful for diabetes etc. are still to be isolated. Similarly, onion is to be further investigated to find out the compounds useful for heart diseases. Prevention of sprouting of onions is of great economic importance. It will not only prevent loss of useful vegetable due to spoilage but also bring more financial benefits to farmers. It is necessary that investigations should be carried out in Pakistan to find methods of preventing sprouting of onions either by the use of plant hormones like maleic hydrazide etc. or by finding better varieties of onion with delayed sprouting activity.

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