

# ITKs in Arid Horticulture



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BIKANER-334 006, RAJASTHAN, INDIA



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## PREFACE

The Indigenous Technical Knowledge (ITK) is socially desirable, economically affordable, sustainable, involves minimum risk and focus on efficient utilization of natural resources. The context of local knowledge systems combining traditional skills, culture and artifacts with modern skills, perspectives and tools is not something that has happened only in the recent past. From time immemorial, new crops were introduced from one part of the world to another and cultural and ecological knowledge systems evolved while adapting these crops, animals, trees, tools, etc., into their new contexts. What may set the traditional ways of dealing with local resources and external knowledge and inputs apart, may be a slower trial and error approach which may not necessarily be unscientific. But, it may not be fully compatible with modern methods of experimentation, validation, and drawing inferences. In spite of advancement in scientific knowledge in agriculture/horticulture, ITK-based practices still remain in use by the vast majority of the farming community, particularly in resource poor situations. In this context, blending of indigenous knowledge with modern scientific technologies is the need of the day to support sustainable development of horticulture and allied sector in our country. Since, information on ITK is seldom documented, it often happens that such information are lost, if not passed on from generation to generation or protected and practiced by the local people. Keeping the above facts in mind, an extensive study was conducted in hot arid regions and the Indigenous Technological Knowledge and related traditional techniques used in horticultural crop production system in the regions were evaluated, collected and documented and a bulletin entitled as "*ITKs in Arid Horticulture*" was prepared on same. This bulletin has detailed information about these traditional knowledge and techniques related to production, value addition, plant protection, soil and water conservation, improving soil fertility, growth and yield and productivity etc., of the vegetables and fruits grown in hot arid regions. We believe that this bulletin could be of useful and great importance, for the various researchers/scientists, policy makers, students, field workers, etc. The Indigenous Technological Knowledge and practices as narrated this bulletin, may provide the basic information/baselines to enrich the existing modern technologies or developing new technologies horticultural crop production, particularly in hot arid regions of the country. The blending of indigenous knowledge/technology with modern technology may be boon in developing a memorable innovative technology for wondrous production of horticultural in hot arid regions of the country. We would like to acknowledge and give sincere thanks to all who extended hands for helped us in preparing this bulletin comfortably with valuable information/data. We express our deepest sense of gratitude and sincere thanks to Prof. (Dr.) P. L. Saroj, Director, ICAR- Central Institute for Arid Horticulture, Bikaner who inspired us to prepare this bulletin with providing all essential facilities and precious guidance in successful completion of writing of the bulletin.

**Date:**

**Place:**

**Authors**



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## 1. Introduction

At present Indian horticulture is confronted with a number of challenges including instability of productivity and diminishing sustainability of natural resources. Hence, it requires the generation of environmentally sound, economically viable and socially acceptable improved horticultural technologies which can make judicious use of available natural resources and practical experiences of farmers/clients to promote the sustainable development of horticulture. These issues have evoked growing interest in the study of indigenous knowledge systems that are based upon the local resources. The Indigenous Technical Knowledge (ITKs) based Traditional Technologies (TTs) are developed based on experiences which gathered momentum through generation after generations and are being developed and improved through informal experimentations. In other words, Indigenous Technical Knowledge (ITK) based traditional technologies of production of a commodity are evolved by the people of a community based on their experience, often tested over long period of use, adopted to local culture and environment. They lay emphasis on minimizing risk and better output or production of the commodity like fruits/vegetables/food grains. Indigenous Technical Knowledge (ITK) has immense potential for innovation, especially at the grassroots level. India is a country populated by a number of indigenous communities, most of which have their own set of unique traditional knowledge and technology base. Many of these knowledge and technologies are at par with the modern knowledge and technology system and have been provided the indigenous communities with comfort and self-sufficiency. Since, information on ITK is seldom documented, it often happens that such information are lost, if not passed on from generation to generation or protected and practiced by the local people. In today's concept of IPR regime, it is more imperative to document and protect our valuable ITK for posterity. In the context of horticultural sustainability, ITK is also required to be properly documented for the benefit of researchers, planners and development officials. Validation of ITK is a logical step to qualify and quantify effectiveness of the practices. Suitable modifications of the local practices, through research and development may help to develop appropriate and acceptable technologies that are more suited to our horticultural/farming situations. Indigenous knowledges are not primitive, left over from the past but on the contrary, are systems of finally tuned and adopted, both biologically and socially, to counter the process of what are often harsh and inimical environment and often represent hundreds, sometimes thousands of years of adaptive evolution in which vagaries of climate, the availability of land, water, the basic need of people and their animals for food, shelter and health have been amalgamated in a system which has allowed society to exist and develop in face-to-face tremendous odds. Various ITKs in horticulture are being used since the human civilization by the farmers, animal owners and other practitioners. In spite of advancement in scientific knowledge in horticulture, ITK-based practices still remain in use by the vast majority of the farming communities, particularly in resource poor situations, without knowing the its scientific rationality. In this context, blending of indigenous knowledge with modern scientific technologies is the need of the day to support sustainable development and economic viable horticulture and allied sector in our country.

## 2. The special characteristic/features of indigenous technological knowledges (ITKs)

- ITKs are local and location specific, deeply rooted in a particular geographical area and communities.
- ITKs are evolved by the people of a community based on their felt needs, experiences and often tested over long period of use and compatible to existing culture, environment and social-economic conditions of the locale. Therefore, they are also denoted as “need based traditional inventions”.
- They are developed based on practical experiences which gathered momentum through generation after generations and are being developed and modified as per need through informal experimentations.
- They are the boundary of separation of the scientific facts from the traditional facts and rational facts from non-rational facts of the problems and solution.
- If, they are transformed or transferred to other situations or generation, there may be risk in aberration and distortion in them.
- Since, they are tacit in nature, hence, difficult to modify them.
- Since, they are transmitted orally or through imitation and demonstration to generation after generation or person to person, therefore, in the process of coding and decoding of the indigenous knowledge may lead to the loss of some of its major properties.
- The universality and authenticity of the indigenous knowledge is always doubtful.
- They are prone to change and dynamic in nature.
- The process of trial and error in testing of the indigenous knowledge is indispensable which generally leads to improvement in it.
- Exogenous knowledge and endogenous creativity always brings change and modification in ITKs.
- The ITKs are intuitive in its mode of thinking and are mainly qualitative in nature.
- Some kind of clues and scientific base is always embodied in ITKs which can be tapped up for improvement and welfare of concerned subject or area.

Keeping the above facts in mind, an extensive study was conducted in hot arid regions including *Thar* desert of western Rajasthan during the year 2011–2016 and the traditional knowledge and techniques related to value addition, plant protection, soil and water conservation, improving soil fertility, growth and yield and productivity, etc., of vegetables and fruits grown in the region were collected and documented. During the study, it was found that the farmers/dwellers of the hot arid regions grow various traditional vegetable and fruits crops applying their own indigenous knowledge/practices and consume them in fresh as well as in different value added forms. The major indigenous vegetables and fruits crops grown, consumed and their parts utilized for production of the traditional value added products by the farmers/dwellers of the hot arid regions of India are shown in **Table- 1**.

**Table 1. The major traditional vegetable and fruit crops grown, consumed and utilized for the preparation of traditional value products in hot arid regions of the country (India).**

Sr. No.	Local name of vegetable/fruit	Scientific Name	Parts used for consumption and value addition
1	Kachri	<i>Cucumis melo var. callosus</i> (Rott. Cong)	Fruits, seeds
2	Mateera	<i>Citrullus lanatus</i> Thumb.	Fruits, seeds
3	Snampelon	<i>Cucumis melo var. momordica</i>	Fruits, seeds
4	Khejri	<i>Prosopis cineraria</i> (L) Druce,	Tendrils & mature pods
5	Cluster bean	<i>Cyamopsis tetragonoloba</i>	Tendrils pods
6	Indian aloe	<i>Aloe vera barbadensis</i> Mill	Leaf/leaf blade
7	Tumba	<i>Citrullus colocynthis</i>	Mature fruits, seeds
8	Spiny brinjal	<i>Solanum melongena</i>	Fruits
9	Phog	<i>Calligonum polygonoides</i> (L.)	Immature flower buds
10	Moringa	<i>Moringa oleifera</i> Lamk	Pods, flowers, leaves
11	Cactus	<i>Opuntia ficus indica</i>	nopales/cladodes
12	Khimp	<i>Leptadenia pyrotechnica</i> (Fork.) Decne	Tendrils pods and stem twigs
13	Ber/ bordi	<i>Ziziphus spp.</i>	Immature/ mature fruits
14	Ker	<i>Capparis deciduas</i> Edgew	Immature fruits, flowers
15	Lasora	<i>Cordia myxa</i> Roxb.	Immature/ mature fruits
16	Karonda	<i>Carissa carondas</i>	Mature fruits

These all above indigenous vegetables and fruits are the potential sources of the food, nutrition and sustenance of the rural life of the hot arid regions. The parts/organs like tender pods, flowers/ flower buds, leaves, fruits, nopales/cladodes, etc., are used to consume in fresh as well as in value added forms. The farmers/dwellers of the hot arid regions prepare various kinds of ITKs based traditional value added products of these vegetables/ fruits using their own knowledge and techniques (**Table - 2**). These value added products are consumed by the dwellers in their daily diet and surplus is sold in local markets to earn money.

**Table 2. Traditional value added products of vegetables/fruits produced and consumed by farmers/dwellers of the hot arid regions of the country (India).**

Sr. No.	Traditional veg./fruit	Forms traditional value added products (consumption forms/pattern)	Producers & Consumers (%)
1	<i>Kachri</i>	Dehydrated slice/ pieces/ <i>papadi</i> , pickle, fried <i>chutney</i> , dry <i>chutney</i> , powder, vegetable, etc.	54 -96
2	Snampelon	<i>Khelara</i> (Dehydrated pieces/slices ( <i>khelra</i> ), pickle, <i>Jem</i> , <i>shek</i> , <i>chutney</i> , vegetable, etc.	33- 93
3	<i>Mateera</i>	Dehydrated roused seeds, <i>magaj</i> , juice, cold drinks, sweets, <i>laddu</i> using seed's powder, vegetable, etc.	39 -88
4	Khejri	Dehydrated pods ( <i>sangari</i> ), pickle, powder, biscuits, <i>khakari</i> , <i>swali</i> , <i>rayata</i> , <i>chutney</i> , vegetable, etc.	24 - 98
5	Cluster bean	Dehydrated pods, pickle, vegetable, etc.	36-98
6	Round melon	Dehydrated pieces/ slices ( <i>Foflial</i> ), <i>rayata</i> , <i>chutney</i> , pickle, vegetable, etc.	36 - 74
7	Indian aloe	Pickle, squash, soft drink, juice, vegetable, etc.	30 - 47
8	<i>Tumba</i>	Pickle, murabbah, dry powder ( <i>churan</i> for medicinal purpose)	16 - 22
9	Phog	<i>Fogla</i> (Dehydrated immature buds of <i>phog</i> ), <i>rayata</i> , <i>curry</i> , etc.	34 -68
10	<i>Khimp</i>	Dehydrated pods, medicine, <i>rayata</i> , vegetable.	28 - 48
11	Drumstick	Vegetable, pickle, <i>rayata</i>	18 -27
12	Cactus	Vegetable, pickle, <i>rayata</i>	33 -42
13	Ber/ boradi	Dehydrated ber, pickle, <i>chutney</i> , vegetable, etc.	22 -31
14	Ker	Pickle, dehydrated fruits, <i>chutney</i> , <i>curry</i> , vegetable, medicinal powder, etc.	34 - 91
15	Karonda	Pickle, dehydrated fruits, powder, vegetable, etc.	30 - 40
16	Lasora	Pickle, dehydrated fruits, <i>chutney</i> , vegetable, etc.	23 -44
17	Aonla	Pickle, <i>laddu</i> , candy, <i>jem</i> , <i>supari</i> , powder, <i>murbba</i> , vegetable, etc.	38 -53

### 3. Factors which compel to produce the traditional value added products of vegetables and fruits grown in hot arid regions.

