

# Physical properties of water environmental sciences essay



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## INTRODUCTION

### WATER

The substance with chemical formula of  $H_2O$  is known as Water. Two hydrogen and one oxygen atoms are linked by covalent bonding. At room conditions, it is liquid and also exists in solid and gaseous state depending upon conditions. Near hydrophilic surfaces, it also exists in liquid crystal state.[1][2] About 71% of Earth surface is water,[3] and is very important to all of existing life.[4] On Earth, oceans contain 96.5% water, groundwater 1.7% ice caps of Greenland, Antarctica and glaciers 1.7% and air as vapor, clouds and precipitation 0.001%.[5],[6] Freshwater is only Earth's 2.5%, groundwater and ice contains 98.8% Earth's water. Less than 0.3% of all freshwater is in the atmosphere, lakes, and rivers, and about (0.003%) of the Earth's freshwater is enclosed in manufactured products and biological bodies.[5] Water on Earth moves continually through the hydrological cycle of evaporation and transpiration (evapo-transpiration), condensation, precipitation, and runoff, usually reaching the sea. Precipitation over land is contributed by transpiration and evaporation. Safe drinking water is essential to humans and other forms of life. Safe drinking water access in nearly world's every part over the last decades has improved, but about one billion people still not have access to safe water and more than 2.5 billion not have access to adequate sanitation. [7] However, by 2025, it is estimated by some observers that more than half of the world population will be facing water-based vulnerability.[8] A report in November 2009 suggested that in 2030, water demand will increase up to 50% in some world's developing regions.[9] Water plays an important role in

the world economy, as it serves as chemical substances solvent and facilitates transportation and industrial cooling. Approximately 70% of the fresh water used by humans goes to agriculture.[10] Water is a universal solvent and also called as Earth's Blood. It is use for the drinking purposes as well as in industries on large scale. This enormous use of water in industries has created a large problem of drainage of industrial wastewater. Effluents from industries deteriorate the quality of the surface water as well as underground water, hence these are considered as a major source of water pollution.[11]

## **FORMS OF WATER**

Like numerous substances, water has several forms. The liquid phase is generally denoted as " water" and obviously the most common one. Water exists as ice in solid phase with common forms as snow and ice cubes. Steam (or water vapor) is the gaseous phase of water, and is characterized by water assuming the arrangement of a translucent cloud. Supercritical fluid is the fourth state of water which is much less common and rarely occurs in nature than other three. When water achieves a specific critical pressure and temperature (22. 064 MPa and 647 K), they merges to form one homogenous fluid phase, with both gas and liquid properties. Since water only becomes supercritical under intense pressures or temperatures, which almost never occurs naturally. In natural water, isotope protium,  $1\text{H}$  is the main content and in heavy water is water it is replaced by heavier isotope, deuterium,  $2\text{H}$ . It is alike normal water chemically, but not the same. This is because the deuterium nucleus is twice heavy than protium, and thus causes clear differences in hydrogen bonding and bonding energies. To

moderate (slow down) neutrons in the nuclear reactor industry heavy water is used.[11]

## PHYSICAL PROPERTIES OF WATER

### Property Value

Molar Mass 18.015 Molar Volume 55.5 moles/liter Freezing Point (FP) 0°C at 1 atm Boiling Point (BP) 100°C at 1 atm Triple Point 273.16 K at 4.6 torr Heat of vaporization 40.63 kJ/mol Surface Tension 73 dynes/cm at 20°C Vapor pressure 0.0212 atm at 20°C Heat Capacity (cp) 4.22 kJ/kg. K Heat of Fusion 6.013 kJ/mol Viscosity 1.002 centipoise at 20°C Dielectric Constant 78.54 at 25°C Density maxima 4°C Density 1 g/cc Heat conductivity 0.60 W m<sup>-1</sup> K<sup>-1</sup> Specific heat 4180 J kg<sup>-1</sup> K<sup>-1</sup> Melting heat 3.34 x 10<sup>5</sup> J/kg Critical Temperature 647 K Evaporation heat 22.6 x 10<sup>5</sup> J/kg Speed of sound 1480 m/s at 293 K Critical pressure 22.1 x 10<sup>6</sup> Pa

