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Ethnobotanical study of indigenous edible dried vegetables in Thar Desert: A review

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Abstract

The present observation aimed at identification and evaluation of valuable wild edible plant vegetables/fruits used by indigenous people as dried vegetables. In this study ethnobotanical, phytochemical and pharmacological activities of twelve wild vegetables of five families including Leguminoceae, Cucurbitaceae, Podaxaceae, Capparidaceae and Asclepiadaceae were evaluated. Cucurbits and legumes were mostly consumed by tribal people due to abundance of these plant families in the Thar Desert followed by *Podaxis pistillaris* (L.) Fr., *Capparis decidua* (Forssk.) Edgew. and *Leptadenia pyrotechnica* (Forssk.) Decne. There is a great need to pay more attention on study of phytochemical and pharmacological activities of unrecognized edible Mushroom *Podaxis pistillaris* (L.) Fr. Wild edible plants are utilized in the dietary habits and medicinal practices of tribal communities, promoting a healthier lifestyle. Additionally, knowledge about these wild edible plants can assist the industry and healthcare professionals in developing innovative drugs, formulas, or food products to enhance human well-being and address various contemporary health issues.

Keywords: Khimpoli; Kachar; Matira; *Podaxis Pistillaris*; Sangari

1. Introduction

The Great Thar Desert is characterized by high velocity wind, huge shifting and rolling sand dunes, high diurnal variations in temp., intense solar radiations, low rainfall & high evaporation.

The sandy soils of the Thar Desert have high infiltration rates, low humus content due to rapid oxidation and high salinity making agricultural practices very difficult and uncertain. Xerophytic flora mainly consists *of Acacia senegal, A. nilotica, A. tortillis, A. jaquemontii, Prosopis cineraria, P. juliflora, Capparis decidua, Lasiurus sindicus, Ziziphus nummularia, Leptadenia pyrotechnica, Calotropis procera, Aerva javanica, Commiphora wightii, Tacomella undulata, Tamarix gallica, Sarcostemma viminale., Euphorbia caducifolia, Heliotropium nerifolium, Chorchorus tricularis* etc. The main rainfed Kharif crops in western Rajasthan are Bajra, moong bean, moth bean, Gwar bean, *Sesamum indicum*, cucurbits i.e. *Citrullus lanatus, C. fistulous, Cucumis melo*, and *C. calosus*.

Indigenous/ tribes people mainly involve bhils, raika, gadolia-luhar, jogi, langa-manganiyar, nuts and banjara community [1]. Survival for the indigenous people in hard, xeric conditions in which food and water are not plenty, is very difficult. In these extreme conditions for life, indigenous people have adjusted and adapted themselves with existing nature. In order to survive, they have discovered new ways of preserving and protecting the available food for future consumption. So that fresh fruits and vegetables could be protected from getting spoiled for a long time and could be used when they were unavailable naturally.

Besides, they find new ways to plant produce, edible that were not even edible earlier. The bitter and astringent, stony seeds of "Tumba", a xeric cucurbit and *Momordica dioica*, a bitter guard are not edible in their natural form but tribals such as Bhils and Nuts, find new ways to lesser the bitterness and astringency by applying some practices. Preservation

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of available food in the form of fruits, vegetables and grains have special significance in the Thar Desert. Due to extreme climatic conditions, there is a requirement for storage and preservation of food stuff for long time consumption.

Traditional methods applied by tribals to preserve food materials with limited knowledge & resources. Preservation practices include pickling, a process of preserving food stuff by anaerobic mode of fermentation making "Achaar" or "Mahudi" a form of vinegar consumed by tribals residing in southern Rajasthan, freezing in earthen pot at low temperature or burying underground in a moist soil, drying under shade/ semi light area, salting treatment to reduce bitterness and astringency. The drying of vegetables/ fruits accomplished by direct exposure to the Sun or boiling them into hot water, temperature ranges from 40°-70° C for 2-3 weeks depending upon the water content available in [2].