- Acute shortage of fresh vegetables and fruits in hot arid regions, particularly during summer and winter seasons.
- Availability/existence of several potential indigenous land races /species of vegetables and fruits in hot arid regions.
- High likeness of traditional value added products of indigenous vegetables and fruits among the people/dwellers of the in hot arid regions.

- Very high demand of traditional value added products of arid fruits and vegetables not only in local markets/areas but also in other states of India, even out of country too.
- Availability of local resources and raw materials for production of traditional value added products.
- Existence of indigenous knowledge based traditional tools and techniques for value addition.
- Availability of high solar radiation as a great source of natural energy used for value addition.
- Availability enough family labour and open space.
- Low atmospheric humidity and clean environment.
- The indigenous technique used for value addition are very simple, sustainable and eco-friendly.
- Low cost of production of traditional value added products
- Traditional technologies and processes are easy in adoption, operation and dissemination.
- Low cost of cultivation of traditional arid vegetables and fruits as most of them grow naturally and some are evergreen in nature too.
- The traditional value added products are culturally accepted and environmentally compatible.
- These products are considered by consumers as pure organic forms of food stuff as most of them are derived/prepared from natural growing vegetables and fruits in the hot arid regions.
- The belief that traditional value added products are safe in use, highly nutritive and energetic.
- The belief that these products are good for health and hygiene point of view and play important roles curing the various diseases and disorders in the body.
- The scattered population in the hot arid regions.
- Long distance from local markets and big cities.
- Lack of transportation and communication means.
- The shelf-life of traditional value added products (like dehydrated products) is very long without special care and management.
- No need of special machineries, tools and infrastructures for the production of traditional value added products.

The above factors/reasons compel and encourage the farmers/dwellers of the hot arid regions to produce the ITKs based traditional value added products of vegetables and fruits grown in the regions. The major indigenous techniques/processes/ methods of preparing the value added products of vegetables and fruits grown in hot arid regions are narrated here in short.

## 4. ITKs based traditional techniques of horticultural importance

### A. ITKs based traditional techniques of value addition for arid vegetables

- ***Kachari (Cucumis melo var. callosus Rott. Cong)***

*Kachari* is the most favourite and drought hardy cucurbitaceous traditional vegetable which is grown in hot arid regions of the country from ancient time. *Kachari*, belongs to the family-

*Cucurbitaceae*, genus-*Cucumis*, species- *melo* and *var. callosus/agrestis*. It is commonly known as small gourd/ wild musk melon (English), *kachari* (Gujarati), *kachari/kachariya* (Hindi), *chibdin* (Konkani), *chibbad* (Punjabi), *shinde* (Marathi), *gurmi* (Nepalese), etc. It is mainly grown during the rainy season under the mixed cropping system at large scale or as sole crop at small scale. Some of the farmers having irrigation facilities grow the *kachari* as sole crop during the summer season also. *Kachari* is an annual climber. Its vines grow up to 1.5 m and spreads on the ground. The fruits are obovoid/ellipsoid/oval-round shaped with green variegated stripes, 4.0–7.5 cm in size, generally with dark green stripes looks like a miniature of *mateera*/watermelon. It is the most liked traditional vegetable in hot arid regions where > 90 % people used it as fresh for vegetable purpose and in the forms of various traditionally value added products.



### (a-1) ITKs based major traditional techniques of value addition for *kachri*.

*Kachri* is considered as a source of pure organic form of vegetable in hot arid regions of the country. In addition to prepare the vegetable, the farmers/dwellers of the hot arid region prepare various traditional value added products of *kachari* using their own traditional knowledge/experiences and techniques for their own consumption and selling out the surplus in the local markets/areas. The major value added products prepared by farmers/rural masses based on their own traditional knowledge and techniques are *pickle, fried chutney, dry chutney, powder, dehydrated slice/ pieces/gote, papadi*, vegetable (54-96 % producers/consumers) of which ITKs based traditional techniques are as follows.

**(i) Dehydrated pieces/slice of *kachri*:** The dehydrated pieces/slice (with skin/without skin) is a very common traditional product of *kachri* which always available in the local markets and used throughout the year to prepare vegetable, powder, chutney, pickle, garnishing agent, etc. Its production method is very simple and cost effective.

**Flow chart of traditional technique for producing dehydrated pieces/slices of *kachri*:** Collection the healthy & mature fruits of *kachri* → Washing them with water → Removing the skin/ not removing skin of fruits → Cutting the fruits in pieces and remove seeds → Full solar drying of the pieces → Making of suitable packing and putting at cool place → thus, very tasty and nutritious dehydrated pieces/slices become ready for futuristic use like preparing vegetable, chutney, pickle, powder, as garnishing agent, etc.

**(ii) Dehydrated whole *kachri* (*kachri gote*):** The dehydrated whole *kachri* fruits (peeled) are very the common traditional product of *kachri* which are locally known as "*kachri gote*". They are also available always in the local markets and used by majority of farmers /consumers throughout the year to prepare vegetable, chutney, garnishing item/condiments for preparing other items at home, hotels, restaurants, etc. Its traditional technique of processing is as follows.

**The traditional technique of dehydration of whole *kachri* fruits:** The mature and health fruits of *kachri* fruits are selected, washed with clean water and dry them for some time to remove the water from their surface. After that, they are peeled (removing of skin) and the whole fruits are beaded with help of needle and threads or spread on the surface at neat and clean shaded place for dehydration. The beaded *kachri* are hanged and left to dry at neat and clean airy-shaded place to avoid the brown spots on the fruits due bright sunlight. These fruits are dehydrated (up to 10-12 % moisture content) using high intensity free solar radiation of the hot arid region. The dehydrated fruits of *kachri* are collected and filled in clean gunny bags and put at cool place for household utilization in future like to prepare vegetable, powder, chutney, pickle, garnishing agent, etc. or for sell out surplus in local markets/areas.



Dehydrated whole *kachri* with peeling and with seeds.



Dehydrated slices/ pieces of *kachri* with peeling and without seeds.



Dehydrated slices/ pieces of *kachri* with seeds and without peeling.

**(iii) Pickle of *kachri*:** The local people/farmers prepare pickle of *kachri* using their own traditional knowledge and technique to consume in their daily diet. Some of the farmers/local people produce the *kachri* pickle to sale in local markets and earn money for their livelihood also.



Pickle of *kachri*

**Flow chart of traditional technique of preparing the pickle of *kachri*:**

Collection of the healthy & mature fruits of *kachri* → Wash them with tap water → Cut the fruits in pieces and remove seeds → Solar drying for 10- 12 hrs to remove excess water → Frying the pieces in mustard oil for few minutes → Mixing condiments (seeds of fenugreek and fennel, *kalongi*, asafetida (*hing*) powder of red chilli and turmeric, salt, etc.) and cooking for some time → Cooling the pickle material → Filling in suitable pot /utensil → Warm the mustard oil & cooling it and filled up to the mark in pot/utensil having prepared material of pickle → Thus, pickle is ready & started using after a week.

**(iv) Fried chutney of *kachri*:** Majority of the farmers/local people prepare the fried chutney of *kachri* using their own traditional knowledge and technique and consume the same in their daily diet.

**Flow chart of traditional technique of preparing fried chutney of *kachri*:**

Collection the healthy & mature fruits of *kachri* → Washing them with water → Removing the skin of fruits → Cutting the fruits in pieces and remove seeds → Grinding the pieces well by hand/ in



Fried chutney of *kachri*

grinder → Mixing condiments (like grinded garlic, powder of red chilli and turmeric, salt, etc.)  
 → Frying the grinded and mixed material in mustard oil till the release out of oil from the mixed material  
 → Cooling the mixed material / chutney → Filling the chutney suitable pot →

Thus, very tasty and nutritious chutney *kachri* is ready to serve.

**(v) Readymade dry chutney of *kachri*:** The readymade dry chutney of *kachri* is also very a common traditional value added product of *kachri*. It very tasty and has long shelf life. It has very high cost and demanding product of *kachri* in local areas/markets of the hot arid regions.

**Flow chart of traditional technique of preparing dry chutney of *kachri*:** Collection of healthy & mature fruits of *kachri* → Washing them with water → Removing the skin of fruits → Cut the fruits in pieces and remove seeds → Full sun drying of the pieces/ whole *kachri* after removing their skins → Grinding the dried pieces with desirable quantity of condiments (like powder of red chilli, common salt, black salt, etc.)



Dry chutney of *kachri*

→ Mixing the some quantity of intact seeds of cumin and white sesame in grinded mixture of *kachri* + condiments → Making of suitable packing and putting at cool place → Thus, very tasty and nutritious dry chutney of *kachri* is ready to use.

**(vi) *Kachri* powder:** The powder of *kachri* (without skin) is a very common traditional product of *kachri* which available throughout the year in the local markets as well as at home of majority of farmers /consumers. It is used throughout the year to prepare the chutney, garnishing item/ condiments for preparing other items/vegetables at home, hotels, restaurants. c.

**Flow chart of traditional technique of preparing the *kachri* powder :** Collecting of healthy & mature fruits of *kachri* → Washing them with water → Removing the skin of fruits → Cut the fruits in pieces and remove or not remove the seeds → Full sun drying of the pieces/ whole *kachri* after removing their skins → Grinding the dried pieces/whole *kachri* fruits to get powder of it. Thus, powder of the *kachri* is ready to use.

**(g) Use of *kachri* as an ingredient of traditional “*Panchkuta*” vegetable :** The dry *kachri* slice/ piece is one of the components of the traditionally very famous dry mixed vegetable, locally called *Panchkuta* [consist of dehydrated tender pods of *khejri* (*Prosopis cineraria* L.) Druce), fruits of *ker* (*Capparis deciduas* Edgew), pices of *kachari* (*Cucumis melo* var. *callosus* Rott. Cong), fruits of *lasora* (*Cordia myxa* Roxb) and seeds of *kumat* (*Acacia senegal*)].

- **Snampelon (*Cucumis melo* var. *momordica*)**

Snampelon is also one of most favourite and drought hardy traditional vegetable of the hot arid regions of the country. It belongs to family- *Cucurbitaceae*, genus- *cucmis*, species-*melo* and var.- *momordica*. It is locally known as ‘*phoot* or *phot kakadi*, *kakadia*. It is mainly grown during the rainy season under the mixed cropping system at large scale or as sole crop at small scale. Some of the farmers which have irrigation facilities grow it as sole crop during the summer season

also. Snap melon is a monoecious, an annual climber, its stem are generally covered with rough hairs and vines grow up to 1.5 m which spreads on the ground. The flowers of the same are small, yellow, solitary or rarely in pairs or threes. Initially, the immature fruits



of the snap melon are green in colour with hairy surface and have bitterness. As soon as the fruits reach at maturity, their hairs and bitterness disappear and become smooth with relish acidic taste. There is wide variability among the shape, size, appearance and colour of the snap melon fruits. Most of the fruits of snap melon are cylindrical, 10-22 cm length with 18-32 central girth, green-yellow/redish-yellow/creamy-yellow or green in colour with yellow/greens strips/pots at maturity stage. Like *kachari*, the snap melon is also one of the most favourite and most liked vegetable of the hot arid regions where it consumed by 33 – 93 % dwellers/people of the region as vegetable and in other different value added forms (**Table 2**). The fresh as well as dehydrated slices of fruits of the snap melon are mainly used for preparing vegetable (pure/mixed with other vegetables). After maturity, fruits reach to over maturity stage and at this stage the fruits start to crake automatically which are locally known as '*phoot*'. The fruits of *phoot* stage have a special pleasant smell and taste like pine apple. These '*phoots*' are of sweet-sour in taste and eaten directly as fresh fruit very eagerly by the people of the region. The fresh mature fruits of the snap melon are also used for *salad* purpose. Snap melon is also considered as a source of pure organic form of vegetable/food stuff in hot arid regions of the country. It has high nutritional value and work as a mean of food seasoning or relish/palatability of the diet for the dwellers of the regions.

