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REVIEW

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Roles of Medicinal Plants in Organic Live Stock Production

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Eco-friendly management is important for farm animals healthy, so the use of naturally occurring compounds like herbs, herbal preparations and other botanicals are important for enhancement of overall animal health and satisfy consumer concerns. Key considerations in organic livestock production are the origins of livestock, livestock feed, living conditions, waste management, health care and record keeping. Some of the medicinal plants which are reported in livestock production are *Hypoxis hemerocallidea, Peltophorum africanum, Drimia sanguine, Elephantorrhiza elephantine, Curcuma longa, Azadirachta indica, Myrsine Africana, Ficus thonningii Blume, Vitex thomasii De Wild, Boswellia frereana, Tillandsia recurvata, Solanum incanum L., Harrisonia abyssinica Oliv., Echinaceae purpurea, Moringa oleifera, Trichilia claussenii, Artemisia absinthium, Ecklonia cava, Carcia papaya, Acacia angustissima, Sesbania sesban, Cajanus cajan, Origanum vulgare, Annona senegalensis, Picrorhiza kurroa, Azadirachta indica, Morinda citrifolia, Rheum nobile, Carduus pycnocephalus, Herba agastaches, Cortez phellodendri, Gypsum fibrosum, Chenopodium album, Glycyrrhiza glabra, Zingiber officinale, Echinacea*, and Devil ,s claw. Medicinal plants have been used effectively for health care treat-ment to make a significant increase in both health and animals productivity. The utilization of traditional medicinal plants are cheaper, easier and more sustainable compare to synthetic drugs and pharmaceuticals. The goal of this manuscript is review on functions of important medicinal plants in livestock production.

Key words: Traditional herbal medicine; Natural products; Livestock production; Sheep; Cattle

Medicinal and aromatic plants and herbs have been used in traditional medicine, food preparation and preservation, animal husbandry, religious observances and cosmetic purposes for many years (Shahrajabian *et al.*, 2019a,b). Nutrition is one of the most important parameters for the maintenance of animal health (Sun *et al.*, 2019a,b), and organic products in organic production systems may lead to organic life (Shahrajabian *et al.*, 2020a,b,c). Organic animal husbandry is defined as a system of livestock production which promotes the use of organic and biodegradable inputs from the ecosystem in term of animal nutrition, animal health, animal housing and breeding. The main goal of organic farming is to create an integrated, humane, environmentally and economically sustainable agricultural system (Nicholas *et al.*, 2004). Due to the growing demand for animal products, there is an urgent need to design new livestock production systems which allow the combination of food security and sustainability. It is also necessary to grow the number of organic livestock farms in response to the necessity to fulfill the growing demand for animal products. Herbal remedies have been reported useful as a therapeutic alternative for treatment of livestock (Aarestrup *et al.*, 2008; Schmid *et al.*, 2012). The goal of this manuscript is review on some important medicinal plants which have been used in live stock production.

Organic Livestock production

Livestock play an important role in the food and economic security of smallholders, and serves as an asset and source of income at the household level and provide food for rural and urban consumers (Rojas-Downing *et al.*, 2017; Campell *et al.*, 2019; Timler *et al.*, 2020). Organic standards require that animals be treated humanely; also, it is important to design an alternative health care strategy that focuses on optimizing animal health through high quality feed and optimal environmental conditions and avoid the use of veterinary medicines or use them under certain circumstances (Lillehoj *et al.*, 2018). The organic standards should be paid attention for both indoor and outdoor systems. General principles for organic livestock productions are a) the areas dedicated for organic livestock production shall be managed and maintained according to the organic agriculture principles on production, processing, labeling and marketing, b) the organic livestock production shall improve and maintain soil fertility, enhance biodiversity and ecology, and diversify the farming system, c) In organic livestock production, herbivores animals should have access to pasture for grazing and open-air exercise areas appropriate to their health, weather conditions, and geography, or to the traditional farming systems with access to pasture, providing an appropriate welfare for the animals, d) stock densities for livestock shall be appropriate to animal species, feeding, stock health, nutrients balance, and environmental impact, e) livestock breeding shall be natural breeding to minimize stress and prevent diseases, f) avoid the use of chemicals or veterinary drugs and livestock by products except milk as raw materials for feedstuff, and maintain animal health and welfare. The most notable rules which apply for livestock productions are shown.

