

ETHNO-MEDICINAL POTENTIALS AND PHYTOCHEMICAL PROPERTIES OF *Aloe vera*: A REVIEW

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ABSTRACT

Aloe vera is a perennial ethno-medicinal potential plant with a xerophytic characteristic, but not a cactus. It has a famous history owing to its phytopharmaceutical properties and this had made it useful in the pharmaceutical, cosmetic and food industries. Studies had shown the positive effects of its extract against bacteria, fungi, virus and parasitic organisms. The phytochemical properties of *A. vera* have been exploited for various economic and commercial purposes. This review contributes literature on the bioactive potential composition, processing and the pharmaceutical potential uses, an adverse side-effect that might spring up in case of over dosage and important safety precautions are summarized. More scientific innovations and developments in the aspect of analytical chemistry are on the way to provide more acceptable, purified chemical characterization of *A. vera* using sophisticated laboratory equipment and machines.

Keywords: *Aloe vera*; Pharmacological properties; Composition; Phytochemical

1.0 INTRODUCTION

Aloe vera as an ethno-medicinal plant is in high esteem position in the pharmacological set up due to the presence of richly bioactive components it possesses which are of medicinal value as established by the World Health Organization (WHO). Their affirmation was that about 80% of the global population solemnly relied on the ancestral medicines for their recovery while the remaining 20% of the global population only resides in advanced countries of the world (Raksha, 2014). However, there is an increase in demand for *A. vera* through out the world because it is a natural product that has no adverse side-effects, non-narcotic, economically affordable, biodegradable and ecology friendly (Maan *et al.*, 2018). Phytochemicals present in medicinal plants are used for new drugs design and discovery. It has its origin from the tropical South and East Africa as well as the Mediterranean areas. There are over 400 species found all over the world and it is cultivated mostly in the subtropical regions. It is a perennial plant with shrubby and succulent green leaves usually varies from bright green to grey colour in a rosette pattern at the plant stem. The flesh of the leaves is triangular with serrated edges made up of a thick epidermis called mesophyll which are enveloped by the cuticle. During the drought long period or warm dry climate condition, the leaves

have great ability to store water in order to survive the harsh condition (Lanka, 2018; Maan *et al.*, 2018; Pansar *et al.*, 2018; Sahu *et al.*, 2013).

However, *A. vera* belongs to the members of the tree lily family called Alliaceae but it is not cactus. Other members of the lily family that are related to this plant are garlic, onion and turnip families. The relationship of this plant with the lily family is a manifestation of tubular yellow flowers that came out during the spring period annually which also has the same resemblance with those of the Easter lily. However, *A. vera* as a medicinal plant has been used in past time for their therapeutic reasons. Its common names are *Zanzibar aloe*, *Aloe spicata*, *Barbados aloe*, *Chirukattali* (India), *Laloi* (Haiti), *Kumari* (Sanskrit), *Luhu* (Chinese), *Sabilla* (Cuba), *Nohwa* (Korean), *Subr* (Arabic), *Aloe*, *Cape aloe* (South Africa), *Ghikummar* (India), *Ghai Kunwar* (India), *Aloe vera*, *Socotrine aloe*, *Lohoi* (Vietnam), *Curacao aloe*, *Rokai* (Japanese), and *Indian aloes* (Raksha, 2014). These plants cannot survive in the cold region; when they are cultivated, matured one can grow to reach 2.5 to 48 in height and 28 to 36 in diameter. Each Aloe plant usually has about 12 to 16 leaves, weighing up to 3 pounds. Every 6 to 8 weeks, the plants can be harvested with about 3 to 4 leaves in each plant is removed.

Furthermore, *A. vera* among other species is regarded as the most populous, commercialised and potential plant in the field of study. Different parts of *A. vera* contain about 200 active compounds such as vitamins, saponins, sugar, amino acids, minerals, lignins, salicylic acid, anthraquinones, and enzymes as well as 75 nutrients (Misir *et al.*, 2014). The flowers contain ascorbic acid and volatile compounds while the rind contains lignin, polysaccharide, pectin, cellulose, and hemicellulose (Maan *et al.*, 2018). Likewise, the leaves serve as a source of different enzymes, vitamins, minerals, organic acids, and phenolic compounds (Maan *et al.*, 2018; Rahimi-Dehgolan *et al.*, 2012).

