Aspirin

Science, Chemistry

Aspirin Aspirin Aspirin is one of the major and oldest pain killers used in the medical science. It is assumed that almost 40000 tonnes of aspirinare consumed every year worldwide. It has many other medical uses in the treatment of fever, inflammation, swelling rheumatoid arthritis, rheumatic fever, and mild infection. Even though the discovery or isolation of Aspirin took place in 1897 through a German chemist; Felix Hoffmann, many scientists worked behind the curtain from 1826 onwards to identify a pain relieving drug.

In 1828, Johann Buchner, professor of pharmacy at the University of Munich, isolated a tiny amount of bitter tasting yellow, needle-like crystals, which he called salicin. Two Italians, Brugnatelli and Fontana, had in fact already obtained salicin in 1826, but in a highly impure form. By 1829, [French chemist] Henri Leroux had improved the extraction procedure to obtain about 30g from 1. 5kg of bark. In 1838, Raffaele Piria [an Italian chemist] then working at the Sorbonne in Paris, split salicin into a sugar and an aromatic component (salicylaldehyde) and converted the latter, by hydrolysis and oxidation, to an acid of crystallized colorless needles, which he named salicylic acid (Bellis, 2012)

Acetyl salicylic acid is the chemical name of Aspirin. In other words, Salicylic acid is the major content of Aspirin. Aspirin plays a vital role in the metabolism of humans and animals. This paper analyses the various aspects of aspirin such as chemical formula, systemic names, physical and chemical properties, relevance of its physical and chemical properties and precautions while taking aspirin etc.

Chemical Formula

As mentioned earlier, Acetyl salicylic acid is the chemical name of Aspirin. C9H8O4 is the chemical formula of aspirin. The elaborated chemical formula of aspirin can be represented as CH3COOC6H4COOH. In other words, each aspirin molecule consists of 9 carbon atoms, 8 hydrogen atoms and 4 oxygen atoms. Structural formula of aspirin can be represented as follows.

(Aspirin, chemical formula, 2011)

Systematic name

2-acetyl benzoic acid is the systemic name of aspirin.

Physical and chemical properties

Physically, Aspirin is a solid substance. It is colorless, odorless, white, crystalline, acidic substance. Its melting point is 137°C and boiling point is 140°C. Moreover, it is soluble in water. As evident from the chemical structure, Aspirin is an aromatic compound with a ring structure. It can be converted into several different useful compounds because of its ring or aromatic structure. “ Molecular Weight of aspirin is 180. 15 g/mole and its Specific Gravity: 1. 35 (Water = 1)” (Material Safety Data Sheet Acetylsalicylic acid MSDS, n. d., p. 3). Acetylsalicylic acid (ASA) or aspirin reacts rapidly with acetates, carbonates, citrates or hydroxides of the alkali metals. However, it is not much reactive with air and remains stable even if exposed to dry air for a prolonged period.

Pharmacological properties of Aspirin

Aspirin, is analgesic, anti-inflammatory, antipyretic and is an inhibitor of platelet aggregation. It inhibits fatty acid cyclo-oxygenase by acetylation of the active site of enzyme and the pharmacological effects of aspirin are due

to the inhibition of the formation of cyclo-oxygenase products including prostglandins, thromboxanes and prostacyclin (The Chemistry of Aspirin, n. d.).

Salicylic acid has excellent antiseptic properties and it is often recommended as an alternative to carbolic acid. It is used for the preservation of meat and milk. “ Of the several discoveries regarding practical applications of salicylates, the most significant was the finding that synthetic salicylates were potent anti-inflammatory analgesics and useful for treating rheumatic diseases” (Schrör, 2009, p. 7) Until the identification of this property of salicylates, medical science had no clue at all in how to treat rheumatic diseases. It should be noted that salicylates are cheap and available plenty in quantity on earth. Its antiseptic, anti-inflammatory and antipyretic properties helped millions of the people all over the world since the identification of its medical use.

At low doses, aspirin inhibits an enzyme called cyclooxygenase-1, or COX-1 in shortened form. This enzyme is responsible for making a molecule called thromboxane A2, which signals platelets to stick together. A medium dose of aspirin inhibits COX-1 and COX-2. COX-2 is responsible for making prostaglandins, substances that communicate messages to nerves and immune cells. A high dose is anti-inflammatory as it inhibits the COX enzymes and might suppress certain activities of immune cells called neutrophils (Fox, 2010).

Many people have the doubts about how aspiring works only on the area in which a person feels pain. When a person takes aspirin, it dissolves in the stomach and the body absorb it. Aspirin will dissolve in the blood and it may

pass through the entire body.

“ Although it is everywhere, it only works where there are prostaglandins being made, which includes the area where it hurts” (Hoffman, 2012). However, it should be noted that aspirin goes through the entire body system and hence it can affect all the areas in which prostaglandins being present. “ The problem with the fact that aspirin goes through your entire bloodstream is that your body needs prostaglandins for some reasons. One place they are useful is in the stomach; it turns out another enzyme called COX-1 makes a prostaglandin that seems to keep your stomach lining nice and thick” (Hoffman, 2012)

Inhibition of prostaglandin biosynthesis is another pharmacological effect of aspirin.

