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Description, Phytochemistry and nutritional profile of Ker (C*apparis decidua*): An important underutilized fruit in hot arid region of India

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Abstract
The underutilized fruits found growing wild in the hot arid regions of India can address to India's key problems of desertification, hunger, malnutrition, rural development and have immense potential to vegetate the degrading lands and deserts. The domestication of these fruits is the sustainable approach to enhance fruit availability in the arid regions providing food security to tribal population as global warming is going to affect the food production. Ker (*Capparis decidua*) fruits are storehouse of energy with macronutrients, micronutrients and dietary phytochemicals which make them nutraceutical foods of the future. The value addition of these fruits is in practice among the native population and the recipes have passed from generation to generation though very less documented. They are processed on household scale and consumed during dearth period or in community functions as traditional dishes. Owing to their medicinal properties, there is immense scope for value added product development to boost the immunity.

Keywords: *Capparis decidua*, nutritional security, underutilized fruits, phytochemicals

Introduction
The hot and dry regions Harbour indigenous fruits and sustain the rural communities by providing food, nutritional security, income and health benefits. These fruits are well acclimatized to harsh abiotic stresses particularly draught and yield a harvest when most of staple crops fail thus serving as emergency foods (Stadlmayr *et al*., 2013) [19]. The domestication of these fruits is still in its infancy and they are quite unknown in global market. The surge towards profit driven intensive agriculture has overlooked the importance these fruits have in the livelihood of rural communities and poverty alleviation strategies. These fruits have been research biased and there is lack of knowledge about their cultivation, management and value addition. Studies on consumption and composition of underutilized fruits are very fragmented and limited which makes it difficult to appraise their contribution to dietary adequacy. For enhancing nutritional security and income generation through fruit domestication, the information about functional and nutritional attributes is of paramount importance and this can be utilized to promote and expand the cultivation. The traditional knowledge can be used to develop value added products from these fruits to supplement their nutritional value which will open avenues for new export channels. In this context, a niche for future scientific research can be established as these fruits are part of Indian folk medicine since ancient times. Extensive collection of data from the tribal belts is necessary to filter authentic and reliable information since most of folklores have not been confirmed by scientific studies. This review covers the information on general growth habit, phytochemical, nutritional, medicinal properties of Ker (*Capparis decidua*) an important underutilized fruit of the hot arid regions of India.

Origin, distribution and physical description
Capparis decidua Edgew (Forssk.) (Syn: *C. aphylla* Roth) belonging to family Capparaceae, thrives luxuriantly in dry and arid regions and considered important medicinal plant. It is native to hot arid regions of the Indian subcontinent, Middle East and Africa. In the Indian sub-continent, it is growing abundantly in hot dry areas of Western Rajasthan, Gujarat, Punjab, Deccan, Tinnevelly, Central India and Western Rajputana. *C. decidua* has adapted itself to abandoned dry lands exposed to intense radiations with an altitude range of 300–1200 m, mean

annual rainfall 100–750 mm and temperature 18–48 ^{0}C (Chishty and Monika, 2016) [3]. Ker plant has excellent adaptations to arid conditions as it is extremely resistant to salinity, drought, soil erosion and tolerates frost to some degree.

C. decidua is a 4–5 meters tall bushy shrub having dark glossy densely tufted apparently leafless green branches, caducuous minute leaves (1–3 mm in width and 2–12 mm in length) are found only on young shoots with each node of twigs having a pair of spines (Fig. 1 a). To thrive through transpirational losses in extremely drought conditions *C. decidua* leaves have evolved to be narrow or modified into spikes (Fig. 1). Ker plant through its tap root system can uptake water from the ground at depth up to 4 m. Apart from this, during scanty rainfall the plant can absorb water from ground surface through extensive secondary root system (Singh and Singh, 2011) [17]. Conspicuous red veins are present on pink flowers and fruit is a mucronate berry having pink colour when fresh changing to black when dry. As the stem matures the green bark of the plant turns to whitish grey or yellow as the stem matures. New leaves sprout in winters from January to November (Joseph and Jini, 2011) [9] while flowers emerge in March–April and also during post monsoon season in Western Rajasthan. Old branches bear flowers mostly while fewer flowers are borne by new branches, which grow along the spine axis. March to April is the fruiting season in some parts of the world such as Saharan Africa whereas, in Thar Desert, Ker plant bears fruit in the months of May to July and October-December.