However, this plant is distinguished for its antidiabetic, antioxidant, immune boost, anticancer, sunburn relief, anti-ageing, and anti-inflammatory activities (Langmead *et al.*, 2004). Recently, *A. vera* has become more popular due to its herbal movement established by yoguru, holistic healers, alternative medicine promoters, and naturopaths. The industrial size of aloe raw product has been evaluated to be around \$125 million dollars and the volume of finished aloe product for the industry is about \$110 billion dollars (Pandey & Singh, 2016). The presence of these unique compounds has initiated different industrial applications of *Aloe vera*. Therefore, this review summarises the medical potential, phytochemical properties with their mechanism of action of *Aloe vera*, and industrial applications.

2.0 BOTANICAL DESCRIPTION

A. vera resembles xerophyte with a spiky cactus (Figure 1). It is a perennial clump-forming plant with a strong fibrous root, it produces about 12 to 16 basal leaves per plant weighing around 1500 g when it matures. When the plant is around 4 years old, it becomes matured; it has 12 years as its life span. The length of the leaves is about 0.5 m long and 8 to 10 cm breadth with a saw-like tooth across its margins. If the leaf is in a transverse section, it will show a slight concave image on the adaxial surface while the convex image will show on a low abaxial surface. The plant flowers stalk grew to about 1.5 m in height while the fruits contain many seeds in a triangular capsule shape (Sahu *et al.*, 2013). *A. vera* is practically free from infections, but sometimes black spot may

appear on the plant due to fungal disease, and this may destroy the entire plant. Soft rotting is usually caused by bacterial infection and *A. vera* enemy is frost because it cannot survive in frost states. Most of the *A. vera* is not toxic, but few contain hemlock like poisonous substance (Sahu *et al.*, 2013).



Figure 1. *Aloe vera*

3.0 CULTIVATION AND PROPAGATION

Inadequate production of *A. vera* to meet the increased demand by both cosmetic and pharmaceutical industries has been revealed in the previous studies (Ahlawat and Khatkar, 2011). Using sucker as a means of natural propagation of axillary shoots of *A. vera* is a slow multiplication way of meeting the growing demand. Likewise, the recent production of leaves is not good enough to meet the increasing demand of this plant for industrial usage. Moreover, the seed for sexual propagation of *A. vera* has a barrier because of the presence of male sterility. Another factor is that the less production of lateral shoot annually for vegetative propagation from a single donor is not encouraging. However, employing the use of standardized micropropagation methods become the better solution to solve these challenges of low production of *A. vera* for industrial purposes (Maan *et al.*, 2018; Molsaghi *et al.*, 2014; Raksha, 2014; Zakia *et al.*, 2013).

4.0 PHYTOCHEMISTRY OF ALOE VERA

The physical chemistry of bioactive compounds in *A. vera* has been identified for many years till date using various techniques including micellar electrokinetic chromatography, capillary electrophoresis, counter current chromatography, HPLC, GC/MS, GC, LC/MS, LC-ESI-MS/MS, atomic absorption spectrometry, size exclusion chromatography, thin layer chromatography, and fluoro-photometry (Arunkumar & Muthuselvam (2009); Mukherjee *et al.*, 2013). Arunkumar and Muthuselvam (2009) used GC-MS and qualitative method to identify about 26 bioactive compounds from the ethanolic extract of *A. vera*. The *A. vera* gel is made up of the following: 55% of polysaccharides, 16% of minerals, 17% of sugars, 1% phenolic compounds, 4% of lipid, 0.66% of solid content, and 0.56% of soluble solid (Pandey & Singh, 2016). The leaf of

A. vera is made up of 98% of water. It is made up a lot of important antioxidant and vitamins such as vitamin A, thiamine (vitamin B1), riboflavin (vitamin B2), niacin, folic acid, choline, vitamin C, and E (Pandey and Singh, 2016). Furthermore, the leaves of most species contain phenolic compounds which have analysed chromatographically. The results showed more than 100 major zones, characterised with a stained colour of different dyes which were identified and characterized as anthraquinone and chromone and other bioactive compounds such as salicylic acid, lactate, magnesium, and bradykininase (Mukherjee *et al.*, 2013). Table 1 illustrates the different important bioactive compounds identified in *A. vera*.