Prostaglandin has the physiological effects such as the regulation of the contraction and relaxation of the muscles in human body. It should be noted that many of the rheumatic arthritis diseases were caused by the problems in the regulation of the contraction and relaxation of the muscles. In 1971, John Vane at the Royal College of Surgeons of England found that aspirin can be used effectively to treat several types of arthritis. “ In his pioneering paper, the later Sir John Vane showed by elegant bioassay experiments that aspirin – and salicylate – inhibited prostaglandin formation in cell-free systems after tissue injury”(Schrör, 2009, p. 13). Some of the other major pharmacological uses of aspirin are; prevention of heart attacks, blood clotting, prevention of cancer etc. “ A lot of research is being done now to find out if aspirin can be used for other problems; it has already shown some promise in helping with problems as diverse as cataracts in the eyes, some

cancers, gum disease, and high blood pressure during pregnancy”(Hoffman, 2012)

Precautions while taking aspirin

Even though aspirin is a useful medicine in treating several diseases, it has some side effects also. One of the major side effectsof aspirin is Gastrointestinal ulcers. Therefore, precautions should be taken while taking aspiring on a regular basis. As mentioned earlier, water has the ability to dissolve aspirin quickly so that the blood will consume the ingredients as quickly as one would take aspirin. “ Aspirin also changes the way your kidneys make urine, can cause some people to have trouble breathing (rarely), and can be dangerous at very high doses” (Hoffman, 2012). Aspirin should never be taken while the stomach is empty. Stomach upset may take place if aspirin is taken while the stomach is empty. Aspirin tablets should be swallowed instead of chewing. Those who are taking aspirin tablet should make sure that their hands are dry.

Patients who are going to face surgery like complicated medical procedures should inform the surgeon about the medicines such as aspirin they are taking. It is not advisable to take aspiring during or immediately after the surgery. Outdated aspirin tablets with the smell of a strong vinegar odor should not be taken under any circumstances. Moreover, aspirin tablets should be kept at room temperature for prolonged use.

Aspirin is meant for adults only. It should not be given to the children or teenagers without doctor’s prescription. It is better to avoid taking aspirin by flu or chicken pox patients.

Do not use this medication if you are allergic to aspirin, or if you have: a

recent history of stomach or intestinal bleeding; a bleeding disorder such as hemophilia; or an allergy to an NSAID (non-steroidal anti-inflammatory drug) such as Advil, Motrin, Aleve, Orudis, Indocin, Lodine, Voltaren, Toradol, Mobic, Relafen, Feldene, and others; asthma or seasonal allergies; stomach ulcers; liver disease; kidney disease; a bleeding or blood clotting disorder; heart disease, high blood pressure, or congestive heart failure; gout; or nasal polyps. If you are taking aspirin to prevent heart attack or stroke, avoid also taking ibuprofen (Advil, Motrin) Aspirin, 2012).

Functional groups of aspirin and the reactions it can undergo

Aspirin (acetylsalicylic acid) contains three groups: carboxylic acid functional group (R-COOH), ester functional group (R-O-CO-R) which are illustrated in the figure given below.

(Aspirin (acetylsalicylic acid), n. d.)

Since Carboxyl functional group in acidic in nature, it reacts with react with bases and neutralizes it. It can converts carbonates into salt, CO2, water. It can react with metals to produce hydrogen and engage in esterification reactions with alkanols (Aspirin (acetylsalicylic acid), n. d.) The ester group in aspirin has the ability to participate in addition reduction reactions.

Reactions of aspirin with prostaglandins

Prostaglandins are unsaturated carboxylic acids, consisting of a 20 carbon skeleton that also contains a five member ring and are based upon the fatty acid, arachidonic acid. Aspirin blocks an enzyme called cyclooxygenase, COX-1 and COX-2, which is involved with the ring closure and addition of oxygen to arachidonic acid converting to prostaglandins (Prostaglandins, 2003).

It should be noted that Prostaglandins are responsible for causing pain, fever, blood clotting, gastrointestinal tract, uterine contractions etc. The acetyl group in aspirin has the ability to block an enzyme called COX1 and COX 2 which is reacting with arachidonic acid or prostaglandins. This reaction is the actual reason for pain and fever. By blocking this reaction, aspirin helps to avoid pain and fever. “ Aspirin is also thought to inhibit the prostaglandin synthesis involved with unwanted blood clotting in coronary heart disease” (Prostaglandins, 2003). The reactions of aspirin with Prostaglandins can be illustrated as follows.

(Prostaglandins 2003)

Conclusions

Aspirin is one of the most useful antiseptic, anti-inflammatory, and antipyretic medicines available at present. It is used widely for relieving pain and also for the treatment of arthritis, fever, etc. It was discovered by Johann Buchner, professor of pharmacy at the University of Munich, in 1828. Acetyl salicylic acid is the chemical name of Aspirin and C9H8O4 is the chemical formula of aspirin. Since aspirin is an aromatic compound with ring structure, it easily reacts with many other substances and form many useful compounds. It is a colorless, odorless, white, crystalline, acidic substance which melts at137°C and boils at 140°C. Moreover, it is soluble in water. Even though aspirin is a useful drug, precautions must be taken while using it. It should not be used without doctor’s prescription under any circumstances. Stomach upset may result if aspirin is taken in empty stomach. Aspirin should be swallowed with a cup of water instead of chewing. Patients who are taking aspirin on regular basis for some diseases

should inform the doctors about it before proceeding for complex medical procedures such as surgery.

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