Majority of the fruits and vegetables contain higher amounts of water as compared to dried & dehydrated ones. Shelf life of fruits/ vegetables can be increased through the dehydration process. Besides, dried vegetables could be transported longer distances. Fresh plant produce could easily spoil but dried couldn't. Upon drying, fleshy plant products also reduce their size and volume, when fresh fruits/ vegetables undergo dehydration and drying process, there are significant changes in their aroma, taste, texture, sugar contents, and nutritional values [3]. A systematic account of wild edible plants' produces of the Thar Desert used by tribal people discussed below.

2. Material and methods

The present study was carried out in Barmer-Jaisalmer districts during year of 2020-21 and 2021-22. Information on wild edible vegetable/fruit plants, collected through survey method, direct observation, conversations with tribal people. Review of literature conducted primarily using online databases & search engines as Google Scholar, PubMed, ResearchGate and Online Flora of India.

3. Result and Discussion

3.1. *Citrullus lanatus*

- Classification
- Division: Plantae
- Class: Magnoliopsida
- Order: Cucurbitales
- Family: Cucurbitaceae
- Genus: Citrullus
- Species: Lanatus
- Vernacular name: Water melon, Tarbooj, Matira, Kalinga

3.1.1. Traditional use

Seeds of "Matira" (Water-melon) are dried and pounded into coarse flour, mixed with Bajra flour and made "Khakhra" or "Hard baked roti/ bread". The seeds are roasted with salt, eaten in the winter season to get relief from "Whooping-cough". The immature, tender fruits called "Loiya" are used as a green vegetable. Sun-dried sliced loiya, stored for later consumption. In the summer season, consumption of "Matira"; ripened fruit helped to quench the thirst. During famine, the slices of mature fruits are sun dried & stored for use in future [4]. *Citrullus colocynthis*, a wild form called "Indrayan or Tumba" are bitter and toxic.

3.1.2. Phytochemistry

"Matira" fruits have a high amount of water 93%, sugar content 6%., and a very good source of vitamin A, B & C. Seeds contain high amounts of protein, fat, water and energy. Fatty acids such as oleic acid, palmitic acid, stearic acid and glycosides of linoleic acid are found in seeds [5].

3.1.3. Pharmacological activity

Citrullus lanatus possess anti-hypertensive, anti-diabetic, antibacterial, antioxidant, anticancer, laxative, anti-ulcer, neuroprotective, anti-prostatic-hyperplasia, gastric-antacid, and anti-inflammatory properties [6].

3.2. *Cyamopsis tetragonoloba* (L.) Taub

- Classification

- Division: Plantae
- Class: Magnoliopsida
- Order: Fabales
- Family: Fabaceae
- Genus: Cyamopsis
- Species: Tetragonoloba (L.) Taub.
- Vernacular name: Cluster bean, Gwar Fali

3.2.1. Traditional use

Gwar pods in the Thar Desert are consumed as green vegetables, a significant source of protein. Pods are boiled in hot water and then placed in a semi-shaded area, stored for future consumption. Seeds, leaves and pods are useful in diabetes, asthma and inflammation, act as appetite depressor [7]. Gwar gum used in cosmetics [8].

3.2.2. Pharmacological activity

Gwar show anti-diabetic, hypocholesterolemic, anti-ulcer, anti-microbial, anti-asthmatic, anti-inflammatory, reversible antifertility effect, anthelmintic activity, wound healing, antioxidant, anti-cataract, cytoprotective effect, anticholinergic, anticoagulant, and hemolytic activity [7]. Gwar extract show anticancer activity against intestine carcinoma (CACO-2) cell line, colon carcinoma cell line (HCT 116) and human prostate carcinoma cell line (PC 3) [9].

3.3. *Acacia senegal* (L.) Willd

- Classification
- Division: Plantae
- Class: Magniliopsida
- Order: Fabales
- Family: Fabaceae
- Genus: Acacia
- Species: Senegal
- Vernacular name: Kumatiyo, Button-seed plant, Khair

3.3.1. Description

A small sized, deciduous, spiny, xerophytic plant with golden yellow colored stem, straight/ less curved, papery and woody pods containing shiny-brown button seeds. Gum Arabic is drained naturally or by man-made injuries on the stem.