Table 1: Bioactive compounds in *Aloe vera*

No	Phytochemical group	Bioactive compounds	Medicinal properties and activity	References
1	Anthrones/ anthraquinone	Aloin A and B (barbaloin), aloetic-acid, aloe-emodin, emodin, ester of cinnemonic acid, resistannol, chrysophanic acid, ethereal oil, isobarbaloin, anthranon, and anthracine	Antibacterial, antiviral and analgesic agent	Maan <i>et al.</i> (2018); Mukherjee <i>et al.</i> (2013); Sandeep and Yadav (2014);
2	Chromones	8-C-glucosyl-(8)-aloesol, 8-C-glucosyl-(2'-O-cinnamonyl)-7-O-methylaloediol A, 8-C-glucosyl-noreugenin, neoaloesin A, 8-C-glucosyl- (S)- aloesol, and isorbaichromone	Anti-inflammatory agent	Maan <i>et al.</i> , 2018; Mukherjee <i>et al.</i> (2013); Sandeep and Yadav (2014); Liu <i>et al.</i> (2013)
3	Enzymes	cyclooxygenase, amylase, cyclooxygenase, catalase, peroxidase, superoxide dismutase, cellulase, alkaline phosphatase, oxidase, carboxypeptidase, phosphoenolpyruvate, carboxylase, and lipase	Antiviral and antifungal agent	Choche <i>et al.</i> (2014); Lanka (2018)
4	Carbohydrates	Sugars such as fucose, glucose, mannose, cellulose, fructose, arabinose, galactose, lactose, fructose, xylose, sucrose, rhamnose, uronic acids, maltose, pectic substance, and lignins	Anti-allergic, inflammatory and anti-viral	Maan <i>et al.</i> (2018); Mukherjee <i>et al.</i> (2013); Sandeep & Yadav (2014)
5	Minerals	Zinc, phosphorous, chlorine, copper, iron, manganese, chromium, calcium, sodium, magnesium, and potassium	Antioxidant	Sandeep & Yadav (2014); Liu <i>et al.</i> (2013); Maan <i>et al.</i> (2018); Mukherjee <i>et al.</i> (2013); Sahu <i>et al.</i> (2013)
6	Vitamins	Choline and vitamin (A, B, B1, B2, B 6, B 9, C, and E)	Antioxidant	Lanka (2018); Maan <i>et al.</i> (2018)

7	Amino acids	Arginine, alanine, aspartic acid, glutamic acid, cysteine, glycine, hydroxyproline, histidine, proline, leucine, serine, lysine, methionine, valine, isoleucine, threonine, phenylalanine, and tyrosine	Anti-inflammatory, antibacterial and analgesic	Maan <i>et al.</i> (2018); Ombito <i>et al.</i> (2015)
8	Organic acids	Citric acid, fumaric acid, formic acid, acetic acid, lactic acid, tartaric acid, pyruvate, succinic acid, and malic acid	Anti-inflammatory agent and antiseptic	Maan <i>et al.</i> (2018); Mukherjee <i>et al.</i> (2013); Sahu <i>et al.</i> (2013); Sandeep & Yadav (2014)
9	Lipids and organic compounds	Beta sitosterol, campesterol, cholesterol, and lupeol	Antiseptic, anti-inflammatory and analgesic agent	Maan <i>et al.</i> (2018)
10	Proteins	Lectin-like substance and lectin	Anti-inflammatory, antibacterial and analgesic	Maan <i>et al.</i> (2018); Sahu <i>et al.</i> (2013); Sandeep & Yadav (2014)

5.0 HOW TO PROCESS *Aloe vera*

A. vera had served as a constituent in various formulations. This plant needs enough of suitable processes and various preparations of different products accordingly. The use of *A. vera* as a constituent is the composition that increases the real ingredient while they are still inactive condition without changing their form to reduce the constituent in a negative form and to produce a needed result as a finished product with a preferable benefit (Eshun & He, 2004). Various processing procedures can be accompanied based on the essential demand of the industry with differences in quality product. Generally, *A. vera* can be produced into a different form such as a concentrate, powder and juice (Eshun and He, 2004; Maan et al., 2018).

5.1 *A. vera* Juice

Traditionally, *A. vera* juice is prepared by detaching and washing the leaf margin that are unpleasant parts. Under a refrigerated temperature of 4 °C, the juices are extracted by adding the materials to the pulpier. Then, the extracted juice can be stored at a lower temperature in order to avoid depletion of sensitive bioactive molecules (Maan *et al.*, 2018). Another method that can be used in preparing the juice is by removing the tip and base of the leaf, grind to make a slurry in form of soup consistency and then, treat with cellulose enzyme to free the constituents in the cell. Later, the material can be placed inside various course filters to filter-out the impurities such as rind particles. The liquid that is produced at the cause of the grinding process may be due to the de-pulping of the large piece of pulp that is formed. Finally, the material can be filtered using filters to eliminate traces of sand, leaves, emodin, aloin, and any particles. The bioactive constituents in the juice were three times compared to the traditional technique using this method (Ramachandra & Srinivasa Rao, 2008).