### (a-2) ITKs based major traditional techniques of value addition for snap melon.

**Techniques of dehydration of snap melon:** The mature and health fruits of snap melon are selected, washed with clean water and dry them for some time to remove the water from their surface. After that, they were peeled (skin is removed) and cut fruits vertically to make its slices. The seeds and waste material are removed each slices and treated them with 2-3 % warm common salt/alum solution for 10-12 minutes to avoid the browning of the slices. Further the treated slices are taken out from the salt/alum solution and put them at neat and clean airy-shady place to dry with heat of solar radiation. The slices are done up-down time to time to facilitate the dehydration / drying properly. They become dry fully (with 10-12 % moisture content) within a week. The duration of dehydration of slices depends on weather conditions/seasonal factors. After full dehydration, the slices are collected, filled in clean gunny bags and put at cool place for futuristic use like preparing vegetable, chutney, garnishing material, etc. Moreover, dry sweet slice, spicy *golchha*, *pickle*, *jem*, *shek*, *chutney*, etc., of snap melon are also prepared by farmers/ local people using their own traditional knowledge and techniques for their own consumption or selling surplus in local markets/areas.



Dehydrated slice of snapmelon



Dry sweet slice of snapmelon



Spicy golchha of snapmelon

- **Mateera (*Citrullus lanatus*, Thumb.)**

In hot arid regions, the *mateera* is also very famous and desirable cucurbit which used as vegetable as well as desert fruit. The scientifically, *mateera* is known as *Citrullus lanatus* (Thumb.) and belongs to family Cucurbitaceae. It is known with different names like *Kalind* (in Sanskrit); *Kalingad* (in Marathi); *Tarbooj* (in Hindi); *Mateera* (in Marwari) *Kalingda* (in Gujarat), etc. It is an annual vine/creeper. It has well developed tap root system with a highly branching/lateral roots extending up to 1 m deep or more into the soil. The stem of the *mateera* is herbaceous, highly branched vines up to 3 m long (but may be up to 8-10 m). The younger shoots are covered with long, woolly curved hairs protecting the plant from overheating. Mostly, the flowers are monoecious but there are found andromonoecious (staminate and perfect) types also. The surface of fruits varies from single colour to various striped patterns. The mature fruits of the *mateera* consist of exocarp, mesocarp and endocarp. The endocarp (placenta) is seed containing part that is consumed as food (edible part) and the mesocarp and exocarp are usually referred to as rind having thickness of 10 to 40 mm. The colour of pulp may be white, pink or reddish-pink (Guner et al., 2004 and Kumar et al., 2013).



It is one of the most drought hardy and multipurpose cucurbit. It is preferably grown during rainy season under traditional mixed cropping system in hot arid regions extensively. However, the farmers which have irrigation facilities grow it during the summer season as a sole at small scale also. It is grown for vegetable purpose, eating as fresh fruits and particularly, to get its protein and oil rich seeds to supports the livelihood of desert dwellers/farmers in a big way. The *mateera* has a great importance not only as a vegetable and oilseed crop but also plays a vital role in livelihood and nutritional security in the hot arid regions. The tender fruits of '*mateera*' locally known as '*loia*' (immature fruits of 100-150g) are traditionally used by farmers/dwellers widely to prepare vegetable or *raita*, *chutney* and also for sale surplus in the local market/*mandies*/localities to earn money. The mature fruits of *mateera* are eaten freshly and much relished. The roasted seeds of *mateera* are generally taken as a common snack in arid region. After removal of seed coat, the kernels of the *mateera* seeds, locally known as '*mateera magaj*' of which the marketing cost is 260 - 350 per kg. The *mateera magaj* is mainly used to prepare sweets, *laddu*

and cold drinks. The kernels (*magaj*) of the seeds are used in restaurants/hotels as source of flavor, taste and thickeners in vegetable preparation. After extraction oil, the byproducts seeds serve as a quality animal feed which is supposed to increase the milk yield of the milch animals.

### (a-3) ITKs based major traditional techniques of value addition for *mateera*.

The dwellers/ farmers of the hot arid region of the country, prepare various traditional value added products of the *mateera* fruits and seeds applying their own traditional knowledge and techniques. Among them the major are dehydrated roasted seeds, highly nutritive *magaj* (kernel of seeds), *mateera* oil, juice, cold drinks, sweets of *magaj*, etc. (Meena et al., 2016). The traditional techniques/process of some of the above value added products is being narrated in short here as below.

**Roasted seeds of *mateera*:** The roasted seeds of *mateera* are highly demanding, very famous and nutritious traditional product of *mateera* which produced and consumed by the dwellers and farmers of the hot arid regions. They are very good source of earning of producer/farmers too. The roasted seeds are sold in local markets at high rates depending on quality, demand and supply factors of the market.

**Flow chart of traditional technique/process of roasted seeds of *mateera*:** Collection the healthy & mature fruits of *mateera* → Extracting seeds from the fruits → Washing the extracted seeds with water → Full sun drying of the seeds → Roasting the seeds in pan putting on fire (*Chullah*) → Cooling the seeds → Wrapping salt and other condiments with seeds → Filling in boxes/gunny bags → Sale in local markets or stored at neat and clean place for utilization (eating) in future.

***Mateera magaj*:** The kernels of the *mateera* seeds are locally called *mateera magaj*. The kernels (*magaj*) of *mateera* seeds are extracted/taken out using their traditional manual method / with the help of some local made machines. The *mateera magaj* is very precious and highly demanding traditional product of *mateera* in hot arid regions. *Magaj* have very high nutritional value and now these days become the substitute of cashew nut while preparing the different kind of sweets and cold drinks. The kernels (*magaj*) of *mateera* seeds are very rich in edible oil and crude protein. The seeds of *mateera*/watermelon has 28% crude fat and 23% crude protein while in kernel corresponding values observed were 49 and 40%, respectively (Das et al., 2002). The further analysis of seed kernel for mineral composition and reported considerable amount of phosphorus (1279 mg/100 g), potassium (1176 mg/100 g), magnesium (542 mg/100 g) and calcium 150 mg/100 g (Adawy et al., 2001). *Mateera magaj* has very high markets value and sold in the local markets @ 250 – 350 per kg depending on quality, demand and supply factors of the market. Thus, it is a very good source of earning of farmers also.

**Sweets of *mateera magaj*:** Local people of the hot arid regions prepare traditional sweets of *mateera magaj* like cashew sweets (*Kaju katali*) which are very tasty, nutritious and cost effective. The *mateera magaj* is also used by local people in preparing special kind of *laddu* with moong/wheat flour and other ingredients.

**Cold drinks of *mateera magaz*:** The dwellers of the hot arid regions prepare traditional soft/cold drink using the *mateera magaz* with fennel seeds, black pepper, petals of rose flower, water, milk, etc., especially during the summer season. It is considered high beneficial for the health point of view during the summer season. It has very high cooling effect on the human body and provides favourable nutrition which protects the body from bad effect (dehydration in body) of high temperature (*Loo*) during the summer in hot arid regions.



Roasted seeds of mateera



Mateera Magaz



Laddu of mateeraa magaz

- **Round melon (*Citrullus vulgaris var. fistulosus*)**

*Citrullus vulgaris var. fistulosus*, commonly known as squash melon, round melon, round gourd (in English) and *tinda* (in Hindi) belongs to family- *Cucurbiteceae*, genus- *Citrullus*, species- *vulgaris* and *var.- fistulosus*. It is an annual climbing or trailing herb with tendril, slender and robust hairy stem. The plant is monoecious. The fruits of the round melon are globose or depressed-globose berry (hispid when immature), pale to dark green outside and creamy white to pale green inside with many seeds. The round melon (*tinda*), especially local type, is also one of the very important and favourite source of green vegetable in hot arid regions. Round melon is considered as a pure form/organic source of traditional vegetable/food stuff in the regions. The fresh fruits of the round melon is mainly used to prepare the vegetable (pure/ mixed) but some traditional value added products / food stuff in hot arid regions for their own consumption and selling out the surplus.



#### **(a-4) ITKs based major traditional techniques of value addition for round melon**

The fresh round melon fruits are mainly used to prepare the vegetable, *rayta*, *kofta*, etc. However, some traditional value added products of the round melon like dehydrated pieces/slice, *rayta*, chutney, pickle, etc., are also prepared by the farmers/dwellers of the hot arid regions their own

traditional techniques/ processes. Among these, major is dehydrated slices of round melon which are locally called *fofalia*. These prepared, collected and filled in clean gunny bags and put at cool place for future use like preparing vegetable, rayata, chutney, garnishing material, etc., throughout the year. These dehydrated slices (*fofalia*) are not only a source of vegetable but also work as very good mean of earning for the producers. They are sold by the farmers/rural dwellers in local markets/*mandies*/ localities. The majority of the farmers/dwellers of the hot arid regions produce the dehydrated slice/pieces (*fofalia*) of the round melon. The traditional techniques/ process of preparing dehydrated slices / *fofalia* of the round melon is being narrated here as flow diagram.

**Flow chart of traditional technology/process of producing dehydrated pieces/slices (*fofalia*) of round melon:** Collection of the healthy & mature fruits of round melon → Washing them with normal water → Cutting the fruits in suitable pieces and removes seeds → Putting the slice in hot for a moment water → Full solar drying of the pieces → Collecting and making of suitable packing and putting at cool place. Thus, very tasty and nutritious dehydrated pieces/ slice of round melon are ready for futuristic use like preparing vegetable, *rayata*, chutney, garnishing agent and sale out the surplus in the local markets/areas.



Rousted seeds of mateera



Dehydrated slice/pieces (*fofalia*) of the round melon



- **Cluster bean (*Cyamopsis teragonoloba* L. Taub).**

Cluster bean belongs to family *leguminacea* Taub. It is called with different name in different area/language viz., in Bangali- Jhad sim, in Gujarat-Gowar, in Hindi-Guar / Gawar, in Kannad-Gori, in Tamil and Malyalam-Kothawar, etc. In hot arid regions, cluster bean is mainly grown during the rainy season for seed and fodder purpose. However, its young tender pods are used for vegetables purpose. It is a delicious and highly nutritious green vegetable. The green pods of the cluster bean are as rich in food value as French bean. The green pods of cluster bean are rich source of vitamin A, iron and also contain vitamin C. The green tender pods of cluster bean is one of the most prominent and favourite vegetable used by more than 90% dwellers of the hot arid regions.



Plant of cluster bean

### (a-5) ITKs based major traditional techniques of value addition for cluster bean

The green tender pods of cluster bean are used to prepare the seasonal vegetable but some of the traditional value products of the cluster bean are also prepared by the local people to consume them during the off season of the year. Among such traditional value added products of cluster bean are: dehydrated tendrill pods, pickle of the pods and fried *namkeeni* pods of cluster bean, etc. The outlines of traditional techniques/process of preparing above traditional value products of the cluster bean are being narrated here in short as blow.



Fresh pods of cluster bean

**Dehydrated pods of cluster bean:** The green as well as dehydrated tender pods of cluster bean are the most prominent and favourite vegetable used by majority of dwellers of the hot arid regions. The farmers/dwellers of the regions prepared/produce the dehydrate the tendrill pods of cluster bean using their own traditional knowledge and technique/process to meet their own requirement during off season /non availability of fresh pods of cluster bean to prepare vegetable purpose or mixed with other vegetables. Some of the farmers produce dehydrated pods in surplus which are sold in the local markets/ areas to earn money. The market price of dehydrated pods of cluster bean ranges Rs. 340 - 600/- per kg depending on quality, season, demand and supply factors of the marketing. Thus, these dehydrated pods are also work as a very good source of income for the farmers/producers. The flow diagram of traditional technique/process of dehydration of pods of cluster bean is as follows.

**Flow chart of traditional technique/process of dehydration of tendrill pods of cluster bean:** Picking of the healthy & tendrill pods of cluster bean → Washing them with normal water → Blanching of the pods for a moment → Drying of the pods at shady place/room → making of suitable packing and putting at cool place → Thus, dehydrated pods of the cluster bean are ready for use in pickle and sale for surplus in the local markets/areas.