3.3.2. Traditional use

Button seeds are a source of protein, cooked either fresh or sun-dried form mixed with Sangari, Ker, Lasoda, and Amchoor forming a valuable and world known Rajasthani Dish “Panchkuta” served on special occasions/ royal ceremonies. Also served on Basoda festival of Goddess “Sheetla” in whole Rajasthan after “Holi” festival. Gum Arabic used as food additive, incorporated into winter seasoned special dish “Goond ke laddu” in Rajasthan, used to treat bronchitis, leprosy, typhoid, respiratory tract infections [10], diarrhea, gonorrhea, and jaundice [11].

3.3.3. Phytochemistry

Alkaloids, tannins, terpenoids, steroids, flavonoids, phenols, anthraquinones and cardiac glycosides are the important secondary metabolites reported in *A. senegal* [12].

3.3.4. Pharmacological activity

Various scientific studies suggested that *A. senegal* showed anticancer, antioxidant, antimicrobial and anti-inflammatory activities [12].

3.4. *Cucumis trigonus* Roxb.

- Classification
- Division: Plantae
- Class: Magniliopsida
- Order: Cucurbitales

- Family: Cucurbitaceae
- Genus: Cucumis
- Species: Trigonus
- Vernacular name: Kachar, Kachri

3.4.1. Traditional use

Kachri fruits are bitter in a semi-mature state used as a green vegetable; in unfavorable conditions, immature fruits are sliced and sun-dried for 4-7 days, stored for future use. *C. trigonus* fruits are beneficial in treatment of fever, leprosy, jaundice, diabetes, cough, bronchitis, ascites, anemia, constipation, abdominal disorders and amentia [13]. Fruit pulp used as thermogenic anthelmintic, liver tonic, cardiotonic, appetizer, expectorant and intellect promoting [14].

3.4.2. Phytochemistry

Important secondary metabolites reported in *C. trigonus* are alkaloids, flavonoids, tannins, lignin, glycosides, serpentines, terpenoids, saponin and phenols [15].

3.4.3. Pharmacological activity

C. trigonus show analgesic, anthelmintic, antiasthmatic, antibacterial, anti-diabetic, antidiuretic, anti-inflammatory, antioxidant, antihyperglycemic, hepatoprotective, proteolytic, and wound healing activities [15].

3.5. *Leptadenia pyrotechnica* (Forssk.) Decne.

- Classification
- Division: Plantae
- Class: Magnoliopsida
- Order: Gentianales
- Family: Asclepiadaceae
- Genus: Leptadenia
- Species: Pyrotechnica
- Vernacular name: Khimp, Khip

3.5.1. Traditional use

In western region of Rajasthan, particularly in Barmer and Jaisalmer districts, green pods “Khimpoli” are consumed as vegetables during the summer season to combat heat stroke. It's a bushy, deciduous plant used to make ropes for various purposes. Sun-dried bushy plant, in expanded carpet form, used to construct roofs of local huts for humans which provide cooler shade.

Yemenis use the whole plant to heal wounds since it has been shown to be effective against *Bacillus subtilis* and *Staphylococcus aureus*. With the plant's fresh juice, an abortion is conceivable. In the Sariska region of Rajasthan, whole plant infusion is combined with buttermilk and used as a therapy for digestive issues and uterine prolapse. It is used to treat constipation in western Rajasthan. Khimp, used in ailments of fever, cough, renal illness, stones, urinary problems, eczema and skin infections [16].

3.5.2. Phytochemical study

Phytochemical screening of the Khimp show the presence of flavonoids, alkaloids, polyphenolic compounds, sterols, terpenes, cardiac glycosides, pregane glycosides, amino acids and sugars [17-22].

3.5.3. Pharmacological activity

Various studies on *L. pyrotechnica* suggested antitumor, antioxidant, anti-inflammatory, antibacterial, anthelmintic, anti-lipoxygenase, cytotoxic, hypolipidemic, antiatherosclerotic, and antiproliferative activities [23].