5.2 *A. vera* Powder

The *A. vera* powder is being produced by washing the *A. vera* fillets, put it inside a humidity chamber under suitable temperature and use hot air to dry the fillets (Ahlawat and Khatkar, 2011). Then, grind the dried materials and packed. However, the sensitive bioactive compounds of *A. vera* can be destroyed using the traditional drying method because it is detrimental to the temperature-sensitive bioactive compounds in the *A. vera*. Although, this process consumed time and not economical. Alternatively, a microwave-assisted drying method is a novel improved effective method that has been introduced to be better than the old and freeze-drying techniques (Maan *et al.*, 2018). The microwave-assisted method is being used to remove the product waters through microwave heating technique. This procedure is not only cost and energy efficiency, but it enhances improved quality product and speedy operations (Maan *et al.*, 2018).

5.3 *A. vera* Concentrate

When the temperature is below 50 °C, *A. vera* juice can be concentrated for about 120 s under vacuum (125 mmHg). The bioactive elements are very sensitive to pressure and temperature. Therefore, to avoid depletion of these bioactive compounds all the conditions must be carefully put into consideration (Ramachandra & Rao, 2008). Then, its juice can now be concentrated into a suitable and desirable consistency for different food applications such as fruit juices, tea, jellies, jams, and squashes.

6.0 PHARMACEUTICAL USES OF *Aloe vera*

A lot of studies on the therapeutic uses of *A. vera* had increased the significant use of this plant in the pharmaceutical industries across the globe due to its medicinal constituents. Various types of preparation of therapeutic drugs have been produced from this plant in the form of tablets, capsule and ointment (Eshun & He, 2004).

6.1 Anti-inflammatory Activity

A lot of studies on the *in vivo* and *in vitro* activity of *A. vera* gel had been reported to illustrate the anti-inflammatory activity of *A. vera*. *A. vera* contains an enzyme called peptidase bradykinase that reduces the bradykinins which produce pain (Kumar *et al.*, 2010). *A. vera* produces great anti-inflammatory activities due to the chromone and anthraquinones. It had been reported in a patient with aphthous stomatitis that oral administration of 2% oral aloe gel in such patient decreased the wound size and severe pains alongside. Anti-inflammatory action of *A. vera* helps to decrease prostaglandin E2 production from arachidonic acid by preventing the cyclooxygenase pathway from taking place (Reynolds, 1999). Some reported results by Sahu *et al.* (2013) recommended that plant sterol in Aloe gel can provide anti-inflammatory effects. Moreover, there was component in the *A. vera* had been identified to be aspirin-like compounds which can contribute to antimicrobial and anti-inflammatory activities (Sahu *et al.*, 2013). In addition, the uses of *A. vera* gel against colorectal mucosa had shown a strong anti-inflammatory potential (Xu *et al.*, 2004).

6.2 Wound Healing Effects

Wound healing is described as a process tissues under the skin to regain themselves after injury. *A. vera* has a healing function that is related to a polysaccharide like mannose (glucomannan) (Bal *et al.*, 2013). In this process, *A. vera* can be administered

orally and topically on the site of an injury; a growth hormone called gibberellin attacked the growth factor fibroblast receptors, thereby causing the cell to proliferate by increasing the synthesis of secretion and collagen (Bal *et al.*, 2013). *A. vera* contains some amino acids which are involved in the healing process of any wounds. Inorganic electrolytes present in the *A. vera* include zinc, iron, calcium, potassium, sodium, chromium, magnesium, and copper; these are the essential elements involved in the healing process of any wound (Sahu *et al.*, 2013). Other studies reported that *A. vera* involves in stimulating a body to produce antibodies and synthesis of growth factors to begin the wound healing process. Many studies have reported the fast healing of wounds using *A. vera* treatment (Maan *et al.*, 2018; Sahu *et al.*, 2013).

6.3 Anticancer Activity

Glycoproteins and polysaccharides in *A. vera* make it a potent chemo preventive agent that is useful against various types of cancers (Reynolds, 1999). These agents stimulate the immune system to fight against cancer (Grace *et al.*, 2008). The *in vitro* anticancer activity of *A. vera* against hepatocellular carcinoma (HepG2) cells, the obtained result indicated that the extract improved cytotoxicity against HepG2 cells in a dose-dependent manner (Shalabi *et al.*, 2015).

6.4 Anti-ulcer Activity

Peptic ulcer is one of the major chronic gastrointestinal diseases that affect the world population today. *A. vera* gel is good at preventing and treatment of gastric ulcers through various mechanisms such as healing, anti-inflammatory properties, regulation of gastric secretions, and mucus stimulation (Maan *et al.*, 2018). Suseela (2018) reported that *A. vera* possessed anti-ulcer property on rats induced with peptic ulcer inform of non-steroid inflammatory drug (NSAID). *A. vera* juice can also be used to relieve any form of gastrointestinal conditions such as the ulcerous cases. Nowadays, many people drink *A. vera* juice because it gives them an improved energy level and greater intestinal relief. Individuals suffering from colitis increased secretion of gastric acid and peptic acid, duodenal ulcer, irritable bowel syndrome, and indigestion have established comfort from these situations after ingesting the *A. vera* juice (Kumar *et al.*, 2010).