## CHEMICAL PROPERTIES

Water is a chemical compound of hydrogen and oxygen with formula of H<sub>2</sub>O. It reacts with certain metals and their oxides forming bases and with oxides of non-metals forming acids. It also forms varied products by reacting with certain organic compounds. Water is a good solvent as it is a polar compound. While absolutely pure water is electricity's poor conductor and due to its self-ionization property, it is better conductor than the majority of other pure liquids, i. e., forming a hydronium ion, H<sub>3</sub>O<sup>+</sup> and a hydroxide ion, OH<sup>-</sup>, by the reaction ability of two water molecules. The high dielectric constant of water is the main reason of its ionization and polarity.[13] Pure

water has a neutral pH of 7, water is pure which is neither basic nor acidic.

[14]

## **WATER POLLUTION**

Water has a unique ability as it can naturally cleanse and renew itself, by allowing pollutants to break down or settle out and by diluting them to a point of concentration where they are not harmful. But this natural process is time consuming and it becomes hard when larger amounts of harmful pollutants are added. And humans are making the drinking water sources by using more and more polluting materials. The point is this: we are making planet's small portion of water (fit for drinking) polluted by dumping contaminants into it.

### **What is Pollution?**

Pollution can be defined in numerous ways and it occurs when energy and other materials are released which degrades the water quality. All of the waste materials that water cannot naturally break down considered as water pollution. In other words, anything that is added to the water, above and beyond its capacity to break it down, is pollution. In certain conditions, nature itself can be the cause of pollution, for instance when water flows through soils with high acidities. But the pollutants that enter the water are more often done by human actions.[15]

## **CATEGORIES OF WATER POLLUTION**

As groundwater and surface water are interrelated yet they have been managed and studied as separate resources.[16] Surface water becomes groundwater when it seeps through the soil. On the other hand, surface

water sources can also be fed by groundwater. Depending upon the origin, surface water pollution sources are normally grouped into two categories.

### **Point Source Water Pollution**

Point source water pollution starts from a identifiable, specific place, like an underground fuel tank, a sewage plant, a factory, or even an animal feedlot.

Point source water pollution might be treated and controlled better by ditching or piping which directs the movement of contaminants or the flow of water.[17]

### **Non–Point Source Water Pollution**

Non-point source pollution generally occurs due to the precipitation, land runoff, drainage, atmospheric deposition, hydrologic or seepage modification. The term " non-point source" means any water pollution source that does not meet " point source" legal definition under Clean Water Act [section 502(14)].

### **POLLUTION BY METALS**

Toxic metals are natural component of the Earth's crust which cannot be degraded and destroyed. In traces, some toxic metals are essential to maintain the body of human. Though, they are poisonous at higher concentrations. Heavy metals are dangerous as they bio-accumulate. When a toxic substance is absorbed by organism at a rate greater in amount than the substance is lost (broken down or excreted) results in occurrence of bioaccumulation. So, the risk of chronic poisoning will be greater if the substance biological half life is longer, while toxin environmental levels are very low. Heavy metals enters water supply by consumer and industrial

waste and even from acidic rain releasing toxic metals into lakes, streams, groundwater, rivers and breaking down of soils. The most toxic heavy metals are cadmium, lead, copper, selenium and chromium, although they are very important from industrial point of view.[19]

## CHROMIUM

Chromium is a chemical element which has the symbol Cr and atomic number 24. It is the first element in Group 6. It is a steely-gray, lustrous, hard metal that has a high melting point and takes a high polish. It is also malleable, tasteless, and odorless. It is derived from the Greek word "chrōma" meaning colour, because many of its compounds are intensely coloured.