3.6. *Prosopis cineraria* (L.) Druce

- Classification
- Division: Plantae
- Class: Magnoliopsida
- Order: Fabales

- Family: Fabaceae
- Genus: Prosopis
- Species: Cineraria
- Vernacular name: Khejadi, Shami, Janti

3.6.1. Traditional use

P. cineraria, are a multipurpose crop plant, most abundant species in alkaline, xeric climate provide livestock, fruit, timber, fuel, gum and tannin [24]. The pods are used as a vegetable. "Sangri", the green pods are boiled and dried. The flowers are useful for honey production. Khejri is also used for soil improvement and sand dune stabilization. The wood is ideal for domestic heating. The bark of the tree has abortifacient and laxative properties. Khejri is reputed for the treatment of asthma and worm [25]. Fresh/ dry leaves "Lunkh" are the most demanding fodder in Rajasthan.

The bark is used for medicine. Bark is dry, acrid, bitter with a sharp taste. It has anthelmintic properties and is prescribed in treatment of bronchitis, asthma, piles etc. The pods are a rich source of protein and carbohydrate and eaten by animals as fodder. It is also eaten as a vegetable and pickle by local people. The leaves are palatable and nutritious feed for livestock in the desert [26]. Shami plant is used to treat anxiety, dysplasia, fever, dysentery, leprosy, wandering of the mind & tremors [27].

3.6.2. Phytochemistry

Khejadi possess various phytochemical compounds including alkaloids, flavonoids, steroids, fatty acids & derivatives, phenylpropanoids and tannins [27].

3.6.3. Pharmacological activity

Recent study reports suggested that Shami tree contains analgesic, antitumor, anticonvulsant, antihyperlipidemic, antipyretic, antimicrobial, anti-inflammatory, antirheumatic and vermifuge activities [27].

3.7. *Vigna radiata* (L.)

- Classification
- Division: Plantae
- Class: Magnoliopsida
- Order: Fabales
- Family: Fabaceae
- Genus Vigna
- Species: Radiata
- Vernacular name: Mung bean

3.7.1. Traditional use

Mung beans are significantly consumed in Rajasthan as a major source of protein, vitamins, minerals, dietary fibers and significant number of bioactive compounds [28]. *V. radiata*, consumed in the form of Dal and "Khichdi" in Rajasthan. Medical practitioners and doctors suggested to consume Khichdi to little infants and persons recovering from sickness. For the vegan people, mung beans are a good source of low-cost protein. Legumes ranked 2nd in most consumed human food.

3.7.2. Phytochemistry

V. radiata, cultivated as a Kharif crop, contains polyphenols, polysaccharides, polypeptides, and flavonoids.

3.7.3. Pharmacological activity

Mung beans showed hypoglycemic, hypolipidemic, antihypertensive, anticancer, immunomodulatory, antioxidant, anti-melanogenesis, hepatoprotective and anti-inflammatory activities [29].

3.8. *Capparis decidua* (Forssk.) Edgew.

- Classification
- Division: Plantae
- Class: Magnoliopsida

- Order: Capparales
- Family: Capparaceae
- Genus: Capparis
- Species: Decidua
- Vernacular name: Karil, Ker, Dhalu

3.8.1. Description

"Ker", a bushy, spiny, leafless (leaves remain for a short time), dark green, multibranched, soil-binder, growing in a dense tuft, converted into a small sized tree with tap root system on proper pruning. Plant bear red-orange color flowers, used to cook as a vegetable with buttermilk; green colored immature fruits stored either sold in market at high cost or consumed in form of pickle, ripened fruits; micronate pinkberry, are juicy and consumed by herdsman in the hot summer to quench thirsts, eaten by camels and goats too. Wood is very hard and used to construct mud houses in Rajasthan.

3.8.2. Traditional use

Bark of "Karil/Ker" is very good to treat asthma, ulcers and boils, vomiting, piles and all inflammations. The immature fruits "Dhalu" have a sharp hot astringent to the bowels; destroys foul breath, biliousness, and urinary purulent discharges; good in cardiac troubles. The root bark is pungent and is given in cases of intermittent fevers, asthma, inflammations and rheumatism [30, 31].