6.5 Antidiabetic Activity

In any population of the world today, *A. vera* has been used as a traditional medication for *Diabetes mellitus*. *A. vera* gel is one of the popularly known antihyperglycemic substances used in the treatment of Type II diabetes. It reduces the blood sugar level by not altering the kidney or liver functions and normal lipid level of the blood (Rajasekaran *et al.*, 2006). *A. vera*, among various plants, has low blood sugar trace elements including zinc, magnesium, and copper which enhances the insulin function of the plants. In the countries that are developing such as the Arab nations, *A. vera* has been used in treating diabetic persons (Ali, 2011). It has been reported that the metabolic effect of *A. vera* extracts on an over-weight patient diagnosed earlier with untreated *Diabetes mellitus*/prediabetes help lowering the insulin-resistance, fast body mass and body weight (Choi *et al.*, 2013). It has also been established that an increase in metabolism resulted in reducing the blood sugars level. Rizk & Sabri (2009) reported a reduction in fasting blood glucose, cholesterol and triglyceride in Type 2 diabetes patient using *A. vera* extracts It has been proposed that *A. vera* contain five phytosterols such as cycloartanol, 24-methyl-lenecycloartanol, 24-ethyl-lophenol, lophenol, and 24-

methyl-lophenol which serves as an antihyperglycemic agent in mice induced with Type 2 diabetes (Tanaka *et al.*, 2006).

6.6 Antioxidant Activity

The process of delaying autoxidation by preventing propagations of free radical through various mechanisms is called antioxidant. *A. vera* contains great numbers of antioxidant compounds which may help in increasing nutritional value and stability of food. It has been reported that the use of different model system showed different antioxidant properties of the extract of *A. vera* (Heş *et al.*, 2016). The cytotoxic and antioxidant activity were reported by López *et al.* (2017). *A. vera* possesses a great number of phenolic compounds (Maan *et al.*, 2018). It is said to have a large content of aloe emodin (1,8-dihydroxyanthraquinone) derivatives and aloins (glycosides) which are involved in cathartics (Miladi & Damak, 2008). Some rich source of antioxidants presents in *A. vera* includes such vitamin C, vitamin A, α -tocopherol, flavonoids, ascorbic acid, tannins, and carotenoids (Chauhan *et al.*, 2014; Cuvas-Limón *et al.*, 2016). Antioxidant potential of the extracts of *A. vera* (leaf and flower) had been reported by Lopez *et al.* (2013). *A. vera* has a dose-dependent antioxidant effect, which is helpful in the treatment of various diseases (Hamman, 2008). Investigations of the antioxidant potential of a polysaccharide isolated from *A. vera* gel showed that it had a protective effect against dihydrochloride induced oxidative stress and cell death in kidney epithelial cells (Upadhyay, 2018).

6.7 Antihyperlipidemic Effects

A. vera gel is professed to have the ability to reduce blood lipid level, this is called antihyperlipidemic activity. A study had shown that the supplementation of *A. vera* gel proves a significant reduction of the blood lipid level in the non-insulin dependent diabetic patient in two groups. The reductions are as follow: low-density lipoprotein cholesterol (LDL-C) (135.9 to 126.8 mg% and 141.1 to 128.1 mg%), very low density lipoprotein cholesterol (VLDL-C) (34.3 to 32.5 mg% and 35.4 to 32.7 mg%), increased high density lipoprotein (HDL-C) (36.9 to 38.8 mg% and 34.9 to 37.2 mg%), triglycerides (TG) (171.9 to 162.7 mg% and 177.4 to 163.8 mg%), and total cholesterol (TC) (207.2 to 196.9 mg% and 211.5 to 198.1 mg%) (Baldiet *et al.*, 2013). *A. vera* contains phytosterols such as lupeol, campesterol and sitosterol which possessed similar structure to cholesterol, they help in reducing the absorption of cholesterol from the small intestine in mixed micelles (Hamman, 2008).