Dehydrated pods of cluster bean

**Mixed pickle of pods of cluster bean:** The local people/ farmers prepare very tasty mixed pickle of pods of cluster bean using their own traditional knowledge and technique/process to consume in their daily diet or to sale surplus in local markets and earn money for their livelihood. The flow diagramed of traditional technique/process of preparing pickle of pods of cluster bean is as follows.

**Flow diagram of traditional technique of preparing the mixed pickle of cluster bean pods:** Picking of tendrill pods of cluster bean → Washing them with normal water → Boiling them for a moment in water having common salt 2.5 g per liter/lit. water → Drying them at shady place for 2 – 3 hours to remove excess water → Mix the lemon juice @ 15 – 20 ml per kg of treated pods

→ Frying the pods + semi-dry pieces of kachri in mustard oil for few minutes → Pouring and mixing the condiments (seeds of fenugreek and fennel, *kalongi*, asafetida (*hing*) powder of red chilli and turmeric, salt, etc.) → Cooking the mixed raw material of the pickle for few minutes → Cooling the so prepared material of pickle → Filling it in suitable pot/ utensil → Warm the mustard oil & cooling it and fill it in pot/utensil of pickle up to the level → Thus, pickle is ready & started using after a week.



Mixed pickle of cluster bean

**Fried *namkeeni* pods of cluster bean:** The local people/farmers prepare very tasty fried *namkeeni* pods of cluster bean using their own traditional knowledge and technique/process. These *namkeeni* fried pods are used to eat in their daily diet as taste changer or dry *salad*. These are also offered to relatives/ friends or sale out surplus in local markets to earn money for their livelihood.

**Flow diagram of traditional technique/process of preparing fried *namkeeni* pods of cluster bean:** Picking of tendril pods of cluster bean → Washing them with water → Boiling them in water having common salt @ 2.5 gm per liter for 5 – 6 minutes → Drying them fully with solar radiation at shady place → Frying the dried pods in mustard oil for few minutes → Take out the fried pods from the pan and cool down them → mixing powder of red chilli, powder of cumin, common salt, etc. → Thus, fried *namkeeni* pods of cluster bean are ready to serve/consumption.



Namakin pods of clusterbean

- ***Khejri (Prosopis cineraria)***

*Khejri (Prosopis cineraria)* is a multipurpose tree which is known as lifeline of the *Thar* desert / hot arid regions of India. It grows luxuriantly under the extremely adverse climatic conditions of the hot arid region without any special care and support. It belongs to Leguminosae family and play very important role in socio-economic livelihood security and ecological balance in hot arid regions. It is a true multipurpose species and often referred to in ancient Indian literature as the 'Kalpvriksha' of the desert. It is known by several vernacular names such as; Janti and Chonksa (in Delhi), Jhind, Jhand and Jand (in Punjab and Haryana), Banni (in Karnataka), Sumri (in Gujarat), Kandi (in Sindh) and *Khejri* (Sanskrit). *Khejri* is a small moderate sized evergreen thorny tree, with conical thorns and light bluish-green foliage. The leaflets are dark green with thin casting of light shade. The trees not only boost the growth and



productivity of companion plants, but also provide fuel, fodder, food, small timber, medicines, gum and tannin. Its foliage is a nutritive fodder for animals and the wood is of good quality for domestic fuel purposes. Unlopped trees produce green pods which mainly used (fresh as well as dehydrated) to prepare vegetable and pickle. Pods are light green-yellow in colour. They grow up to 8 to 19 cm. These are locally called as *sangar* or *sangri* in Rajasthan. These *sangari* are wonderful and most liked traditional vegetable of the hot arid regions / *Thar* desert of western Rajasthan from ancient time. The ripened and dry mature pods are locally called 'khokha' and eaten directly or prepared the flour/powder of the same which are consumed in different ways. The pods of *Khejri* containing up to 25 dull brown seeds, 0.3 to 0.8 cm long. The pods (*sangari*) of *khejri* have high nutritional value and potential source protein, minerals, carbohydrate, vitamins, etc. The moisture content of the pods (*sangari*) of *khejri* is quite low (8.5-10.2 %) which may be advantageous for its shelf life. They were found to be rich in carbohydrates (56.5). There was an appreciable amount of protein (18-22 %) making it as a good source of protein. *Sangari* (pods) has very low amount of fat (2.30%) which makes it ideal diet for overweight people. It has 0.4% phosphorus, 0.4 % calcium with good amount of Mg, Zn, Se, Fe and fibres. There is evidence that the dietary fibre has a number of beneficial effects on digestion in the small intestine (Pareek, 2002).

#### (a-6) ITKs based major traditional techniques of value addition for *sangari* of the *khejri*.

(i) **Dehydrated *sangari* of *khejri*:** The immature (tendrils) and healthy *sangari* of *khejri* are

selected, washed with clean water and dry them for some time to remove the water from their surface. After that, they were boiled for 5- 6 minutes in water having 2-3% common salt. Further the boiled *sangari* were taken out



Fresh green sangari of khejri



Dehydrated sangari of khejri

from the boiled water and

left them at neat and clean airy-shady place to dry. The *sangari* were done up-down time to time to facilitate the dehydration / drying properly. These *sangari* were got full dry (with 10-12 % moisture content) within a week (the duration of such kind of dehydration of *sangari* is varied , depends on weather conditions/seasonal factors). The *sangari* are collected, filled in clean gunny bags and dehydrated put at cool place for future use like *sangari* based *Pacnhkuta* mixed vegetable, pure vegetable, pickle, etc

(ii) **Pickle of tendrils *sangari* (pods) of *khejri*:** Selection and harvesting of healthy tendrils *sangari* (pods) → Boiling them for some time → Frying slightly with mustard oil for some time → Mixing some of the processed immature fruits of *ker* with pods of *khejri* while frying → Mixing

condiments and spices → Cooling down the material of the pickle → Fill the prepared pickle in the suitable pots → Fill boiled and cooled mustard oil till sinking of the prepared material → Put it at a neat and cool place and started to consume after some days.

**(iii) Powder/ flour of mature dry pods (*khoka*) of *khejri*.**

The mature dry pods of *khejri* which are locally called *khoka* are used in various ways. The powder/ flour of the full mature and dried *khoka* pods of *khejri* is prepared by grinding them in mixer or flour mill. This powder is mixed with flour of wheat/ gram/green gram/ *maida* and various traditional products like *khankhari*, *suhali*, *laddu*, *chapaties* and other dishes are prepared by the local people of the hot arid regions.



Khoka (mature dry pods) of *khejri* after removing the seeds



Pieces Khoka (mature dry pods)



Powder/flour of Khoka (mature dry pods) of *khejri*

**(iv) Preparation of *khakari* (*laddu*) and *Suhali* (*papadi*) of mature dry pods (*khoka*) of *khejri*:**

The local people/dwellers of the hot arid regions, prepare the special kind of sweets of powder of mature dry pods of *khejri* which are locally called *khakari* and consumed very eagerly. Likewise, the *namakin*/sweet *papadi* which are locally called *suhali* are also prepared from powder of mature dry pods of *khejri* eaten with curd of curry. The powder/flour of the full mature and dried *khoka* pods of *khejri* is prepared by grinding them in mixer or flour mill. This powder is mixed with flour of wheat/ gram/green gram/ *maida* and *khankhari* (*laddu*) and *suhali* (*papadi*). Some the people of the hot arid regions used to mix the powder of *khoka* of *khejri* with wheat flour and prepare the *chapaties* of the same.



Pickle of tendril *khejri* pods (*sangari*)



*Khankari* of mature pods (*khokha*) of *khejri*



*Suhali* of powder of mature pods (*khokha*) of *khejri*

### (a-7) ITKs based major traditional techniques of value addition for phog, Indian aloe, moringa, vegetable type cactus and *Tumba*:

- **Phog (*Calligonum polygonoides* Linn.):**

Phog (*Calligonum Polygonoides* Linn.) belongs to the family Polygonaceae. It is a shrub in habit but sometime old age plant look like a tree. It is locally known as “Phog”. It is mainly found in hot arid regions of western Rajasthan and surrounding areas. Usually, it grows between 4 feet to 6 feet in height but occasionally may reach even up to 10-12 feet in height with a girth of 1 to 2 ft. It commonly grows on dry sandy soil and on sand dunes in hot arid regions. It is very hardy and being capable of growing under adverse climatic conditions of soil and moisture. It is highly frost and drought hardy shrub.



Bush of Phog

It produces root suckers and is easily propagated by cutting and layering. In hot arid regions of the western Rajasthan, the mature flower buds of *phog* are the unique sources of the traditional vegetable. The mature flower buds of the *phog* plants are shed and collected from the *phog* plants and dehydrated at shaded place. These dehydrated mature flower buds locally called “*Phogla* or *Lasson*”. They are very nutritious and powerful sources of traditional vegetable. Abortive flowers and succulent fruits are eaten during food scarcity by famines in arid regions of India. The flower buds (*phogla*) are mainly used to prepare *rayta* with butter milk (whey) and adding some salt, powder of cumin, chilli, etc., particularly during summer season as



Phogla (mature dry flower buds of phog)

they are supposed to have cooling effect on the body. Flowers made into bread or cooked in clarified butter or coconut oil to make a local delicious preparation. The flower buds have high nutritional value and high value of energy. According to Srivastava (2006) unripe fruits of *C. polygonoides* have a vast nutritive value such as protein (18%), carbohydrate (71.1%), fat (64%), fiber (9.1%), Vitamin B2 (0.7mg/100g), calcium (670mg/100g), phosphorus (420mg/100g) and iron (12.7mg/100g). Seeds are also usually eaten raw. Branches of *C. polygonoides* are used in zinc purification. The most beneficial role of this plant in hot arid region/desert area is as soil binder on sand dunes of Western Rajasthan and to increase soil fertility. The local people the of the region use the different parts of the *Phog* to prepare the traditional medicine also to treat the different diseases/disorders of the body.

- **Indian aloe (*Aloe vera barbadensis* Mill) :**

*Aloe vera* has a number of synonyms: *Aloe indica* Royle, *Aloe perfoliata* L. var. *vera* and *A. vulgaris* Lam. and common names including Chinese Aloe, Indian Aloe, true Aloe, Barbados Aloe, burn Aloe, first aid plant, etc. The species name *vera* means "true" or "genuine." It is a succulent and an evergreen perennial plant species of the genus *Aloe* and which belongs to family *Asphodelaceae*, it originates from the Arabian Peninsula but grows wild in tropical climates around the world and is cultivated for agricultural and medicinal use. It is well known fact that the Indian *aloe vera* has loaded with high nutrient contain. Aloe Vera contains as much as 12 vitamins, 18 amino acids, 20 minerals, 75 nutrients and 200 active enzymes, in this gel. Minerals of this plant concludes calcium, zinc, copper, potassium, iron, sodium, magnesium, chromium and manganese. These naturally found nutritional components contribute to emerge it as one of the most potent herbal plants. The leavea/pads of the *aloe vera* are mainly used to prepare the traditional vegetable. Some of the farmers/dwellers of the hot arid region prepare the pickle *aloe vera* using their own traditional method which has very good taste with best quality of produce. It has various herbal medicinal properties; hence the *aloe vera* is also used as a source of traditional medicine to treat some diseases and disorders of the body. The other traditional products of *aloe vera* prepared the local people of the hot arid regions are squash, soft drink, juice, etc.



Pickle of aloe vera

- **Drumstick (*Moringa oleifera* Lamk).**

*Moringa oleifera* is the most widely cultivated species of the genus *moringa* which belongs to family *Moringaceae*. It is known with different names in different languages/areas like sanjna, suhujna, sohanjna, shajna, sainjna, mungna (in Hindi); sujina, sohjna, sajina (in Bengal); moringa tree, ben-oil tree, cabbage tree, clarifier tree, horse-radish tree, drumstick tree (in English); midho-saragavo (in Gujarati) and murunga, murangai (in Tamil). It is a fast-growing, deciduous tree that can reach a height of 10–12 m (32–40 ft) and trunk diameter of 45 cm (1.5– 5.0 ft). The bark has a whitish-grey colour and is surrounded by thick cork. Young shoots have purplish or greenish-white, hairy bark. The tree has an open crown of drooping, fragile branches and the leaves build up a feathery foliage of tripinnate leaves. Flowering begins within the first six months after planting. In cool regions, flowering occurs only once a year between April and June. In more constant seasonal temperatures and with constant rainfall, flowering can happen twice or even all year-round. The pod/fruit is a hanging, three-sided brown capsule of 20–45 cm size. In hot arid region, the trees of moringa are found very less. However, the people who have the moringa plants used its pods, leaves and flowers for vegetable purpose. Some of them prepare the pickle of morings pods.