General Properties  
 Name Symbol Number Chromium Cr 24  
 Element category Transition metal  
 Block Period Group D 4 6  
 Standard Atomic Weight 51.9961  
 Electron configuration [Ar] 4s<sup>1</sup>3d<sup>5</sup><sub>2, 8, 13, 1</sub>  
 Physical Properties  
 Phase Solid  
 Density 7.19 g·cm<sup>-3</sup>  
 Liquid density at M. P. 6.3 g·cm<sup>-3</sup>  
 Melting Point 2180 K, 1907 °C, 3465 °F  
 Boiling Point 2944 K, 2671 °C, 4840 °F  
 Heat of Fusion 21.0 kJ·mol<sup>-1</sup>  
 Heat of Vaporization 339.5 kJ·mol<sup>-1</sup>  
 Molar Heat Capacity 23.35 J·mol<sup>-1</sup>·K<sup>-1</sup>

## Chromium in Nutrition

For a large class of organisms, trivalent chromium is a nutritional component. Trivalent chromium in trace amounts affects lipid and sugar metabolism in humans, and its deficiency causes a disease named chromium deficiency. Still, chromium deficiency is considered to be extremely rare in common population and three people has only ever been confirmed on parenteral nutrition, that is when liquid diet is fed to a patient by intravenous drips.[21] On the contrary, hexavalent chromium is mutagenic and very toxic

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when inhaled. Cr(VI) in solution is not recognized as a carcinogen, while it can cause allergic contact dermatitis (ACD).[22]

## **Chromium Toxicity**

The exposure of people to chromium or chromium compounds can be happened through drinking or eating, skin contact and breathing. The chromium level in water and air is usually low and in drinking water as well, but the dangerous hexavalent chromium might be contained in contaminated well water. The natural occurrence of chromium in fruits, vegetables, meats, grains and yeasts in the main route of chromium uptake for the majority of people eating that food. The contents of chromium in food can be altered by varying the ways of storage and food preparation. For humans chromium (III) is an important nutrient and its shortage can cause diabetes, metabolisms disruption and heart conditions. But it's too much uptake may affect health as well, for example skin rashes. For humans chromium (VI) is dangerous, primarily for people working in the textile and steel industry. Chromium exposure chances are higher for the people who smoke tobacco. Chromium (VI) is recognized for causing various health effects. In leather products, when it is a compound, it causes allergic reactions, as skin rash and after breathing, it causes nosebleeds and nose irritations. Other health problems by chromium (VI) are: Respiratory problems, Skin rashes, Upset stomachs and ulcers, Weakened immune systems, Alteration of genetic material, Kidney and liver damage, Lung cancer, Alteration of genetic material, Death. National Toxicology Program (NTP) listed that chromium and its most trivalent compounds gives insufficient proof to be carcinogen in experimental animals. According to NTP,

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hexavalent chromium compounds gives enough proof to be carcinogen in experimental animals such as; zinc chromate, strontium chromate, lead chromate, chromium trioxide and calcium chromate. Chromium and its trivalent compounds has been listed within Group 3 by International Agency for Research on Cancer (IARC). Results of several studies on animals have shown that their exposure to chromium (VI) may increase the rate of lung cancer. Department of Health and Human Services (DHHS) and World health Organization (WHO) have accepted that chromium (VI) may cause cancer and therefore it is human carcinogen.[22]

### **Applications: Metallurgy**

Chromium is an important alloying material for steel as it strengthens the forming of stable metal carbides at the boundaries of grain and increase in corrosion resistance. The corrosion resistance and relative high hardness are the reasons of good surface coating of unalloyed chromium and still the most " popular" metal coating with unmatched combined durability. By electroplating techniques, pretreated metallic surfaces are coated with a thin layer of chromium. There are two deposition methods: Thin, below 1  $\mu\text{m}$  thickness, layers are deposited by chrome plating, used for surfaces decoration. Thicker chromium layers are coated, if wear-resistant surfaces are needed. acidic chromate or dichromate solutions are normally used for both methods.[23]