3.8.3. Phytochemistry

Phytochemical screening of Ker reported the presence of important various phytocompounds, polyamine alkaloids, glucosinolates, phenolics, glycosides, sterols, flavonoids and vitamins [32,33].

3.8.4. Pharmacological activity

Karil trees possess analgesic, diaphoretic, emmenagogue and laxative properties [34]. *C. decidua* is an important xeric plant, contain sedative and anticonvulsant, anti-diabetic, antistress, hypocholesterolemic, anthelmintic, antioxidant, antibacterial, antiatherosclerotic, hypolipidemic, hepatoprotective, anti-inflammatory, insecticidal and oviposition inhibitory, hypotensive and spasmolytic activities [35].

3.9. *Podaxis pistillaris* (L.) Fr

- Classification
- Division: Basidiomycotina
- Class: Agaricomycetes
- Order: Agaricales
- Family: Podaxaceae
- Genus: Podaxis
- Species: Pistillaris
- Vernacular name: Desert puffball, Mushroom, Khumbi

3.9.1. Description

'Khumbi', a desert, edible, solitary, naturally occurring on baren sandy soil, oval shaped white pileus with grey stripe, used to eat in cooked form as a valuable vegetable available for a short period in the rainy season or a cut made into the saprophytic fungi and a pinch of salt poured in it, roasted on fired "Siniya"; *Crotalaria burhia* a bushy perennial herb grown in arid zone. Sun-dried "Khumbi" pounded into powder and mixed with cow's butter/fresh butter given orally to patients suffering from fractured bones issues due to quick wound healing activity. In the Thar Desert, local people preserve and store "Khumbi" for Medicinal purposes. "Khumbi" are a great source of proteins and essential amino acids contain carbohydrates, lipids and minerals.

3.9.2. Traditional use

P. pistillaris is used to treat skin diseases in Yemen [36], sun-burn and inflammation, also possess antibacterial, cosmeceutical and fibro-lytic properties [37].

3.9.3. Phytochemistry

Secondary metabolites present in *P. pistillaris* are phenols, flavonoids, steroids, Beta-carotene & lycopene source of antioxidant [37].

3.10. *Momordica dioica* Roxb

- Classification
- Division: Plantae
- Class: Magnoliopsida
- Order: Cucurbitales
- Family: Cucurbitaceae
- Genus: Momordica
- Species: Dioica
- Vernacular name: Spine Gourd, Kantola, Kankoda, Bad karela

3.10.1. Description

"Kankoda", are an unrecognized green vegetable in xeric climatic conditions, member of Cucurbitaceae family, grow as a creeper-climber wildly generally in association with *Capparis decidua* or on local fencing comprising of Ziziphus nummularia around cultivated fields. Fruits are bitter and astringent, used to cut into pieces and poured into salted water for some time to reduce bitterness.

3.10.2. Traditional use

Tribal people used to treat asthma, prevent excessive saliva formation in infants, maintain skin health and reduce inflammation caused due to snake bite, lizards, elephantiasis, fever, mental/digestive disorders [38]. Kankora act as an astringent, febrifuge, antiseptic, anthelmintic, spermicidal and used to treat bleeding piles, urinary infections and as a sedative also [39].

3.10.3. Phytochemistry

Various scientific reports show the presence of important phytocompounds such as vitamins, alkaloids, glycosides, steroids, triterpenoids, flavonoids, ursolic acid, amino acids and minerals in M. dioica [38].

3.10.4. Pharmacological activity

Kankora possess antioxidant, hepatoprotective, anti-ulcer, antibacterial, anti-inflammatory, anti-lipid, peroxidative and analgesic properties [39].