Moringa tree



Pods of moringa



Pickle of moringa pods

- **The traditional processes and techniques of preparation pickles of moringa pods:**

The tendril and health pods of moringa are selected washed with clean water and dry them for some time to remove the water from their surface. Then, they were cut down in two pieces. After that the common salt was mixed with pieces of moringa pods and left them as it is for 24 hours. After 24 hours, the water generated due to salt was removed from the pieces and the same were left for dry at shady place for 12 hours. Then, they are slightly fried with mustard oil for a moment and mixed the condiments with them and left open for 12 hours at room temperatures. Thus prepared pickle material is filled in suitable pot/utensil along with warmed and cooled mustard oil and put for a week in normal condition. After a week, it is ready to use/ serve.

- **Vegetable type cactus (*Opuntia ficus indica*)**

Vegetable cactus belongs to family- *Cactaceae*, genus-*Opuntia* and species- *ficus-indica*. It is a thornless species of cactus. It is a very famous and nutritious source of the traditional vegetable in the hot arid regions, particularly in western Rajasthan. Day by day, it is getting more popularity among the dwellers of the region due to its high nutritional, therapeutic value and unpolluted cheapest source of vegetable. The 100g edible portion of vegetable cactus has 95 % moisture, 1.5 % protein, 0.4 % fat, 1.54 %, fibre, total carbohydrate 5.0%, 15.5 µg/g total chlorophyll, 22.0 mg vitamin C, 31.0 µg *beta* carotene, 110 mg calcium, 20 mg phosphorus, 1.95 mg iron and other nutrients (Pimienta, 1993). The pads of the cactus are used to prepare mixed vegetable with onion, tomato, potato or with some pulses. Some of the farmers/dwellers of the hot arid region prepare the pickle of this cactus using their own traditional method which has very good taste and quality of product. It has various herbal medicinal properties also, hence, the cactus is also used as a source of traditional medicine to treat some diseases and disorders in the body.



Pictorial flow diagram of preparing the pickle of cactus

- **Tumba (*Citrulus colocynthis* (L.) Schrad)**

Tumba is a trailing, scabrid herb, belonging to genus *Citrullus*, species *colocynthis* and the family cucurbitaceae. It is a desert creeper which spreads rapidly after monsoon on the sand dunes/sandy soil in hot arid regions. Its fruits are available in the month of October and November. It is one of the important cucurbit having better xerophytic adaptation in hot arid climatic conditions and sandy soils. Though, *tumba* is still an under-utilized fruit due to its bitter taste and mainly it has great importance in the field of traditional medicines in rural areas of the hot arid regions.



Since, *tumba* has high medicinal value with a good source of protein and fat, therefore, some of the people of the hot arid regions make its some value added products for direct consumption like pickle and *murabba* of the *tumba*. The traditional technique /process of preparing the pickle of *tumba* is as follows.

**Traditional technique of preparing the pickle of *tumba* :** The mature fruits of *tumba* are selected and harvested. Then, the fruits are cut into pieces of desirable size. Put these pieces in water solution of limestone for a week. After this, remove the pieces from water solution of limestone & dry the same for removing water from them. The maximum seeds of the pieces are removed. Now, frying these pieces slightly with mustard oil for some time and mixing condiments/spices while frying the pieces. After this, cool down the so prepared material of the pickle and filled it in the suitable pots. Finally, filled the boiled and cooled mustard oil till sinking of the prepared material. Put it at a neat and cool place and started to consume after some days.



Pickle of tumba fruit

## B. ITKs based traditional techniques of value addition for arid fruits.

### (b-1) Ber

*Ber* (*Ziziphus mauritiana* Lam.) also known as Chinese date, Chinee apple, jujube, Indian plum, Indian jujube etc. which belongs to family Rhamnaceae. There are three main species of *ber* found in north-western India. The *Ziziphus mauritiana* (Lam) is the main species of commercial importance with its several varieties. It is a small to medium-sized, single or multi-stemmed, spiny shrub or tree, which is almost evergreen, but is deciduous during the dry season. It has a round, spreading crown. It can reach up to 4-8 m tall and 30 cm diameter at breast height. It has deep and lateral



Dehydrated ber fruits of Gola variety

root system. Stipules are mostly spines and the leaf shape ranging from almost round to an elongated ellipse. Flowers are minute, greenish-white or yellow, hermaphrodite and are insect pollinated. The fruit is



Dehydrated fruits of jhar ber



Dehydrated fruits of bordi

initially green and turns yellow, orange and red on ripening. Being a drupe, fruits containing sour-sweet pulp and a hard stone. Another species of *ber* is *Z. nummularia* which is prized for its leaves (rich in protein) and provide fodder (*Pala*) for livestock and also produce very small sized fruits which locally known as *jhar ber*. The *jhar ber* are very tasty due to their sweetly-acidic taste and the local peoples them like very much. The third species is *Z. rotundifolia* which is mainly used as rootstock for propagation of commercial species of *ber* (*Ziziphus mauritiana* Lam). This species also bears edible fruits of smaller size but bigger than *jhar ber*.

### Traditional technique of preparing the pickle of *ber* (*Ziziphus mauritiana*).

The farmers /dwellers of the hot arid region prepare pickle of fruits of *ber* using their own traditional knowledge and techniques. The mature fruits of *ber* / *bordi* cut them in pieces desirable and removing the stone of the fruits. Slightly wash the pieces and mix some juice of lemon with them and then dry for some time to remove the excess water of the pieces. Now, frying these pieces slightly with mustard oil for some time and mixing condiments/spices. After this, cool down the so prepared material of the pickle and filled it in the suitable pots. Finally, filled the boiled and cooled mustard oil till sinking of the material filled in the pot. Put it at a neat and cool place and started to consume after some days.

Flow chart of major steps in preparing pickle of mature fruits of Gola variety of *ber*

Some of the farmers/local people collect fruits of wild species of *ber* *Ziziphus nummularia* (*jhar ber*) and *Ziziphus rotundifolia* (*bordi*) from their natural habitats and used as fresh fruits and some value added products of the same like dehydrated fruits, chutney, sauce, etc.

**(b-2) Ker (*Capparis deciduas* Edgew):**

*Ker* belongs to family-capparidaceae. It is a perennial bush having tough multifarious branches. It is the most drought and frost hardy bush. It is found widely and wildy distributed in throughout the hot arid regions, particularly in western Rajasthan. The immature fruits of the *ker* are of green colour and used for preparing the vegetable, chutney, pickle and traditional medicines. The pickle of the immature green fruits of *ker* has not only regional or national repute but also has international reputation.



Ker bush/tree

At the stage of ripening, *ker* fruits become bigger in size and red in colour with sweet yellow flesh/pulp. These ripened fruits are eaten directly by the local people even though they have somewhat acrid taste and smell. The *ker* fruits have high nutritional value which supports nourishing system of the population in hot arid regions of the country. The 100g edible portion of the *ker* fruit has 56% moisture, 8.6% crude protein, 5.02% true-protein, 1.8 total sugar, 1.1% reducing sugar, 0.057% phosphorus, 1.026% potassium, 0.055% calcium, 0.055% magnesium, 7.81mg vitamin C, etc. (Kheda et al.,1975). As the *ker* fruits have very high nutritional as well as medicinal value with a unique taste and aroma. Therefore, the people of the hot arid regions use the *ker* fruits widely in various ways and forms. They make the various traditional value added products of tendril fruits of *ker* like pickle, dehydrated fruits, chutney, *curry*, vegetable, etc. and consumed in their daily diets with keen interest for great pleasure and enjoyment. The dehydrated tendril fruits of *ker* are highly demanding traditional value added product of *ker* which have very high market value. The market value of dehydrated tendril fruits of *ker* range between Rs.800 –1000 per kg depending quality, season, demand and supply factors of the market. Some time, the market value of dehydrated tendril fruits of *ker* becomes as high as Rs. 1500/- per kg. These value added products are prepared by the people of the hot arid regions by using their own traditional knowledge and technique for their own consumption and sale out the surplus in the local markets for their livelihood security.



Fresh fruits of ker



Processed fruits of ker



Pickle of ker fruits



Dehydrated fruits of ker

**(b-3) Lasoda (*Cordia myxa* Roxb.)**

*Lasoda* belongs to family-Boraginaceae. The tree of lasoda has medium height, simple broad leaves with 3-5 veins and white flowers in clusters. Generally, the fruits are measured in 0.5-1.0 cm in size having roundish shape. The fruits are drupe type and immature fruits has green colour but at ripening stage, the fruits change into reddish-brown in colour. At the ripening stage, the fruits of the *lasoda* become sweet with mucilaginous whitish pulp/flesh. The mucilaginous pulp of the repined fruit shares about 70% part of the fruit. These fruits have high nutritional and medicinal value. The ripened fruits are eaten directly by the people. The green immature fruits of the *lasoda* are mainly used to prepare vegetable, pickle (as sole or mixed with other fruits/vegetables). The fruits of the lasoda are used to prepare traditional medicines to treat some diseases or disorders of the body. The fruits of the *lasoda* have high nutritional value. The 100g of edible portion of the *lasoda* fruit has 82.5g moisture, 1.8g protein, 1.0g fat, 2.2g minerals, 0.3g fibre, 12.2g carbohydrate, 65 Kcal energy vitamins and other nutrients (Panday A K, 2007). Some other research reports shows that the fruits of the *lasoda* has 2% protein, 2% fat, 2% fiber, 394 Kcal energy, 6mg iron, 275mg phosphorous, 55mg calcium,etc. It is very helpful in nourishment and sustenance of the population/life of the hot arid regions like western Rajasthan. In addition to vegetables, the people/dwellers of the hot arid regions prepare some traditional value added of *lasora* fruits like dehydrated fruits, pickle, chutney, etc., for their own consumption and to sale the surplus in local markets to earn money.



Fresh fruits of lasora



Pickle of lasora



Vegetable of lasora



Dehydrated fruits of lasora

**(b-4) Aonla (*Phyllanthus emblica*)**

Aonla (*Phyllanthus emblica*) is important fruit crop which is grown in arid and semi-arid regions of the country. It also known as emblic, emblic myrobalan, myrobalan, Indian gooseberry, Malacca tree, amla or amalaki, etc. It is a deciduous tree and belongs to Phyllanthaceae family. Aonla tree is small to medium in size, reaching 1–8 m in height. The branchlets are not glabrous or finely pubescent, 10–20 cm long, usually deciduous; the leaves are simple, subsessile and closely set along to branchlets, light green, resembling pinnate leaves. The flowers are greenish-yellow. The fruit is nearly spherical, light greenish yellow in colour, quite smooth and hard with vertical stripes or furrows. The fruits of



the aonla ripe in autumn (November- December) in hot arid regions. The taste of aonla fruits is highly sour, bitter and astringent, and it is quite fibrous. In hot arid regions of the country, the local people/farmers made various traditional value added products using their own indigenous knowledge and techniques. Among such traditional *aonla* products, major are pickle, *laddu*, candy, aonla *supari*, powder, *jem*, dehydrated aonla, etc. and consumed in their diet or sold in local markets to earn money. The traditional technique/ process of preparing some of the above products are narrated in short as follows.