### **Dye and Pigment**

Shortly after the discovery of the mineral crocoite (lead chromate  $\text{PbCrO}_4$ ), it was used as a yellow pigment. Chrome yellow mutually with cadmium yellow were one of the most used yellow pigments. Lead chromate  
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( $\text{PbCrO}_4 \cdot \text{Pb(OH)}_2$ ) which is basically chrome red known as the bright red pigment. Zinc chromate an important chromate pigment, was used extensively in metal primer formulations, which is currently replaced by zinc phosphate.[24] Ruby which are made when chromium(III) doped into the crystals of corundum to achieve red color and therefore used to produce synthetic rubies.[25] For glaze in ceramics and green color in glassmaking, chromium oxides are used.[26] Green chromium oxide is used in cladding coatings and is also the main component in IR reflecting paints, armed forces use it to paint their vehicles to give them green leaves IR reflectance.[27]

## **Wood Preservative**

For the preservation of wood, chromium(VI) salts were used as they are toxic in nature. Such as, chromated copper arsenate (CCA) is used in timber treatment to protect wood from decay fungi, wood attacking insects, including termites, and marine borers.[28]

## **Tanning**

Chromium(III) salts, especially chrome alum and chromium(III) sulfate, are used in the tanning of leather.[29] Chromium between 4 and 5% is contained in chromium tanned leather, which is tightly bound to the proteins.[30]

## **Refractory Material**

The high melting point and heat resistivity makes chromium(III) oxide and chromite a material with applications in high temperature refractory, like cement kilns, blast furnaces, foundry sands for the metals casting and molds for the bricks firing. In these applications, mixtures of magnesite and chromite are used for the manufacturing of refractory materials. The

possibility of the formation of chromium(VI) is declining the use as per environmental regulations.[31]

## **Catalysts**

Several chromium compounds are used as catalysts for processing hydrocarbons. For example, the Phillips catalysts for the production of polyethylene are mixtures of chromium and silicon dioxide or mixtures of chromium and titanium and aluminium oxide.[32]

## **ADSORPTION**

Adsorption is the adhesion of atoms, ions, or molecules from a gas, liquid, or dissolved solid to a surface.[33] This process creates a film of the adsorbate on the surface of the adsorbent. This process differs from absorption, in which a fluid (the adsorbate) permeates or is dissolved by a liquid or solid (the adsorbent). Absorption involves the material's whole volume while adsorption is a surface-based process. [34]

## **The Nature of Adsorbents**

Adsorbents are available as irregular granules, extruded pellets and formed spheres. The size reflects the need to pack as much surface area as possible into a given volume of bed and at the same time minimize pressure drop for flow through the bed. Sizes of up to about 6 mm are common. To be attractive commercially, an adsorbent should embody a number of features: It should have a large internal surface area. The area should be accessible through pores big enough to admit the molecules to be adsorbed. It is a bonus if the pores are also small enough to exclude molecules which it is desired not to adsorb. The adsorbent should be capable of being easily

regenerated. The adsorbent should not age rapidly, that is lose its adsorptive capacity through continual recycling. The adsorbent should be mechanically strong enough to withstand the bulk handling and vibration that are a feature of any industrial unit.[35]

## **TYPES OF ADSORPTION**

Based on the interaction between the adsorbent and adsorbate, there are following types of adsorption.

### **Physio-sorption**

The adsorption in which the molecules or atoms are held to the solid or liquid surface by Vander wall's attraction forces is called physical adsorption. For example, the adsorption of toxic metals on clay. It provides information about the structure of solids and its surface area.

### **Chemi-sorption**

The adsorption of a substance at a surface involving the formation of chemical bond between the adsorbate and the adsorbent which may be covalent or ionic is called chemical adsorption. The chemical adsorption is of fundamental importance in heterogeneous catalysis.[36]

## **FACTORS AFFECTING ADSORPTION**

The most important factors affecting adsorption are:

### **Surface Area of Adsorbent**

Larger sizes imply a greater adsorption capacity. Particle Size of Adsorbent Smaller particle sizes reduce internal diffusion and mass transfer limitation to the penetration of the adsorbate inside the adsorbent (i. e.,

equilibrium is more easily achieved and nearly full adsorption capability can be attained). However, wastewater drop across columns packed with powdered material is too high for use of this material in packed beds. Addition of powdered adsorbent must be followed by their removal. Contact Time or Residence Time The longer the time the more complete the adsorption will be. However, the equipment will be larger.