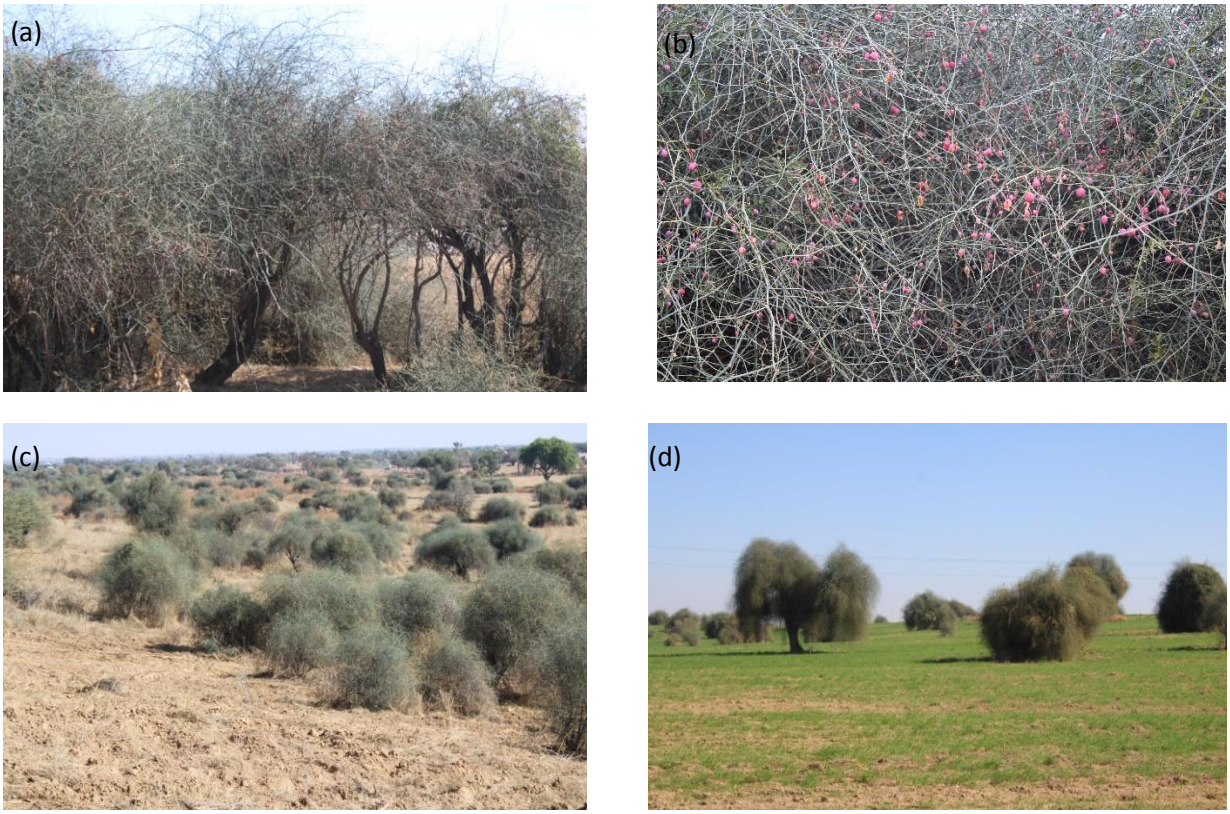

Fig. 1: Ker groove (a), fruiting (b), in ravines (c), at farmer's field (d) at Sikar, Rajasthan.

Phytochemical composition

The physical and chemical properties of the plants themselves also bear on their selection by people for medicines, as does the array of plants available for people to choose from (Jena *et al*., 2021) [8]. *C. decidua* contains a number of glycosides, terpenoids, alkaloids, and fatty acids. The root bark of Ker plant contains two sitosterols (24-*β*-methylcholest-9 (11)-ene-22-one3*α*-ol and 24-*β*-methylcholest-7- ene-22-one-3 *β*-ol), two aliphatic constituents (25-oxooctosan-1,20-diol and butyl-3-oxoeicosanoate), one diterpenic ester (9-(11,15,15-tri methylcyclohex-11-ene-13-one-yl)-one-6-hydroxymethylene-7-one-yl,4′ -Methyl heptanoate) and one diterpene alcohol (3-methyl-7-hydroxymethylene10-(12,16,16-trimethylcyclohex-11-enyl)-dec-9-ene-5-one-8-ol) Rathee *et al*., 2010) [15]. For proliferation, growth, and development of mammalian cells, spermidine and spermine polyamines have an important role. Moreover, these biomolecules also possess anti-allergenic, anti-arteriosclerotic and antioxidant properties (Soda, 2010) [18]. Healthy hair growth is promoted by these polyamines because of their cell proliferative properties (De la Pena *et al*., 2014) [5]. Capparidisine, capparisinine and isocodonocarpine are the important spermidine alkaloids isolated from *C. decidua* root bark (Dahot, 1993) [4]. Stachydrine, capparisine, 14-*N*-acetyl isocodonocarpine, 15-*N*-acetyl capparisine, cadabicine and codonocarpine are other important alkaloids isolated from root bark (Ahmed *et al*., 1987) [2]. The aerial parts of *C. decidua* contained four fatty acids, two sterols, two lupine terpenoids, two acyclic terpenoids and one shikimate derivative (Gupta and Ali, 1997) [7]. The methanolic extract of aerial parts isolated two sesquiterpene lactones, germacr-3*β*-ol-7,9-dien-6,14-olide-15-oic acid and germacr3*β*-ol-12-ene-6,14-olide-15-oic acid (Mohammed *et al*., 2014) [13]. Methyl isothiocyanate and glucocapparin were also identified from methanolic seed extract. Cancer preventive activity has been exhibited by isothiocyanates (Tesoriere *et al*., 2007). Unsaponifiable fraction of seeds yielded *β*-sitosterol, *β*-carotene and Npentacosane. Flowers and fruit husk has been reported to contain ascorbic acid (1190 mg kg^{-1}), phytic acid (680 mg kg^{-1}), oxalic acid (1 mg kg^{-1}) (Mishra *et al*., 2007) [12]. Other important phytochemicals present in flowers of