**The traditional technique/ process of preparing the pickle of aonla :**

The mature and health fruits of *aonla* are selected, washed with clean water and dry them for some time to remove the water from their surface. After that they are cut down in small pieces and remove the stone of the fruit. Then, the common salt is mixed with pieces of the *aonla* and left them as it is for 24 hours. After 24 hours, the water come out from the pieces of the *aonla* is removed and the pieces are left to dry to evaporate the excess water from the pieces. Further, they were slightly fried with mustard oil for a moment and mixed the condiments with them and cool down the material. Thus prepared material of pickle is filled in suitable pot. After that the desired amount of mustard oil is warmed, cooled up to room temperature and filled in the pot up to the mark. Now, the pickle is put for a week at room temperature and start to use after 3 - 5 days.



Pickle of aonla

**The traditional processes and techniques of preparing laddu of aonla:**

The mature and healthy *aonla* were selected, washed with clean water and dry them for some time to remove the water from their surface. After that, the fruits were boiled and their segment are separated from the fruit's stone. These segments were grinded thoroughly in electric mixer. Then, the grinded mixture of *aonla* fruits and wheat flour are fried in *deshi ghee*, separatly. The sugar and other ingredient are mixed thoroughly in already cooked/ fried mixture of aonla + flour. Thus, final grand mixture is ready to prepare *aonla laddu*. Other traditional products of *aonla* prepare by the local people of the hot arid regions are *murabba*, *aonla supari*, *jem*, juice, candy, dehydrated aonla, etc.



Aonla laddu

**(b-5) Karonda (*Carissa carandas*)**

*Carissa carandas* is a species of flowering shrub which belongs to family, *Apocynaceae*. It produces berry-sized fruits that are commonly used as a condiment in Indian pickles and spices. It is a hardy, drought-tolerant plant that thrives well in a wide range of soils and climatic conditions. The plants of the karonda are propagated seed sown in August and September. Vegetative propagation also is practiced in the form of budding and inarching. Cuttings may

also be succeeded. The planting time of the *karonda* in north India is the commencement of the shower of the monsoon (July – August). Plants raised from seeds start bearing two years after planting. The farmers and local peoples of the hot arid regions, use the mature fruits of *karonda* in various ways. They prepare the vegetable and some traditional value added products of the *karonda* fruits using their own traditional knowledge and techniques like pickle, *jem*, jelly, beverage, powder, preserved fruits in the form of candy, etc. The latex of the fruits of *karonda* are used for treating arthritis, piles, cardiac diseases and nerving disorder. The roots are utilized to treat the stomach disorder, intestinal worms, scabies, diabetes, ulcer.

**The processes and techniques of preparation pickles of *karonda* :** The mature and health fruits of *karonda* are selected, washed with clean water and dry them for some time to remove the water from their surface. After that they were cut down in two pieces. After that the common salt was mixed with pieces of the *karonda* are left as it is for 24 hours. After 24 hours, the water generated due to salt was removed from the pieces and the same were left for dry at shady place for 12 hours. After this, they were slightly fried with mustard oil for a moment and mixed the condiments with them and left open for 12 hours at room temperatures. This pickle material is filled in separate pot along with warmed and cooled mustard oil. Thus, prepared pickles are put for a week in normal condition. After a week they are ready for consumption to serve.



Fresh fruits of Karonda



Dehydrated fruits of ker



### C. ITKs based traditional techniques of plant protection.

**(i) Application of tobacco water:** This ITKs is used mainly for protecting the vegetable seedlings from the attack of insect and pests in nurseries as well as in fields. For this purpose the dry powdered tobacco is mixed in water and kept it for 2-3 days in sun light. After that the water of this mixture is filtered out and filled in glass bottles. Now, this tobacco water is applied in nurseries of vegetable seedlings by drenching or with irrigation water or sprayed over the seedlings to control soil born diseases/insect-pests and foliar attack of insects - pests. Since, the tobacco water solution has enough quantity of nicotine sulphate which possibly act as an insecticide or controlling substance for insect pests of vegetable crops. Some of the farmers use **Hukka** (*Hubble bubble*) water for controlling attack of insect-pests in



vegetable crops, particularly at nursery and transplanting stage of the vegetable crops. It was also reported that some of the farmers apply tobacco powder directly in to the soil to control the soil born diseases, termites and other insect-pests.

**(ii) Spraying of Kerosene oil and ash mixture:** The farmers prepare a mixture of ash and Kerosene oil and spray it on vegetable seedling and fruit crop plants to control the insect- pests and viral diseases. The farmers argued that this practices helps in avoiding the attack of insect pests and provide resistant to seedlings against attack of the disease. The spray of this mixture also protects the seedlings/nursery plants from the frost injury during winter season. This practice is safe and easy in application and increase the overall production of the crops.

**(iii) Dusting of cow-dung ash and FYM mixture:** This is another important ITK which is used by the farmers to protect their vegetable seedling and crops from the attack of insect- pests, diseases and frost injury. The farmers prepare a mixture of cowdung ash and well rotten FYM and spray it over standing seedling/plants of vegetable and fruit crops which protect the plants/ seedlings from the attack of insect-pests, diseases and frost injury during very cold winter season.

**(iv) Burning of mustard/sesamum oil in crop fields:** This ITK is used to control the viral diseases like leaf curl disease of brinjal, tomato, okra, etc. and attack of insects. The farmers make small-small heaps of dry wood at different places in vegetable fields and put on fire in these heaps. After that pour some quantity of mustard/sesamum oil drop by drop in the burning wooden heaps which generate smoke, oily smell and heat in the vegetable crop fields which supposed to avoid the viral infection and attack of pests on vegetable crops. Some time iron utensils like pan /iron sheets, etc. are also used to burn the mustard/ sesamum oil in the crop fields.

**(v) Spraying of cowdung/goat/sheep excreta and kerosene oil solution:** This ITKs is used to protect the fruit and vegetable crops from the attack of wild animal. In this technique a solution of fresh cowdung, goat and sheep excreta with kerosene oil is prepared and it is sprayed over the standing fruit and vegetable crops so that wild animal cannot eat the crops due to the bad smell and bad test of the above solution. This technique is widely used by the farmers to protect the fruit and vegetable crops from wild animals like Neel Gai (Blue bulls).

**(vi) Smoking and dusting of dry ash on fruit and vegetable crops:** This techniques is used by the fruit and vegetable growers to protect their crops from frost injury due to very low temperature during winter season. The farmers are very intelligent and they can predict the night during which frost injury may occur. Before occurrence of frost injury, the farmers put on fire using easily available weeds at different blank space in fruit and vegetable crop fields and dry ash is also dusted on these crops which protect the crops from the frost injury during very cold nights of winter season.



**(vii) Application of butter milk or curd in individual pit of fruit plants:** This technique is used by farmers mostly in fruit plants to protect them from the attack of termites. They apply the butter milk or curd in individual pit of fruit plants just after irrigation which is supposed to avoid

the attack of termites in the roots of the fruit plants. It may be due to the fat and acids present in the butter milk or curd.

**(viii) Application of Kerosene oil:** Some of the farmer apply kerosene oil with irrigation water to fruit and vegetable crop fields to avoid the infestation of termites.

**(ix) Application of the powder of kernel of neem (*Azadirachta indica*) seeds in the soil:** This techniques is used to control the attack of termites, soil born diseases and insect-pests on horticultural crops. In this technique, the dry neem kernels are collected and dried. These dried neem kernels are grinded and converted in powder form. This powder is applied directly in soil at root zones which inhibit the attack of termites, soil born diseases and insect-pests on roots/ stems of fruit and vegetable crops.

**(x) The use of extract of neem (*Azadirachta indica*) seeds :** The extract of neem seeds are used to control the insect pests and diseases in arid fruits and vegetables. In this process the crush or grind seeds, keep in water with regular stirring and filter after 10 -12 hours. This extract is spray on the crops after proper dilution in the normal water.

**(xi) Application of neem cake in the soil. :** The neem prepared with help of seeds + leaves of the neem trees are used to control the insect-pests in fruits and vegetable crops grown in hot arid regions. The application of such cake, not only control the insect-pests but also provides nutrients to the crop plant. It is very helpful also in improving the physical and chemical properties of the soil.

**(xii) Spraying of hing (*Asafoetida*) solution over vegetable crops:** The farmers use this ITKs mainly in cucurbitaceous vegetable crops (bottle ground, ridge ground, round melon, snap melon, *mateera* ), chilli, brinjal, etc. to control the some diseases and pests attack. The diseases like leaf curl in tomato, brinajl, chilli, flowers and fruit dropping in bottle gourds, ridge gourds, round melon, root wilt in tomato, etc. are controlled by spraying the hing solution on these crops or it applied in root zone of crop plants . After transplantation of tomato, chilli and brinjal plants get infested with leaf curl virus/diseases very quickly due to abrupt change in temperature and humidity. To control this disease, the farmers a solution of hing (*asafetida*) by dissolving 15–20g hing in 100 litres of water. This solution is sprayed over the infested vegetable crops 3-4 time at 15 day intervals which is helpful in controlling leaf curl virus/disease in brinjal tomato, chilli and flower dropping in cucurbitaceous vegetables. It was also reported that the drenching of hing solution in soil, control the soil born diseases of the vegetable crops.

#### D. ITKs based traditional techniques to increase the germination, growth, quality and yield of horticultural crops.

**(i) Seed soaking and softening:** This practice is followed in vegetable crops like- bottle gourd, ridge gourds, *mateera*, snapmelon, okra, etc for better seed germination. The climatic conditions of arid regions are very severe and



harsh. Vegetable seed germination is very poor and delayed due to lack of soil moisture in dry environment. In such conditions, the farmers give moisture treatment to the vegetable seeds before sowing them for quick and better germination. In this practice, the vegetable seeds (having hard seed coat) are soaked in water before sowing and wrapped in moist gunny bags/ cotton clothes. This gunny bag is put in vessel and buried in farmyard manure (FYM) for a day. After that these soaked seeds are sown in the well prepared vegetable nurseries/fields. By this way, the germination of these seeds takes place very quickly and profusely. The logic of the farmers behind this practice is that the moisture of wet gunny bag or cotton cloth and the heat produced inside the manure heap soften the hard seed coat of the vegetable seeds thereby enhancing the germination percentage of the seeds in lesser period of time.

**(ii) Pasting of cowdung:** The farmers paste the fresh cow dung on pruned part of the fruit plants. Farmers assume that the pasting of fresh cowdung on pruned part of fruit plants will be helpful in sprouting healthy and more buds/branches resulting higher fruit yield. The application of fresh cowdung also protect the pruned part of the fruit trees from dryness, high temperature, hot winds etc. and buds/branches sprout quickly and profusely. Thus, the production of fruit per plant and per unit area is increased.

**(iii) Application of tea water:** Some of the vegetable growers apply the tea water in brinjal, caluliflower, cabbabge, tomato crop fields with the idea that it will increase the size, growth, quality, better look and yield of these vegetables. The farmers prepare tea water by boiling the tea in fresh water. After boiling, the tea water is filtered out and cooled down. This cooled tea water is applied in vegetable crop plants just before irrigation or with irrigation water. This practice is followed twice or thrice in the whole life duration of the vegetable crops which increase the size, yield, quantity and quality of the vegetables and make them more attractive with good shining.

**(iv) Application of mustard/sesamum oil cakes:** This practice is followed mainly in brinjal, chilli and tomato crops. The powdered form of the mustard/sesamum oil cakes is applied in soils of vegetable fields before flowering stage. Farmers think that these oil cakes are helpful in providing plant nutrient and help in moisture conservation of the soil. It also increases the organic matter content of the soil and reduces the attack of soil born diseases & pests. Hence, the quality and quantity/yield of the concerned vegetable crop is increased with contrast colour of the vegetable fruits.

**(v) Soaking of vegetable seeds in buttermilk:** This practice is followed by the farmers to increase germination percentage of vegetable seeds like brinjal, tomato and chilli. In this process, the dry seeds of the above vegetable crops are soaked in 2-3 day old butter milk for 5-8 hours before sowing in the nursery beds. After 6-8 hours, these seeds are taken out from the butter milk and seeds are sown in well prepared nursery beds which results in better germination and healthy seedling. The logic behind this practice is that the water and acids of the butter milk soften the seed coat and activate the embryo for early and batter germination.