6.8 Antibacterial Activity

A. vera as an antimicrobial efficacy was used for decontaminant of gutta-percha cones. The effectiveness of *A. vera* as an antimicrobial agent in decontaminating process was evaluated and determined using diffusion method. The result showed that after 48 h of incubation, there were zones of inhibition on the media plate which proves that *A. vera* is an effective decontaminant of gutta-percha cones (Hills *et al.*, 2014; Kargaran *et al.*, 2016). *A. vera* gel extract can shows maximum and effective antibacterial activity against common skin infections usually caused by gram-positive bacteria like *Staphylococcus aureus* and *Staphylococcus epidermidis*; and gram-negative organisms such as *Escherichia coli*, *Klebsiella pneumonia*, *Pseudomonas vulgaris*, *Pseudomonas aeruginosa*, and *Pseudomonas mirabilis*. Some of these causative organisms are resistant to broad-spectrum antibiotics like methicillin and vancomycin. This reveals the

significant of *A. vera* gel as a natural product that can help in controlling antibiotics resistant pathogen which has been a great challenge to human health (Bashir *et al.*, 2011; Udgire & Pathade, 2014). Similar results were observed using *A. vera* juice to evaluate antimicrobial activity in human life (Kumar *et al.*, 2017). Furthermore, high concentrations of *A. vera* gel showed better antimicrobial properties against oral pathogenic bacteria in oral-health treatment (Jain *et al.*, 2016). Studies had shown that *A. vera* gel can be used as an antimicrobial edible coating for various kinds of fruits to maintain the food quality requirements and safety (Maan *et al.*, 2018; Misir *et al.*, 2014). Hence, *A. vera* gel can provide safety condition to food by preventing them from foodborne microbial spoilage.

6.9 Antifungal Activity

A. vera is all-round natural product with no side effects, it is used in the treatments of stubborn yeast and fungal infections. Fungi infections are the leading cause of mortality and morbidity in the world today. A report was proposed using a diffusion method, it was reported that about 1000 µg/ml concentrations of *A. verae* extract inhibit the growth of *Candida albicans* effectively (Manipal *et al.*, 2015). Another study was investigated using *A. vera* as an antifungal agent to inhibit the growths of *Colletotrichum cococodes*, *Rhizoctonia solani* and *Fusarium oxysporun*. Moreover, *A. vera* plants contain saponins, a soapy substance which serves as antiseptic and cleansing agents against fungi and yeast (Sahu *et al.*, 2013). Another study affirmed that alcoholic *A. vera* leaf extracts can be used as a therapeutic agent to inhibit the growth of some selected fungal species that causes infection of the middle and external auditory canal of the ear such as *Aspergillus sp.* and *Candida albicans* (Saniasiaya *et al.*, 2017).

6.10 Activity on Genital Herpes

Genital herpes is one of the popular sexual transmitted infections caused by Herpes simplex virus, it is identified as a red bump with painful fluid in the genital area. Genital herpes cannot be cured but can only be prevented by not allowing its symptoms to become an outbreak. Treatment for this disease requires self-care activity such as the use of *A. vera* supplements, eating habit and stress reduction. *A. vera* gel extract has been reported to have antiviral effects on Herpes simplex virus Type 1. In an *in vitro* study, the results showed that about 0.2-5% of *A. vera* gel significantly inhibits the growth of Herpes Simplex Virus Type 1 in Vero cell line (Rezazadeh *et al.*, 2016). In addition, hydrophilic cream containing 0.5% of *A. vera* extract had been reported used for treating genital herpes in men (Syed *et al.*, 2009).

6.11 Activity on HIV Infection

HIV disease is caused by an RNA virus. There are two causative agents of acquired immunodeficiency syndrome namely: Human immunodeficiency virus Type 1 and 2. About forty million of the world population are living with HIV infections. About 80% of people living with HIV are found in Sahara Africa (Olatunya *et al.*, 2012). *A. vera* possesses a unique complex polysaccharide called glucomannan which is made up of mannose sugar (Sushen *et al.*, 2017). The damaged tissues are repaired by this glucomannan by interacting with fibroblast to stimulate, activate their growth and replication (Olatunya *et al.*, 2012). The extract of mannose, one of the sugars found in *A. vera* was used to treat human immunodeficiency virus Type 1 and the result showed 30% reduction in virus reproduction, suppressing the spreading of the virus and increasing in the chance of survival (Kumar *et al.*, 2010). *A. vera* gel is an essential part

for human immunodeficiency positive patients in a nutritional support program. Researchers had also discovered that *A. vera* can be used to stimulate T4 helper cells in immunosuppressed patients (Kumar *et al.*, 2010). Moreover, the use of herbal drugs for the treatment of HIV infected patients was investigated due to lesser adverse side effect and inexpensive (Olatunya *et al.*, 2012).