plant included two new saturated aliphatic ketones (C28 and C32), *β*-sitosterol, n-nonacosanol, *β*D-glucoside of *β*-sitosterol, a new isomer of *β*-sitosterol, a new glycoside pelargonidin-3-galactoside, glucocapparin, glucocappasalin and two free sugars, D galactose and D glucose. Fruit pulp, fruit husk and flowers contained stachydrine (2-carboxy-1,1-dimethyl pyrolidine). Fruits and fruit husk of ker also contained considerable amounts (210 mg kg^{-1}) of carotene (Mishra *et al.*, 2007) [12]. Phenolic constituents detected in the leaves are salicylic acid, vanillic acid, phydroxybenzoic acid, sinapic acid, protocatechuic acid, syringic acid, gentisic acid and 2-hydroxy-6- methoxybenzoic acid (Abra and Ali, 2011) [1]. Phenolic compounds, flavonols and flavonoids were reported in the aqueous, n-hexane and acetonic extracts of *C. decidua* leaves (Mann *et al*., 2013) [11].

Nutritional profile

Use of plants for curing human ailments is an ancient practice. Recently there is revival of interest and ethno-botanical field surveys are being done which reflects concern about the possible loss of valuable information on traditional medicine (Sahoo, 2019) [16]. Undernourishment of population residing in developing and third world countries is the basic cause of different diseases and ailments mainly in women and children. Since time immemorial, pickle prepared from this berry has been used by the rural people of arid regions and served as good source of carbohydrates, protein and vitamins (Ozcan, 2005) [14]. Goats and cattle are fed with branches of this shrub due to its good palatability and nutritional quality. For maintenance of physiological functions and biochemical metabolism of human beings and livestock, neutral fibers, crude protein and minerals of this plant played a vital role. This plant is a potential source of nutrients although a few studies have been conducted to investigate the biochemical composition of *C. decidua*. Ker fruits and buds are very nutritious and the quality is at par with or even better than most fruits and vegetables. Carbohydrates followed by crude proteins and neutral fibers are the major constituents of Ker fruits, buds (Kumar *et al*., 2011) [10]. Stem bark and roots are major source of fiber while *C. decidua* fruits are rich in proximate contents particularly proteins, followed by the flowers. To assess a plant's edible acceptability, minerals profile of plants is an important factor. This plant is highly acceptable as fodder or vegetable in the arid regions because the mineral content (Na, K, Ca, Zn, Mn, Fe) is found to be high while heavy metals i.e., Ni, Co and Cd are present in trace concentration in all parts of *C. decidua* (Gull *et al*., 2015) [6].

Conclusion

Ker (*Capparis decidua*) has inherent potential to bestow health benefits and improve the nutritional level of the rural population, thanks to the nutrients and phytochemicals present in ample quantities. This undomesticated fruit has considerable functional (sensory) properties and its nutritional composition is as good as, or even better than the cultivated fruits and vegetables. This article reviews and appraises the contribution that this fruit can make in uplifting the nutritional and economic status of rural families during the periods of long draughts and famines. In this context, this fruit tree has evolved and acclimatized itself in most harsh climates of arid regions and catered to the needs of vulnerable impoverished children and pregnant women in rural communities. The package and practices for cultivation of this fruit needs to be developed to provide a sustainable farming system model to farmers of hot arid regions. Nonetheless, the traditional knowledge about its uses, processing, and value addition is very less documented and we are constantly losing this information in this current era of rapid urbanization. In comparison to other exotic fruits, research acumen towards value addition in this fruit is very little. To develop a nutritious fruit product, maintaining the antioxidants, nutrients, organoleptic properties and lessening toxic alkaloids during processing is of foremost importance. Thus, state of art processing infrastructure needs to be developed to optimize the production protocols of products from this fruit and further promotion.

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