**(vi) Application of cowdung and cow urine mixture to improve the quality of pomegranate fruits:** The farmers of arid region of Rajasthan are adopting pomegranate crop as a new crop in

their cropping system. But due to the the hard and harsh climatic conditions of the region, the quality of pomegranate fruits is poor. To improve the quality of pomegranate fruits, the farmers apply a mixture of cowdung and cow urine as a basal dose in early growth stage and another basal dose at the time of flowering. This is very simple, eco-friendly and economic techniques to improve the fruit quality. This techniques is also supposed to impart the resistance in pomegranate plants against the attack of pests and diseases.

### E. ITKs based traditional techniques for improving soil fertility and productivity:

**(i) Mixing of *khejri* leaves into the soil:** The *khejri* tree is the king amongst the vegetation of the arid eco-system of western Rajasthan. It is very much drought hardy and prolific with respect to growth and development even in drought conditions. It grows very well in arid environment of western Rajasthan. It produces large quantity of *sangari* (pods) and leaves (Loong) naturally. The *sangari* (pods) of the *khejri* are used for vegetable purpose and leaves of this tree are used by the farmers to increase the soil fertility. The leaves of the *khejri* plants are collected and buried in the soil of crop fields in lean period before crop sowing followed by some water application in soil, if possible. After some time these leaves are decomposed in soil and become source of plant nutrient, soil organic matter which increase the fertility of the poor soil. Thus, the farmers of arid zone of Rajasthan use the leaves of *khejri* tree to increase the fertility & productivity of the aridsols .



**(ii) Application of oil cakes with wooden ash and FYM:** This is also one of the dominant ITK used by the farmers of arid environment to increase the soil fertility and productivity. The farmers prepare a mixture of ash, powdered farmyard manure (FYM) and oil cakes. This mixture is applied in poor soils to increase the fertility and productivity of the soil. Farmers perceived that the mixture of oil cakes, ash and FYM helps in providing essential nutrient to the crop plants and it increase organic matter and water holding capacity of the soil. It improve the overall chemical and physical properties of the poor aridsols.



**(iii) *In-situ* burning of crop residues and farm wastes:** In this ITK, the farmers collect the crop residues and farm waste products and burnt it in the vegetable crop field or in individual pit of the fruit crop before sowing or planting of the crop. After cooling the fields or pits are irrigated and seed sowing or planting is done. The farmer follow this practice with the aim that the burning of crop residues and



farm waste products in the vacant vegetable fields or pits of fruit crops leads to enriching the soil with micro-macro plant nutrients and minerals through burnt ash and reduce the infestation of termites, soil born pests and diseases. Hence, soil fertility and productivity is increased.

## F. ITKs related to soil and water conservation

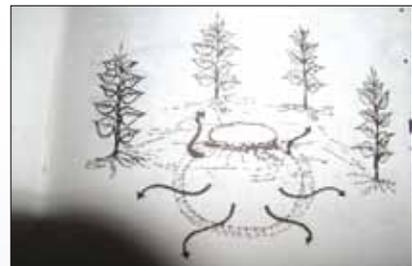
**(i) Biotic and abiotic mulches:** These are the ITKs in which the soil surface is covered with some biotic and abiotic materials like cover crops, crop residues, farm wastage, inter-cropping, grasses, crushing hard crust of soil, application of organic soil amendments, use of organic soil erosion retardants and other soil moisture conserving traditional practices.



Bui shrub foliage mulch in brinjal

**(ii) Nipple system of irrigation:** This is very important traditional method of irrigation system used to save the irrigation water to a great extent. This method of irrigation is used, mostly, in orchard/fruit crop production like *ber*, *aonla*, *pomegranate*, *kinnow*, etc. In this techniques a big earthen pot is placed at elevated central place in between the four fruit plants planted at recommended equi-distance in four direction ( North-South and East- West directions ) of the earthen pot. While this earthen pot is prepared, four earthen nipples with micro-pores are made in lower surface of this pot in four directions as mentioned above. The earthen pot so designed is put on the central elevated place with the condition that each nipple of this pot should be in front of four plants planted in four direction. Now the pits of the fruit plants are connected with the nipples of the earthen pots using suitable sized plastic pipe. After that the earthen pot is filled with water. The water oozes drop by drop in each fruit plant through intervening plastic pipe. The farmers reported that through this method of irrigation, about 70-80 per cent irrigation water can be saved in comparison to traditional method of irrigation without negative impact on quality and yield of the fruit crops.

**(iii) Jaldhara method of irrigation:** Generally this techniques is used by farmers in gourds, melons, pumpkins, and other trailing vegetable crops grown in arid regions where water is a scare resource. In this practice, about 70 cm wide and 70 cm deep pit is prepared in the soil. After that 15-20 Kg composted manure/FYM is filled in each pit with 15-20 kg soil and mix them well and a bed is prepared around this pit. Now, a big earthen pot having some micro-pores/holes in all-around the side portion is buried in each pit of the each bed so prepared. After that the seeds of vegetable are sown in beds around the pits having perforated earthen pot. Therefore the earthen pot is filled with water upto brim and covered the each pot leaving its mouth open. The water is received by crop seeds/plants through capillary movement / gravitational flow of water through micro-pores of the pot. The water level of the pot is checked regularly. Whenever the water level of the pot is decreased and water requirement of crop plants



is felt, the earthen pot is refilled again and again. Using this technique, the farmers save about 70-80 percent of irrigation water in vegetable crop production in arid regions of Rajasthan.

**(iv) Spreading of kerosene or mustard oil on water bodies:** This is techniques used to reduce the evaporation loss of water from the surface of water bodies like farm ponds, Diggies (Open water tanks), reservoirs, water harvesting bodies, water ways, etc. The farmers spread the kerosene or mustard oil on the water surface of the water bodies making a thin film of oil on water surface which reduce the water loss through evaporation from water bodies due to the high temperature and hot winds of arid environment and thus saving the water through evaporation loss.

**(v) Tanka (underground cistern):** It a very important man made circular structure to collect/harvest the rain water for drinking purpose in hot arid regions of western Rajasthan and Gujarat. It is kind of tank of 20 ft depth and 18 ft width adjacent to house and used to collect water from roof and adjoining field. It is constructed in a circular or rectangular shape on a bare ground where surface runoff can be diverted to the tanka. It can store up to 92000 more L of water. The water is used for drinking purpose and irrigating the field in off-season. But now days some of the farmers construct the bigger size of *Tanka* on their crop fields and harvest the rain water to grown arid vegetables and fruits at very small scale under drip irrigation system to meet their domestic household needs of fruits and vegetables. It is constructed normally on bare ground where surface runoff can be diverted to the *tanka* by creating a clean catchment around the *Tanka*. Earlier, the *tanka* was constructed with the help of lime and mud but now it is constructed concrete and cement or bricks and cement which hold the water for long time and utilization.

**(vii) Khadin system of crop production:** *Khadin* system of crop production/farming system is a most ancient and important system of *in-situ* water conservation and crop production on it in hot arid regions, particularly in western Rajasthan. It is also known as *khudi* or oasis crop production/ farming system used to harvest water. It is a indigenous technique of rain water conservation in the crop fields and conserved moisture is utilized to grow the crops/plants. It is designed indigenously to harvest surface runoff water for growing agri-horticultural crops. The main features of the *Khadin* is a very long (100–300 m or more) earthen embankment built across the runoff of the uplands or hills and excessive rain water is collected/harvested it. The *khadin* system is based on the principle of harvesting rainwater on farmland and subsequently water-saturated land of the *khadin* is used for the crop production during the succeeding season. It is a traditional runoff crop production/ farming system and is found where rocky catchment and valley plains occur in proximity. Water from large surrounding field area is collected to a natural common point. Here, first the natural slope of the land surface is assessed and then some natural collection point of water is identified at community level. The crops adapted to dry condition are grown in *khadin* system without any irrigation as the soil is fertile in *khadin* area and its retention capacity of residual soil moisture is high. The system is very effective even when annual rainfall is less than 200 mm. The water is collected and used for irrigation purpose in the off season. Jaisalmer is reported to have 500 such *khadin* over an area of 12140 hectare (Prakash, 2013). The water of *khadin* helped to recharge aquifer and ground water. This ITK is an effective option for efficient water resource management in context of water scarcity/low rainfall areas.

**(viii) Kund or kundi :** *Kund/kundi* are the permanent structure found in hot arid region of the country and used for harvesting the rain water, specially for drinking purpose, but the surplus water of this *kund* is used to grow vegetables at very small scale like kitchen gardening for household use only. Essentially, a circular underground well, *kunds* have a saucer-shaped catchment area (called *Agor*) that gently slopes towards the centre where the well is situated.

**(ix) Kuis / Beris:** These also very important indigenous structure found in western Rajasthan and used for drinking water and surplus water to grow vegetables at small scale for household consumption. These are may be 08 – 11m deep pits like a small tube well in which rainwater or seepage water of IGNP canal is collected for drinking as well as for irrigation at small scale.

**(x) Nadi:** It is the oldest and still the most prevalent storage structure for rainwater harvesting in hot arid regions of western part of India. It is a indigenous structure like a pond which dug-out by villagers to collect/harvest the rain water from an adjoining natural catchment during the rainy season. The site is selected by the villagers based on available natural catchments and its water yield potential. The water stored in a *nadi* is generally used for drinking by livestock and human beings. However, some time the surplus water is used for production of arid fruits and vegetables crops on community land of the concerned village of the *Nadi*.

**(xi) Other ITKs related soil and water conservation, are:**

- To grow perennial shelter belts and wind breaker vegetation on field bunds, small stone checks across rills in fields, subdividing land holdings into smaller fields, diversion of the drainage for safe disposal of runoff from upper reaches.
- Deep plowing in summer, sowing across the major slope, furrowing and cross-plowing, shallow intercultural operations or tied ridging, compartmental bunding, short-term or rainy-season fallowing.
- Mixed farming, water harvesting, conservation of moisture by use of mulches, combined production system, use domestic energy, etc.
- The farmers allow certain local weeds and xerophytic plants viz. *bui* (*Kochia indica*), *fog* (*Calligonum polygonoids*), *Khimp* (*Leptadenia pyrotechnica* (Fork.) Decne, *bordi* (*Zizyphus moritiana*) to grow undisturbed maintaining adequate *khejri* (*Prosopis cineraria*) tree population in the fields to conserve soil and soil moisture in the crop fields.

## 5. Importance of ITKs in horticulture development in hot arid regions.

As mentioned earlier that the Knowledge (ITK) has immense potential for innovation, especially at the grassroots level. India is a country populated by a number of indigenous communities, most of which have their own set of unique traditional knowledge and technology base. Many of these knowledge and technologies are at par with the modern knowledge and technology system and have been provided the indigenous communities with comfort and self-sufficiency. ITK is momentous in many sustainable grassroots innovations which provide substantial substitutions for many modern systems and methods. These, Indigenous Technical Knowledge

(ITKs) and traditional techniques are playing very important role in sustainable production, nourishment and value addition of the traditional fruits and vegetables grown in hot arid regions of the country (India). These traditional knowledge and technologies have played a significant role in the overall socio-economic development of the communities. There are serious issues related to intellectual property rights. An appropriate association between the traditional and modern knowledge and technological systems has immense potential to benefit the societies. The importance of Indigenous Technical Knowledge (ITKs)/Traditional Technologies (TTs) so collected and documented during the present study are mentioned in short under different headings as below.