Livestock production and medicinal plants

Traditional livestock management with considering medicinal plants is of great socio-economic importance for farmers and pastoral populations (Greathead, 2003; Gauer *et al.*, 2010; Bhatt, 2015; Traore *et al.*, 2020). Medicinal plants are cheaper than western drugs (Yinegar *et al.*, 2007; Kone and Atindehou, 2008; Parthiban *et al.*, 2016). Many studies have shown the potential use of aromatic plants, herbs and their extracts, such as essential oils, as alternatives to the antibiotics use in ruminant nutrition (Caroprese *et al.*, 2020). Naturally occurring plants compounds including tannins, saponins and essential oils are extensively assessed as natural alternatives to in-feed antibiotics (Huang *et al.*, 2018). Greathead (2003) reported that plant secondary metabolites are a natural resource that is largely unexploited in conventional animal production systems. The implementation of fruit waste and farm residues also as a supplement for livestock feed is becoming urgent, as the nutritive compounds plant a critical role in metabolic reactions and physiological transformations on the animal bodies, while the secondary metabolites available in plants waste

products may inhibit certain degenerative disease-causing agents which can potentially cause harm in livestock (Achilonu *et al.*, 2018). The application of plant extracts containing high level of plant secondary metabolites such as saponins, alkaloids, essential oils, glucosides, flavonoids and tannins could improve animal performance and resolve human safety issues (Hirstov *et al.*, 2013; Kliebenstein, 2013). Plant secondary metabolites varies from species to species and also in the plants of same species (Barton and Koricheva, 2010); also they are dependent on the growing conditions and metabolic pathways of related secondary metabolites of plants (Ramakrishna and Ravishankar, 2011). Terpenes, also known as terpenoids or isoprenoids, are generally insoluble in water and plant important role in the growth of plants and a vital role in defense, as toxic to insects and mammals (pyrethroids) (Dhanasekaran *et al.*, 2019). The main examples of phenolic compound groups are flavonoids and tannins (Fang *et al.*, 2011). Nitrogen containing compounds such as alkaloids, glucosinolates and cyanogenic glycosides are another important category of secondary metabolites (Dhanasekaran *et al.*, 2019).

Tannins are a group of polyphenolic compounds which possess various biological activities including antimicrobial, anti-parasitic, anti-viral, antioxidant, anti-inflammatory, immunomodulation, etc (Waghorn, 2008; Wang and McAllister, 2011; Redondo *et al.*, 2014). The use of nutraceuticals such as tannin containing legumes has been recommended for digestive parasites in livestock for many years (Ole-Miaron, 2003; Hoste *et al.*, 2015); plant bioactives for ruminant health and productivity (Benchaar *et al.*, 2008; Rochfort *et al.*, 2008). Application of Chinese herbal mixtures also recommended in the diet in ruminant production (Githiori *et al.*, 2006 Wang *et al.*, 2011). Tannin-rich plants as anti-nutritional compounds can be a valuable component of sustainable small ruminant production systems (Alonso-Diaz *et al.*, 2010). *Allium cepa*, *Azadirachta indica*, *Curcuma domestica*, *Piper nigrum*, *Trachyspermum ammi*, *Trigonella foenum-graecum*, and *Zingiber officinale* have multiple usages in animal health care (Rastogi *et al.*, 2015).

Anaplasmosis is a tickborne disease caused the bacterium *Anaplasma phagocytophilum* which is spread by the bite of infected blacklegged ticks; it is also known as yellow-bag or yellow-fever. For managing anaplasmosis, East coast fever and ectoparasites, two plant families are frequently in usage which are Asteraceae and Lamiaceae, the most important utilized plant species are *Synadenium compactum* N.E.Br. (Euphorbiaceae), *Solanecio manii* (Hook.f.) C. Jeffrey (Asteraceae) and *Senna didymobotrya* (Fresen.) Irwin and Barneby (Caesalpinaceae) (Njoroge and Bussmann, 2006). Durmic *et al.* (2010) found that Australian woody perennial plants can be considered for grazing systems because they may manipulate rumen fermentation with tremendous plant compounds associated with bioactivity in the rumen. *Sideroxylon mascatense*, *Raphanus sativus*, *Salix babylonica*, *Solanum nigrum*, *Sophora mollis*, *Taraxacum campylodes*, *Tulipa stellata*, *Boerhavia erecta*, *Celtis australis*, *Chamaecyparis obtuse var. obtuse*, *Eryngium biehersteinianum*, *Gossypium arboreum*, *Narcissus tazetta*, *Opuntia littoralis* and *Streblus asper* are important indigenous plants, which are traditionally uses against livestock 's diseases in tribal areas in Pakistan (Aziz *et al.*, 2018).