6.12 Activity on Chronic Bronchial Asthmatic

Storage of *A. vera* extract at 4 °C in the dark for a period of 3-10 days produces some active compounds (prostanoids) in the glycoprotein and polysaccharide fractions. These active compounds have shown effectiveness against chronic bronchial asthmatics. However, the activity against asthma becomes ineffective if the patient has been previously administered with a steroid drug (Reynolds, 1999).

6.13 Protection of Teeth and Gum

A. vera is very useful in the area of dentistry because it is mostly used after the periodontal surgery to provide pain relief and quick recovery (Subramaniam *et al.*, 2014). *A. vera* has a wide range of dental uses such includes application in gum tissues when they have been traumatized by sharp foods, toothpick or scratched by tooth brush-dentifrice abrasion; it can be applied on the alpthous ulcer, cracks at the corners of the lips, and herpetic lesions. It is beneficial to people with denatures maladaptive, sore teeth and gum. It is used in the treatment of periodontal diseases called periodontitis and gingivitis by reducing inflammation, swelling and bleeding of the teeth. *A. vera* is used in producing mouthwashes which are affordable and effective antiplaque herbal agent substitute for chlorhexidine. A study had reported that sodium hypochlorite and chlorhexidine cytological were toxic to the periodontal ligament cells of human thereby retarding mitochondrial activity and protein synthesis causing detrimental of the vital tissue (Subramaniam *et al.*, 2014).

6.14 Laxative Agent

A. vera gel composed of potent laxative called anthraquinones. It is locally used in the treatment of constipation. It helps to stimulate mucus secretion for improving intestinal peristalsis and water content. After oral administration of about 0.25 mg of *A. vera*, the laxative effects take place between 6 to 12 h but sometimes more than 24 h before intestinal peristalsis takes place. There is no laxative activity in infants, therefore, nursing mothers are safe to take it (Maan *et al.*, 2018; Sahu *et al.*, 2013).

6.15 Activity on the Stress

A. vera juice plays an important role in protecting body machinery from oxidative stress and in smooth functioning of the cell during stress. It helps in minimizing physiological and biochemical changes in the body. A study had reported how *A. vera* moderately reduced physiobiological and morphological trait salt stress (Murillo-Amador *et al.*, 2015).

7.0 OTHER USES OF *Aloe vera*

7.1 Cosmetic Usage

A. vera contains a special anti-ageing property which helps in maintaining fresh-looking healthy skin. Cosmetics are applied externally on the hair, eyes, lips, nails, and skin to enhance or change their beauty. *A. vera* composed about 20 amino acids and minerals such as sodium, magnesium, calcium, nitrogen, polysaccharides, vitamins, and others

that made it a beautiful miraculous herbal plant (Sushen *et al.*, 2017). The cosmetic property is its soothing, moisturizing, protective, and anti-inflammatory functions. In the seventies in the United States of America, it became very famous as a moisturizing component in cosmetic (Periasamy *et al.*, 2014). Its moisturizing and penetrating effects help in stimulating cell growth and rejuvenating injured skin. *A. vera* gel gloves are used to reduced erythema, acne wrinkle and enhancing skin integrity. Furthermore, *A. vera* gel can be used to treat pimples and to make the skin moist during dry weather. Due to its antimicrobial activities, it used in the treatments of benign skin cyst, boils and fungi infection such as tinea (Periasamy *et al.*, 2014; Qadir, 2009; Sahu *et al.*, 2013; Yadav, 2017).

In addition, *A. vera* can be used in the treatment of baldness and alopecia (Basmatker *et al.*, 2011). This is a process whereby hair is loss faster than their re-growth. *A. vera* consists of several ingredients that make it very helpful in treating hair loss. Hair loss is prevented because the pH value of *A. vera* is 6 and a weak acid that is very near to the normal skin pH value of 5. Its pH value is used to improve the revitalizations of the hair bulb by enhancing the penetration of the ingredients and strengthening its re-growth. Moreover, *A. vera* is very useful in the treatment of onychitis. This is inflammation nerve endings of the nails. It serves as an analgesic agent by reducing pains observed around the nerve ending of the nails (Basmatker *et al.*, 2011). Nowadays *A. vera* has become the most valuable dermatological extract used in the cosmetic industries throughout the world.

7.2 Applications in Food Industries

Recently, food industries across the world have shown high interest in the use of *A. vera* gel as a functional ingredient in food such as beverages, ice creams and drinks. Traditionally, *A. vera* is being used as an edible coating to increase food conservation and appearance. The coating can be in the form of polysaccharide, lipid and protein, it can be used as a combination or alone. They serve as an obstruction to oxygen and moisture from processing to the last stage for storage. Natural biocide property of *A. vera* is not only to prevent food from spoilage but, to enhance food safety. Another merit of an edible coating is that they are biodegradable to lower packaging waste, giving headway for new products. In Table 2, grapes, chitosan was effectively used to control storage graymold, reduce decaying and prolonged storage (Romanazzi *et al.*, 2002). Summary of application of *A. vera* in food is outlined in Table 2.