### **Solubility of Solute (Adsorbate) in Liquid (Wastewater)**

Substances slightly soluble in water will be more easily removed from water (i. e., adsorbed) than substances with high solubility. Also, non-polar substances will be more easily removed than polar substances since the latter have a greater affinity for water.

### **Affinity of the Solute for the Adsorbent (Carbon)**

The surface of activated carbon is only slightly polar. Hence non-polar substances will be more easily picked up by the carbon than polar ones.

### **Number of Carbon Atoms**

For substances in the same homologous series a larger number of carbon atoms is generally associated with a lower polarity and hence a greater potential for being adsorbed (e. g., the degree of adsorption increases in the sequence formic-aceticpropionic-butyric acid).

### **Size of the Molecule with respect to Size of the Pores**

Large molecules may be too large to enter small pores. This may reduce adsorption independently of other causes.

## **Degree of Ionization of the Adsorbate Molecule**

More highly ionized molecules are adsorbed to a smaller degree than neutral molecules.[37]

## **Effect of Bed Thickness**

The efficiency will increase with the bed thickness of the adsorbent while the saturation or the equilibrium value is of course not affected. This effect decreases as the bed becomes thicker and there is a minimum thickness variable with the rate flow, below which there is no break of point.

## **Effect of Temperature**

Generally heat is evolved during the process of adsorption. So, the magnitude of adsorption should increase with falls in temperature (Le-Chatelier's principle).

## **Effect of Pressure**

Since adsorption of a gas causes decrease of pressure, so the magnitude of adsorption should increase with increase of pressure.[38]

## **pH**

The degree of ionization of a species is affected by the pH (e. g., a weak acid or a weak basis). This, in turn, affects adsorption. Also, It depends upon the composition of adsorbent. This is due to solubility of constituents of adsorbent which leads to smaller number of available sites for adsorption.

[37, 38]Adsorption EquilibriaThe rate of adsorption of molecules on to a surface equal to the rate of desorption is called Adsorption Equilibrium. The capacity of an adsorbent for a particular adsorbate involves the interaction

of three properties—the concentration  $C$  of the adsorbate in the fluid phase, the concentration  $C_s$  of the adsorbate in the solid phase and the temperature  $T$  of the system. If one of these properties is kept constant, the other two may be graphed to represent the equilibrium. The commonest practice is to keep the temperature constant and to plot  $C$  against  $C_s$  to give an adsorption isotherm. When  $C_s$  is kept constant, the plot of  $C$  against  $T$  is known as an adsorption isostere. In gas–solid systems, it is often convenient to express  $C$  as a pressure of adsorbate. Keeping the pressure constant and plotting  $C_s$  against  $T$  gives adsorption isobars.[35]

## Adsorption Isotherms

The relationship between equilibrium pressure of a gas and its amount adsorbed on the solid adsorbent at any constant temperature is called Adsorption Isotherm. It can be an equation or in the form of graphical curve. [39]