A wide variety of herbs and spices such as thyme, oregano, rosemary, marjoram, yarrow, garlic, ginger, green tea, black cumin, coriander and cinnamon have been used in poultry for their potential application as antibiotic growth promoters (Gadde *et al.*, 2017). Herbs and spices which contain essential oils such as thymol, carvacrol, cinnamaldehyde, eugenol, coriander, star anise, ginger, garlic, rosemary, turmeric, basil, caraway, lemon and sage have been used individually or as blends to improve animal health and performance (Gadde *et al.*, 2017). The immune-activating properties of medicinal plants such as dandelion (Ta*razacum officinale*), mustard (*Brassica juncea*) and safflower (*Carthamun tinctorius*) have been evaluated in vitro using avian lymphocytes and macrophages (Lee *et al.*, 2010).

It has been reported that *Calendula officinalis*, *Matricaria recutita*, *Picea abies*, *Sanicula europaea* and *Senecio ovatus* use for skin disorders, orally

administered plant species are *Artemisia absinthium*, *Avena sativa*, *Citrus x limon*, *Quercus robur*, for gastrointestinal diseases and metabolic dysfunction, *Matricaria recutitia*, *Linum usitatissimum* and *Camellia sinensis*; and *Quercus robur* is mainly used to treat diarrhea in calves (Bischoff *et al.*, 2016). Capsaicin, ginger, feverfew, turmeric, devil's claw, ginseng (for fibromyalgia), kava-kava (for neuropathic pain), St. John's Wort (for sciatica, arthritis, and neuropathic pain), and valerian root (for spasms and muscle cramps) are certain common herbal remedies which are used for natural relief to pain (Sengar *et al.*, 2017). Githiori *et al.* (2003) found that *A. sanguineum*, *D. angustifolia* and *H. sepalosa* had no impact on either total worm (TWC) counts and faecal egg counts (FEC); the application of santonin and *M. Africana* significantly reduced the number of TWC, but not FEC, and the use of embelin, *R. melanophloeos* and *A. indica* reduced EFC but not TWC. Feeding of maca (*Lepidium meyenii*), and khat (*Catha edulis*) have been shown to positively affect sperm production and quality in animals (Clement *et al.*, 2012). Gathuma *et al.* (2004) reported that herbal anthelmintic remedies, viz. *Myrsine Africana*, *Albizia anthelmintica* and *Hilderbrantia sepalosa* were administered in the traditional way by the healers and their efficacy determined using percent fecal egg count reduction test. Elghandour *et al.* (2018) found that garlic, ginseng, primerose, and rose hip possess potent antioxidative properties, and their supplementation in regular diet may lessen the chance of occurrence of oxidative stress-related diseases. Shrubby vegetations types called maquis and garrigue may lead to reduction livestock productivity, cause significant toxicity and abortion problems, and reduce efficiency of use of rangeland shrubs (Rogosic *et al.*, 2008). The extracts from *Maytenus macrocarpa*, *Dracontium loretense*, *Tabebuia impetiginosa*, *Eucalyptus camaldulensis* and *Uncaria tomentosa* exhibited significantly antibacterial activity against *Pseudomonas aeruginosa* (Ulloa-Urizar *et al.*, 2015). Towhidi (2007) indicated that *Atriplex lentiformis*, *Alhagi persarum*, *Seidlitzia rosmarinus*, *Saueda fruticosa*, *Haloxylon ammodendron*, *Salsola tomentosa*, *Hammada salicornica*, Tamrarix *kotschyi*, *Salsola yazdiana*, *Tamarix aphylla* and *Artemisia siberi* were pleasure feed for camels in Iranian desert rages. Different parts of Alhagi species are good sources of antioxidant, cardiovascular, anti-ulcer, hepatoprotective, antispasmodic, antidiarrheal, antinociceptive, antipyretic, anti-inflammatory, anti-rheumatic, antibacterial, and antifungal (Muhammad *et al.*, 2015). Abdallah *et al.* (2019) found that Astragalus by-product could be reclaimed through dietary inclusion in animal feed since it had beneficial impacts on rumen fermentation patterns and lipid metabolism and had no adverse impacts on performance and humoral immunity in sheep.