3.11. *Praecitrullus fistulosus* (Stocks) Pangalo

- Classification
- Division: Plantae
- Class: Magnoliopsida
- Order: Cucurbitales
- Family: Cucurbitaceae
- Genus: Praecitrullus
- Species: Fistulosus
- Vernacular name: Indian round gourd, Tinda, Tindsi

3.11.1. Description

"Tinda" a cucurbit, cultivated in the rainy season, an annual climber resembling *Citrullus* species; immature fruits are used as a vegetable in Rajasthani cuisine, or cut into slices, Sun-dried and stored for future consumption known as "Fofaliya". Tribal people cultivated *P. fistulous* mixed with *Citrullus lanatus* crops to protect "Matira" from whiteflies [40].

3.11.2. Traditional use

Indigenous people have the knowledge about the medicinal properties and nutritional values of *P. fistulous*. They had included medicinal valued plants and produce in their food style to live longer and healthier. Seeds of *P. fistulous* are a source of protein and consumed the same as Matira seeds.

3.11.3. Phytochemistry

"Tindsi" contain various important secondary metabolites, antioxidants, polyphenols, vitamins, minerals and flavonoids [41].

3.11.4. Pharmacological activity

Pulp/peelings and seeds of P. fistulosus possess antihyperglycemic, anthelmintic, anti-inflammatory, anticancer and cardioprotective properties, used to treat dry cough, aided to those suffering from blood circulation disorders and age degenerative diseases [41].

3.12. *Vigna aconitifolia* L. (Jacq.) Marechal

- Classification
- Division: Plantae
- Class: Magnoliopsida
- Order: Fabales
- Family: Papilionaceae
- Genus: Vigna
- Species: Aconitifolia

3.12.1. Traditional use

Unrecognized but most prominent in arid regions, moth bean considered as a nutraceutical legume. Immature, cylindrical pod "Moth Fali" used to cook as a fresh green vegetable in season, the ripened whole seeds are either used in boiled and fried form or made sprouts and eaten for breakfast. Split seeds of moth bean are cooked as "Dal". The moth-beans are sometimes ground into flour, which is mixed with other pulses' flours to make "Papad" served during meals and made into savory items play an important role in Indian cuisine and culture. Moth Beans are used as green manure, forage and hay in Rajasthan. Moth Beans are used to aid fever and roots are said to be narcotic [42]. Seeds of *Vigna aconitifolia* is believed to be a traditional source, used in healing of paralysis, weight management, rheumatism, cough, and liver ailments [43].

3.12.2. Phytochemistry

Moth beans contain several important secondary metabolites albumin, globulin, tannins, flavonoids, phenolic acids, phytic acid [44, 45] and trypsin and chymotrypsin inhibitor [44, 46, 47].

3.12.3. Pharmacological activity

Moth beans show antioxidant activity, anti-inflammatory, neurodegenerative diseases [48], anti-diabetic and antihypertensive activities [49].

4. Conclusion

The great Indian Thar Desert, situated in western Rajasthan, is rich in various medicinal plants. Historically, people of the tribal community enjoyed long and healthy lives as they recognized the beneficial properties of local medicinal plants and incorporated them into their diets and healthcare practices. The wild food plant families that were examined include cucurbits and legumes, which are plentiful in arid regions, along with Asclepidaceae, Capparidaceae, and Podaxaceae, all of which possess significant medicinal properties.

The Khejri plant, a vital species in desert regions, has been designated as the state tree of Rajasthan. All wild edible plants are recognized for their medicinal significance, and products derived from them are sold at high prices due to their limited availability and strong market demand. Thanks to their extensive knowledge and experience with medicinal plants, tribal communities handle the necessary processing, storage, and preservation of edible plant products. The rising demand for these food products has contributed to an improvement in the living standards of tribal populations. Gum Arabic, Gwar Gum, Panchkuta, matira, and the local mushroom Khumbhi are valuable plant products

found in arid regions. Due to extensive application of modern cultivation practices and tools in agriculture, change in traditional food habits & lifestyle, rapid urbanization, and deforestation process lead to extinction of local flora and fauna.

Government officials, the scientific community and the international community should pay attention to scientific culture and the preservation of these wild edible plants and it is preferable to contribute to the usefulness of plant products so that these plants can be protected from extinction in the near future.

Compliance with ethical standards

Disclosure of conflict of interest

Author declares no conflict of interest.

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