## Langmuir Adsorption Isotherm

At higher gas phase concentrations, the number of molecules absorbed soon increases to the point at which further adsorption is hindered by lack of space on the adsorbent surface. The rate of adsorption then becomes proportional to the empty surface available, as well as to the fluid concentration. At the same time as molecules are adsorbing, other molecules will be desorbing if they have sufficient activation energy. At a fixed temperature, the rate of desorption will be proportional to the surface area occupied by adsorbate. When the rates of adsorption and desorption are equal, a dynamic equilibrium exists. For adsorption which is confined to a mono-molecular layer, the equilibrium may be written as:  $k_0a_0C = k_0(1 -$   
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$C = k_1 a_1 / (1 + k_1 a_1)$  where;  $a_0$  = the fraction of empty surface.  $a_1$  = the fraction of surface occupied by a monolayer of adsorbed molecules.  $k_0$  = the velocity constant of empty surface for adsorption.  $k_1$  = the velocity constant of a monolayer for desorption. Equation (A) is developed for adsorption from the gas phase. It can be expressed convenient in terms of partial pressures, which gives;  $C_s / C_{sm} = B_1 P / (1 + B_1 P)$  (B) where;  $C_s$  = the adsorbed phase concentration.  $C_{sm}$  = the adsorbed phase concentration when monolayer is complete.  $B_1 = B_0 / R T P$  = the partial pressure of adsorbate in the gas phase. Equations (A) and (B) describes the adsorption of gases on to plane surfaces of glass, mica and platinum and is form of the LANGMUIR equation, developed in 1916. A number of assumptions have been made. As being limited to monolayer adsorption, the Langmuir equation assumes that: There are no interactions between adjacent molecules on the surface. The energy of adsorption is the same all over the surface. Molecules adsorb at fixed sites and do not migrate over the surface.[35]

## Freundlich Adsorption Isotherm

Freundlich proposed an empirical relation in the form of a mathematical equation.  $w/m = k P^{1/n}$  where;  $w$  = mass of gas adsorbed  $m$  = mass of adsorbent  $P$  = pressure and  $k, n$  are the constants depending on the nature of the gas and adsorbent and on temperature. This relation is generally represented in the form of a curve obtained by plotting the mass of gas adsorbed per unit mass of adsorbent ( $w/m$ ) against equilibrium pressure. Freundlich Isotherm is not applicable at high pressures. Taking logarithms on both sides of the freundlich equation, we have  $\log w/m = \log k + 1/n \log P$



This is the straight line equation. Thus a plot of  $(\log w/m)$  against  $\log P$  should be straight line with slope of  $1/n$  and intercept of  $\log k$ . However, it is actually found that the plots were straight lines at low pressures, while at high pressures they show slight curvature, especially at low temperature. This indicated the Freundlich Equation was approximate and do not apply to adsorption of gases by solids at higher pressures.[39]

## **Applications of Adsorption**

### **Production of High Vacuum**

If a partially evacuated vessel is connected to a container of activated charcoal cooled with liquid air, the charcoal adsorbs all the gas molecules in the vessel. This results in a very high vacuum. This process is used in high vacuum equipments as Dewar Flask for storage of liquid air or liquid hydrogen. Silica gel is also useful as an adsorbent in the production of high vacuum.

### **Gas Masks**

All gas mask are devices containing an adsorbent (activated charcoal) or the series of adsorbents. These adsorbents remove the poisonous gases by adsorption and purify the air for breathing.

### **Heterogeneous Catalysis**

In heterogeneous catalysis, the molecules of reactants are adsorbed at the catalyst surface where they form 'adsorption complex'. This decomposes to form the product molecules which then take off from the surface.

## **Removal of colouring matter from solution**

Animal charcoal removes colors of the solution by adsorbing colored impurities. So, for cane-sugar manufacturing, activated charcoal or animal charcoal is used for the clarification of the colored solution.

## **Froth Flotation Process**

Low grade sulphide ores ( $ZnS$ ,  $PbS$ ,  $Cu_2S$ ) are freed from silica and other earthy matter by Froth Flotation Process. The finely divided ore is mixed with oil (pine oil) and agitated with water containing a detergent (foaming agent). When air is bubbled into this mixture, air bubbles are stabilized by the detergent. These adsorb the mineral particles wetted with oil and rise to the surface. The earthy matter wetted by water settles down at the bottom.

## **Chromatographic Analysis**

Mixtures of small quantities of organic mixtures can be separated with the help of Chromatography which involves the principle of selective adsorption. Mixtures of gases can be separated by the adsorption of gases by liquids (Gas Chromatography).[39]

## **TURNIP**

The turnip or white turnip (*Brassica rapa* subsp. *rapa*) is a root vegetable commonly grown in temperate climates worldwide for its spherical, white taproot. For human consumption, small and tender varieties are grown whereas for livestock feed, larger varieties are grown.