Aqueous extracts of the roots of *Artemisia absinthium* L. has significant anthelmintic impacts on eggs and larvae of *Haemonchus contortus* (Varadyova *et al.*, 2018). Olagaray and Bradford (2019) revealed that flavonoids can increase ruminant productivity with beneficial impacts.

Lourenco *et al.* (2008) concluded that some plant secondary metabolites, present in herbs of botanically diverse forages, are suggested to be potential modifiers of rumen biohydrogenation based on their impacts on rumen methanogenesis. *Khaya senegalensis*, *Anacardium occidentale*, *Cassia sieberiana*, *Pterocarpus erinaceus* and *Vitellaria paradoxa* are species with the highest value for relative frequency of citation (RFC) and use for treat gastrointestinal disorders (Ouachinou *et al.*, 2019). Rhizomes and roots of *Rheum officinale* (rhubarb), bark of *Frangula alnus* (frangula or alder buckthorn) and bulbs of *Allium sativum* (garlic) may decrease methane production and acetate to propionate ration (Garcia-Gonzalez *et al.*, 2008). *Allium sativum*, and *Bunium persicum* have potential candidate species for the development of novel veterinary drugs with low cost and fewer side effects against mastitis of dairy animals (Amber *et al.*, 2018). Grazing an association of Leucaena (*Leucaena leucocephala*) and Stargrass (*Cynodon nlemfuensis*) can replace part of the concentrate without detrimental impacts on milk production and reproduction on dual purpose cows (Peniche-Gonzalez *et al.*, 2014). Habibi and Ghahtan (2019) recommended *Trachyspermum copticum*, *Stachys lavandulifolia*, *Zingiber officinale*, and *Majorana hortensis* as a natural food additive in Quail and Quail products. Wormwood (*Artemisia absinthium*

L.) and mallow (*Malva sylvestris* L.) as dietary supplements do not have a sufficient effect on lambs infected with *Haemonchus contortus* (Mravcakova *et al.*, 2020). Hashemi and Davoodi (2011) reported that the future of using herbs in animal nutrition will depend on the knowledge of chemical structure, herbs' values and characteristics, well-being of animal and consumer 's preferences and expectations. Kama-Kama *et al.* (2016) reported that extracts from five plants namely: *Solanum aculeastrum*, *Albizia coriaria*, *Ekebergia capensis*, *Piliostigma thonningii* and *Euclea divinorum* showed the highest activities against the *Mycoplasma* strains tested, and *Mycoplasma* negatively affect the agricultural sector especially in developing countries. Chinsembu *et al.* (2014) found that skin rashes were managed using *Aloe esculenta*, *Ziziphus mucronata* healed wounds and it was a remedy for diarrhea, *Fockea angustifolia* was a treatment for anthrax and eye infections were treated using *Ximenia americana* (Chinsembu *et al.*, 2014). The important functions of some important medicinal plants which are common in livestock production in shown in Table 2.

Table 1. The most important rules which apply to livestock farms.

*Non-organically raised animals may be not brought onto holding unless for breeding purposes and then only comply with specific rules.
*Farmers have to provide 100% organic feed to their animals in order to market their products as organic.
*The feed should primarily be obtained from the farm where the animals are kept or from farms in the same region.
*Cloning animals and transferring embryos is strictly forbidden.
*Growth promoters and synthetic amino-acids are prohibited.
*Suckling mammals must be fed with natural, preferably maternal, milk.
*Natural methods of reproduction must be used, artificial insemination is however allowed.
*Non-organic feed materials from plant origin, feed materials from animal and mineral origin, feed additives, certain products used in animal nutrition and processing aids can only be used if they have been specifically authorized for use in organic production.

Table 2. The function of some important medicinal plants and herb in Livestock production.