Table 2: Summary of the applications of *A. vera* in food

No	Food products	Applications	References
1	Blueberries, grapes, kiwifruit, nectarines, pomegranate, stone fruit, sweet cherries, and shrimp	Edible coating	Chrysargyris <i>et al.</i> (2016); Mani <i>et al.</i> (2017); Misir <i>et al.</i> (2014); Supapvanich <i>et al.</i> (2016); Maan <i>et al.</i> (2018); Vargas <i>et al.</i> (2008)
2	Mangoes, sweet cherries, table grapes, beverages, yogurts, and milks	Therapeutic agent	Aloui and Khwaldia (2016); Elbandy <i>et al.</i> (2014); Gharibi <i>et al.</i> (2015)
3	Ice cream, carbonated beverages, squashes, lassi, juices ready to be served, and dahi, sweetened <i>A. vera</i> juice	Nutraceutical and functional agent	Elbandy <i>et al.</i> (2014); Hussain <i>et al.</i> (2015); Maan <i>et al.</i> (2018); Romano <i>et al.</i> (2012); Upadhyay, (2018)

8.0 COMPLICATIONS AND SAFETY PRECAUTIONS

Several *in vivo* and *in vitro* assays had been carried out on *A. vera* latex; the analysis had shown some adverse side effect after consuming the chemical compounds present in the latex such as aloin, danthron, emodin, and aloe-emodin. These chemical components produced a carcinogenic, genotoxic and cytotoxic effect (Guo & Mei, 2016). In *salmonella* assay, the genotoxicity of anthraquinone derivatives was observed but, the clinical importance of the experimental results was not clear enough. Another side effect of a laxative drug like rhubarb or Senna includes abdominal pain, cramps, meteorism, haemorrhoid congestion, flatulence, and urine coloration become reddish if the pH is alkaline or becomes orange if acidic (Mukherjee *et al.*, 2013). Overdose can result in watery diarrhoea or bloody diarrhoea with mucus leading to haemorrhagic gastritis and electrolyte imbalance, vomiting and nephritis (Mukherjee *et al.*, 2013). Also, it will lead to hypokalaemia that cause decreasing in colonic movement while sodium loss can end up in secondary hyperaldosteronism which lead to muscular weakness, steatorrhea, mental disturbance, kidney dysfunction, impaired autoimmune nervous system, and weight loss (Guo & Mei, 2016; Mukherjee *et al.*, 2013). However, *A. vera* laxative activity may be toxic and teratogenic during pregnancy (Minwuyelet *et al.*, 2017).

Currently, aloin and anthraquinone in the *A. vera* gel had been reported to be the cause of colon cancers and tumour. Therefore, it has been recommended and mandated that cosmetic product produced from *Aloe vera*, aloin and anthraquinone content must not go beyond 50 ppm to prevent photo-oxidative destruction to both DNA and RNA (Maan *et al.*, 2018). Likewise, an allergic reaction may occur if *A. vera* is applied directly on a deep or open wound but, it is advisable to apply it safely on skin surface directly without injury (Christaki & Florou-Paneri, 2016; Maan *et al.*, 2018).

9.0 CONCLUSION

A. vera as an ethno-medicinal potential plant has been exploited globally for its therapeutic functions in the pharmaceutical, cosmetic and food industries. It is popular for its medicinal values. This miraculous and wonder plant has widely proven to be used in the treatments of many complications. The bioactive components in its succulent leaves are good for human health in immeasurable ways. However, the demand for the phytotherapeutic drugs across the globe has increased tremendously and there is need to search for new drugs that are herbal nature because most of the allopathic and synthetic drugs used these days usually developed antimicrobial resistant; this has been a major and global health challenge today in the health sector. Many trial studies had been reported on the bioactivity of this plant both in human and animals which had proven to be suitable for pharmaceutical, cosmetic and food applications. Although, some adverse side effect had been recorded in the laxative activity of this plant and safety precautions have been provided through many studies when taking this plant in form of laxative drugs or in the production of cosmetic and preservation of food. In addition, considering the increase in demand for natural products across the world and its economic importance, there is a need for more advanced technology in the vegetative cultivation of this plant and more studies are required to achieve this in a better and economical way. Additionally, there is a need for more health education on the use of herbal drugs to avoid its overdose complications. Conclusively, due to its positive effects that had been reported by various studies, *A. vera* can still be a cure or treatment for the infections.

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