## History

Turnip (*Brassica rapa* L.) is a root Brassica crop and since prehistoric times its been consumed in Europe by humans as a vegetable. For at least 600 years, it has been used as a popular livestock fodder. Researchers in the United States determined in the early 1900 that for young ruminant animals, roots of turnip are important energy source. Because of much labor requirement for the large roots production and utilization, livestock farmers were quitting from using the Brassica root crops for fodder. In 1970's ending, potential of turnip was demonstrated by the researchers as a pasture. With variety of partly exposed roots provided the roots more accessible to grazing animals. The look for food is of high quality as turnip roots and tops are readily grazed by domestic animals. The physical labor in harvesting and storing is eliminated by pasturing. Generally, due to existing pastures, the root Brassica's are well adapted to seeding, high yielding, and fast-growing. Turnip is a crop of cool-weather and is quite well adapted for the Europe, United States, Canada and Great Britain. On the other hand, some areas of the South in all seasons also produce turnip greens and roots for human consumption.[40]

## Description

The very common form is generally white-skinned separately 1–6 centimeters from the above, which stick out of the ground and are greenish, red, or purple. This projected part is fused with the root and develops because of stem tissue with entirely white interior flesh. The whole root is almost conical, but rarely global with 5–20 centimeters diameter. The taproot is thin with 10 centimeters or more in length which is wiped off before

marketing. Turnip roots weigh almost one kilogram and can be collected when smaller. Size is partly a function of time the turnip has took to grow and somewhat as a variety.[41]

## **Nutrition**

Vitamin C is the only constituent in the root of turnip. Turnip greens are a good source of folate, calcium, vitamin A, C and K. Turnip greens are highly enriched in lutein. According to the USDA, an average raw turnip (122g) contains the following nutrition:[41]Calories : 34Fat: 0. 12Carbohydrates: 7. 84Fibers: 2. 2Protein: 1. 10Cholesterol: 0

## **Environment Requirements**

### **Climate**

Brassicas can be planted as a second crop and provide grazing of high-quality in the late fall. Turnip will supply crop from September to November, if it is planted in July. In the fall, at low temperature (400 to 600 F), the root grows vigorously. Being after exposed to frost, the leaves still maintain their nutrition.

### **Soil**

Turnip grows at their best in a slightly acid , fertile and deep soil, like other Brassicas. Turnip does not grow well where the soil is poorly drained, wet or having high texture of clay. Turnip grows good in a well aerated and loose soil.[40]

## **DATE-PLUM PERSIMMON**

*Diospyros lotus*, with common names Date-plum or Caucasian Persimmon, is a widely cultivated species of the genus *Diospyros*, native to subtropical southwest Asia and southeast Europe. Its English name derives from the small fruit, which have a taste reminiscent of both plums and dates. It is among the oldest plants in cultivation.

### **Ecology**

The tree grows in the lower and middle mountain zones in the Caucasus. They usually grow up to 600 m above sea level. In Central Asia, it rises higher - up to 2000 m. They rarely grow in stands but often grows with the frame, ash, maple and other deciduous species. It is not demanding on the soil and can grow on rocky slopes but requires a well lit environment.

### **Biological description**

This is a tree height of 15-30 m with sloughing of aging bark. The leaves are shiny, leathery, oval shape with pointed ends, 5-15 cm long and 3-6 cm in width. The flowers are small, greenish, appearing in the June-July. Fruits are berries with juicy flesh, yellow when ripe, 1-2 cm in diameter. Seeds with thin skin and a very hard endosperm.

### **Uses**

Caucasian persimmon fruits are edible and contain lots of sugars, malic acid, and vitamins. They are used as fresh fruits or after frost, but usually dried. Drying and frost destroy their tartness.[42]