Medicinal plants	Plant family	Livestock	Function	References
Hypoxis hemerocallidea	Hypoxidaceae	Cattle	a. Constipation, intestinal parasites, anaemia, pain, inflammation, diarrhoea	Moichwanetse *et al.* (2020)
Peltophorum africanum	Fabaceae	Cattle	a. Constipation, intestinal parasites, anaemia, pain, inflammation, diarrhoea	Moichwanetse *et al.* (2020)
Drimia sanguine	Asparagaceae	Cattle	a. Constipation, intestinal parasites, anaemia, pain, inflammation, diarrhoea	Moichwanetse *et al.* (2020)
Elephantorrhiza elephantina	Fabaceae	Cattle	a. Constipation, intestinal parasites, anaemia, pain, inflammation, diarrhoea	Moichwanetse *et al.* (2020)
Curcuma longa	Zingiberaceae	Cattle	a. Aliment, followed by diarrhea and horn avulsion. b. Its β-glucan shows a beneficial effect on growth, nutrient digestibility of dry matter and ATTD of nitrogen, and beneficial microbial Lactobacillus of weanling pig.	Jayakumar *et al.* (2018) Serpunja *et al.* (2018)
Azadirachta indica	Meliaceae	Cattle	a. Aliment, followed by diarrhea and horn avulsion	Jayakumar *et al.* (2018)
Myrsine africana	Myrsinaceae	Sheep	a. It has anthelmintic efficacy and safety against mixed gastrointestinal nematodes	Muthee (2018)
Ficus thonningii Blume	Moraceae	Ruminant livestock	a. Its leaves are a good source of nutrients (protein, fats, carbohydrates and minerals), and it is an appropriate supplement/substitute livestock feed.	Berhe and Tanga (2013)
Vitex thomasii De Wild	Lamiaceae	Cattle Goat	a. Gastrointestinal parasitic diseases	Embeya *et al.* (2014)
Boswellia frereana	Burseraceae	Small ruminants	a. Administration of Boswellia carteri-PPR vaccine (Intranasal Peste des	Mumin *et al.* (2020)

			petits ruminants) combination through intranasal or subcutaneous route, elicited similar antibody titre.	
Tillandsia recurvata	Bromeliaceae	Ruminants	a. It has nutritional and mineral characteristics and can be included in the diet of ruminants.	Gamez Vazquez *et al.* (2018)
Solanum incanum L.	Solanaceae		a. Treatment of gastrointestinal disorders	Guadie *et al.* (2020)
Harrisonia abyssinica Oliv.	Rutaceae		a. Treatment of gastrointestinal disorders	Guadie *et al.* (2020)
Echinaceae purpurea	Asteraceae	Laying hens	a. Its powder can improve egg production, improve yolk oxidative and decrease yolk cholesterol content.	Jahanian *et al.* (2017)
Moringa oleifera	Moringaceae	Pigs Rabbits	a. It has high content of crude fiber, neutral detergent fiber, acid detergent fiber, and acid detergent lignin, and it may cause a low content of metabolizable energy.	Jalilzadeh-Amin *et al.* (2012) Falowo *et al.* (2018) Valdivie-Navarro *et al.* (2020)
Trichilia claussenii	Meliaceae	Sheep	a. It has anti-parasite potential and anthelmintic activity.	Cala *et al.* (2012)
Artemisia absinthium	Asteraceae	Ruminants	a. Wormwood can be an important factor to enhance animal production, product quality and also to lower feed cost in developing countries.	Beigh and Ganai (2017)
Ecklonia cava	Lessoniaceae	Pigs	a. *Ecklobia cava* and probiotics are beneficial for weanling pigs	Choi *et al.* (2016)
Carcia papaya	Caricaceae	Goats	a. Papaya leaf supplementation could be a useful feeding strategy to modulate the biohydrogenation of linoleic acid in rumen of goat.	Jafari *et al.* (2018)
Acacia angustissima	Fabaceae	Small ruminants in the tropics	a. The can improve nutrition at simultaneously limited methane emissions	Soliva *et al.* (2008)
Sesbania sesban	Fabaceae	Small ruminants in the tropics	a. The can improve nutrition at simultaneously limited methane emissions	Soliva *et al.* (2008)
Cajanus cajan	Fabaceae	Small ruminants in the tropics	a. It can improve nutrition at simultaneously limited methane emissions	Soliva *et al.* (2008)
Origanum vulgare	Lamiaceae	Sheep	a. The dietary supplement may increase production efficiency and the production of higher-quality meat.	Dudko *et al.* (2018)
Annona senegalensis	Annonaceae		a. It has anthelmintic activity and shows larval recovery when whole ground plant material is being used.	Alawa *et al.* (2003)
Picrorhiza kurroa	Scrophulariaceae		a. It can decrease total gas production and ammonia concentration and increase propionate production.	Alexander *et al.* (2008)
Azadirachta indica	Meliaceae	Goats	a. The goats treated with *A. indica* almond showed anti-coccidian effects.	Affian *et al.* (2017)
Morinda citrifolia	Rubiaceae	Dairy cows	a. Feeding with M. citrifolia fruit juice to dairy cows showed improvement in the quality and biophysical parameters of milk of mastitis-infected dairy animals.	Sunder *et al.* (2013)
Rheum nobile	Polygonaceae	Ruminants	a. It may decrease methane production without negatively affecting other parameters of the rumen fermentation.	Bodas *et al.* (2008)
Carduus pycnocephalus	Asteraceae	Ruminants	a. It may decrease methane production without negatively affecting other parameters of the rumen fermentation.	Bodas *et al.* (2008)

Cortez phellodendri	Rutaceae	Beef Cattle	a. Improve nutrient digestibility and ruminal enzyme activity and modified fermentation and microbial community.	Zhu *et al.* (2018)
Gypsum fibrosum	Menispermaceae	Beef Cattle	a. Improve nutrient digestibility and ruminal enzyme activity and modified fermentation and microbial community.	Zhu *et al.* (2018)
Chenopodium album	Amaranthaceae		b. It is a good source of retinol precursors and biologically active lutin; and it can be exploited to meet carotenoid requirements.	Sangeetha *et al.* (2010)
Glycyrrhiza glabra	Fabaceae	Sheep	a. Licorice dry powder may decrease lactic acid bacteria, and increased feed conversion ration.	Rahchamani *et al.* (2019)
Zingiber officinale	Zingiberaceae	Sport horses Rabbit	a. Ginger extract as a feed additive is encourageable as it manages to attain quick recovery after exhaustion in racing and jumping events. b. Ginger powder could be a potential supplementation in diet of rabbits for increasing meat shelf-life.	Elghandour *et al.* (2018) Mancini *et al.* (2018)
Echinacea	Asteraceae	Horse	a. It is able to stimulate the equine immunocompetence on addition to the regular diets of equine species.	Elghandour *et al.* (2018)

Conclusions

Medicinal plants and herbs have been used for the remedy of different diseases and its domestic use is from a very long period of time that have gets its start from early human civilization for the proper treatment of a variety of diseases. The main compositions of botanical origins are terpenes, saponin, flavonoids, phenylpropanoid and etc. The most important medicinal plants which are common in livestock production are *Hypoxis hemerocallidea*, *Peltophorum africanum*, *Drimia sanguine*, *Elephantorrhiza elephantine*, *Curcuma longa*, *Azadirachta indica*, *Myrsine Africana*, *Ficus thonningii* Blume, *Vitex thomasii* De Wild, *Boswellia frereana*, *Tillandsia recurvata*, *Solanum incanum* L., *Harrisonia abyssinica* Oliv., *Echinaceae purpurea*, *Moringa oleifera*, *Trichilia claussenii*, *Artemisia absinthium*, *Ecklonia cava*, *Carcia papaya*, *Acacia angustissima*, *Sesbania sesban*, *Cajanus cajan*, *Origanum vulgare*, *Annona senegalensis*, *Picrorhiza kurroa*, *Azadirachta indica*, *Morinda citrifolia*, *Rheum nobile*, *Carduus pycnocephalus*, *Herba agastaches*, *Cortez phellodendri*, *Gypsum fibrosum*, *Chenopodium album*, *Glycyrrhiza glabra*, *Zingiber officinale*, *Echinacea*, and Devil 's claw. Considering the importance of medicinal plants livestock production, more researches are need to find their functions in animal production.

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