## **(I) Importance in technological improvement and development.**

### **(i) Importance of land races as a base material for horticultural crops' improvement.**

As mentioned earlier that the farmers of the hot arid regions grow various indigenous (traditional land races) of vegetables and fruits crops which are most suitable in harsh climatic conditions of the region. Among these, the major were *Kachri* (*Cucumis melo* var. *callosus* (Rott. Cong)), *mateera* (*Citrullus lanatus* Thumb.), snapmelon (*Cucumis melo* var. *momordica*), round melon (*Citrullus vulgaris* var. *fistulosus*), khejri (*Prosopis cineraria* (L) Druce, cluster bean (*Cyamopsis* ssp.), Indian aloe (*Aloe vera barbadensis* Mill), tumba (*Citrullus colocynthis*), spiny brinjal (*Solanum melongena*), phog (*Calligonum polygonoides* L., moringa (*Moringa oleifera* Lamk), cactus (*Opuntia ficus indica*), khimp (*Leptadenia pyrotechnica* (Fork.) Decne, ber/ bordi (*Ziziphus* spp.), ker (*Capparis deciduas* Edgew), lasora (*Cordia myxa* Roxb.), karonda (*Carissa carondas*), aonla (*Phyllanthus emblica*), etc. These all above traditional vegetables are the potential streams for the food, nutrition and sustenance of the dwellers/ rural life of the hot arid zone of the western Rajasthan. The parts/organs like tender pods, flowers/ flower buds, leaves, fruits, nopales/cladodes, etc., of these traditional vegetables and fruits are used as raw material by the dwellers in preparing various kinds of vegetables and value added products having high calories and nutritional value to nourish and sustain themselves and others. These traditional vegetable/ fruits are the life line for the farmers/dwellers of the hot arid region. They play a great role in socio-economic development, nutritional and livelihood security of the farmers and masses as a whole. These vegetable are unique source of potential gene pool/ genotype for the improvement vegetable/ fruit crops and advancement of horticulture in harsh climatic conditions of the regions. There in tremendous scope exploiting the potentiality of the above and such other vegetables/fruits with respect of their improvement, production, value addition and commercialization of the same at large scale for the socio-economic up-liftment of dwellers of the hot arid regions.

### **(ii) Importance in developing new techniques/improving the techniques of value addition of fruits and vegetables**

- The ITKs of value addition as mentioned above may be beckon light for the scientists, researchers, planners, policy makers working for horticultural development in hot arid regions of the country. A proper technological association and combination may be made between the

potential indigenous and modern technologies of value addition to develop the cost effective and sustainable innovative technologies for the advancement of post harvest management and value addition of arid fruits and vegetables.

- It is well known fact that the horticultural development in hot arid region of the country is a very recent phenomenon and needs great efforts to flourish the same in the regions. At present, the weakest area of arid horticultural development is post harvest management and value addition. Hence, the potential ITKs based traditional technologies of value addition may work as the readymade base lines the production of improved quality products of value addition of arid fruits and vegetables grown in hot arid regions of the country.
- The potential traditional value added products may play a crucial role in strengthening arena of value addition of the horticultural by refining, improving and standardizing the same.

### **(iii). Importance of as alternates of horticultural plant protection.**

The injudicious use of chemical pesticides has been reported to contaminate the environment, causing serious health related issues. In India, despite being claimed to be a country with very low pesticide consumption, the factors like lack of awareness about safe use of chemical pesticides, improper dosages, false label claims, wrong ways of handling and application, etc., leads to acute danger to all living being and environment as whole. There has always been a demand to divert from synthetics to organic farming and/or use of bio-pesticides for pest management in plant protection. Many farmers are practicing their indigenous knowledge in plant protection, since ages, without any scientific validation for the same. Their indigenous practices could be applied scientifically as part of the IPM program to protect the horticultural as well as other crops from the attack of insect pests and diseases. Adopting of indigenous practices will not only help in reducing the chemical pesticides load on environment but also appreciate in encouraging the age old wisdom of our country. They could be integral component of IPM programs for pest management. The use improved Indigenous Technical Knowledge (ITK) will help not only in sustainable and safe production of horticultural/ agricultural crops but also will conserve biodiversity with no risk to environment and low cost of cultivation.

### **(iv). The other technological importance**

The other ITKs collected on (a) increasing growth, quality, yield of the arid fruits and vegetables, (b) improving soil fertility and productivity (c) soil and water conservation, etc., may also play very important role in production and advancement in hot arid region of the country. These ITKs may be boon after scientific verification and improvement in increasing the growth, quality, yield of the arid fruits and vegetables with increasing the soil fertility, productivity and water conservation, in hot arid regions of the country, etc. The blending of these indigenous knowledge/technology with modern technology may be boon in developing some innovative technologies which can important role in advancement of horticultural development in hot arid regions of the country.

## (II) Socio - economic importance of ITKs in the field of horticulture

### (i) As source of income and employment generation

During the study, it was found that the farmers of the hot arid regions grows several traditional vegetables and fruits in considerable amount using their own knowledge and methods for own consumption and sale surplus in the local markets/*mandies*. In addition to preparation vegetable, the farmers/dweller of the region, prepare several value added products of arid vegetables and fruits applying their own traditional techniques. These products are very good sources of income generation and trade specific activities for the farmers/dwellers in the study areas of the hot arid regions. These products are sold in the local markets/*mandies*/localities at high price to earn substantial amount of money from the same. The major value added product prepared by the farmers/rural dwellers in hot arid regions with their whole price and farmer's price in given **Table-4**. Thus, the production of traditional vegetables/ fruits and their value added product reveals the wide scope of income generation and generating entrepreneurial activities and self-employment in the field of arid horticulture. By adoption of these indigenous technologies of value addition with desirable scientific modification and improvement, the economic advancement and earning of through horticultural crops may be increased tremendously in hot arid regions of the country which ultimately leads to socio-economic upliftment of farmers and rural masses of the regions.

**Table 4: Entrepreneurial and marketing earning through traditional value added products of horticultural crops in hot arid region.**

Sr. No.	Traditional Vegetables	Part/products sold as fresh vegetable/ value added product	Range of whole sell market rates per kg (Rs.)	Range of farmers/ /producers rates per kg (Rs.)
1	<i>Khejri (Prosopis cineraria L.)</i> Druce	Green tender pods ( <i>sangari</i> )	125 – 200	60 – 130
		Dehydrated tender pods ( <i>sangari</i> )	400 – 850	250 – 380
2	<i>Ker (Capparis deciduas Edgew)</i>	Green tender fresh fruits	120 – 220	146
		Green tender processed fruits	140 – 400	80 – 200
		Dehydrated tender fruits	800 – 1000	350 – 500
3	<i>Lasoda (Cordia myxa Roxb.)</i>	Green immature fruits	15 – 30	8 – 20
		Dehydrated fruits	150 – 250	120 – 160
4	<i>Kachri (Cucumis callosus Rott. Cong.)</i>	Green immature fresh fruits	25 – 50	16 – 35
		Dehydrated fruits	200 – 340	140 – 180
5	Snapmelon ( <i>Cucumis melo var. momrdica</i> ),	Green immature fresh fruits	10 – 35	8 – 20
		Dehydrated slice of fruits ( <i>Khelare</i> )	160 – 270	120 – 140

Sr. No.	Traditional Vegetables	Part/products sold as fresh vegetable/ value added product	Range of whole sell market rates per kg (Rs.)	Range of farmers/ producers rates per kg (Rs.)
6	Roundmelon ( <i>Citrullus vulgaris</i> var. <i>fistulosus</i> )	Green tender fresh fruits	20 - 45	15 - 30
		Dehydrated fruits ( <i>Fofaliya</i> )	200 - 250	90 - 140
7	Cluster bean ( <i>Cyamopsis tetragonolobus</i> (L.)Taub.	Green tender fresh pods	40 - 160	30 - 90
		Dehydrated tender pods	340 - 600	220 - 325
8	<i>Mateera</i> ( <i>Citrullus lanatus</i> Thunb.),	<i>Loia</i> (tender fresh fruits)	30 - 80	20 - 50
		Rousted seeds	120 - 160	80 - 110
		<i>Mateera magaz</i> (kernel of mateera seeds)	260 - 350	160 - 210
9	Bottlegourd ( <i>Lagenaria siceraria</i> )	Tender fruits	15 - 40	10 - 25
10	Spiny brinjal ( <i>Solanum melongena</i> )	Tender fruits	30 - 60	25 - 40
11	<i>Phog</i> ( <i>Calligonum polygonoides</i> Linn)	Dry flower buds ( <i>Fogala</i> )	125 - 180	184
12	<i>Khimp</i> ( <i>Leptadenia pyrotechnica</i> (Fork.) Decne)	Green tender pods ( <i>khimpoli</i> )	60 - 100	40 - 60
		Dehydrated tender pods	240 - 300	145 - 230

## (ii) Importance as the source of organic food stuff and nutrition of horticultural origin

The *Kachri*, snapmelon, *mateera*, round melon, *khejri*, cluster bean, (*Cyamopsis tetragonolobus* L.), Spiny brinjal, *Phog*, *ber/ bordi*, *ker*, *lasora*, etc., are the major traditional vegetable/fruits of the hot arid regions which grow naturally or are grown under traditional system without using the chemical fertilizers and pesticides. Hence, the products of these vegetables and fruits are of organic type in nature and their consumption is highly safe and hygienic for health point of view. They have high nutritional value and work as mean of food seasoning or relish/palatability of the diet of the dwellers. The world famous mixed dry vegetable stuff, locally called "*Panchkata*" is also a pure form of organic vegetable which consist of dehydrated tender pods of *khejri* (*Prosopis cinerari*), dry tendrils of *ker* (*Capparis deciduas*), dry pieces of *kachari* (*Cucumis melo* var. *callosus*), dehydrated fruits of *lasora* (*Cordia myxa*) and dry seeds of *kumat* (*Acacia senegal*). All these vegetables/fruits are supposed to have high nutritional value with high calories. For example, *kachri* fruits have very good amount of nutrients like vitamins, mineral, carbohydrates, etc. The 100 gram of fresh edible portion of *kachri* has 88.8% water/moisture, 7.45% carbohydrate, 47-54 Kcal energy, 0.28% protein, 1.28% fat, 1.21% fibre, 1.46% total ash, 0.09mg calcium, 0.0029mg phosphorus, 0.182mg iron, 0.0046mg copper, 0.052mg zinc and 29.81mg Vit. C. In 100g dry powder of *kachari*, 63.68% carbohydrate, 2.41% protein, 11.0

% fat, 10.41% fibre, 12.50mg minerals, 17.02mg Vit. C, 0.8 mg calcium, 1.56mg iron, 0.025 mg phosphorus, 0.45 mg copper, etc., are found (Samadia, 2017). Likewise, the pods (*sangaria*) of *khejri* have high nutritional value and potential source protein, minerals, carbohydrate, vitamins, etc. The moisture content of the pods (*sangari*) of *khejri* is quite low (8.5-10.2 %) which may be advantageous for its shelf life. They were found to be rich in carbohydrates (56.5). There was an appreciable amount of protein (18-22 %) making it as a good source of protein. *Sangari* (pods) has very low amount of fat (2.30%) which makes it ideal diet for overweight people. It has 0.4% phosphorus, 0.4 % calcium with good amount of Mg, Zn, Se, Fe and fibres. There is evidence that the dietary fibre has a number of beneficial effects related to its indigestibility in the small intestine (Pareek, 2002). Thus, all indigenous horticultural crops (vegetables /fruits) and their traditional value added products play very important role in food and nutritional security in hot arid regions which may be boon for advancement of horticultural production system in the regions.

### (iii) Importance as means horti-based traditional medicine and health care

The traditional vegetables/fruits are used/considered not only as a food stuff but also used as a source of traditional medicines to treat/cure health problems, diseases and disorders in human beings as well as in animals of the hot arid regions. For example, traditionally, fruit juice of *mateera* is used against sun strokes to the body, to cure the stone formation and cardiac and kidney troubles, regulate blood sugar, promote healthy skin, increase the blood, purification of blood, improve blood flow and reduce the risk of heart disease. The people/ dwellers believe that the use/eating of *mateera* and its products work as an anti-inflammatory, anticancerous, diuretic, laxative, antihypertensive, and antidepressant. The *mateera* is used to eradicate the urinary problems, weakness (Singh et al. 2014). Likewise, the dwellers/people of the study areas of the hot arid regions use the *kachri* fruits, seeds, juice and their combinations for health care and to cure different health problems. The fruits of *kachri* are used as a cooling light cleanser or moisturizer for the skin. They are also used as a first aid treatment for burns and abrasions. The flowers of the *kachri* are used as expectorant and emetic while fruits are used stomachic. The seeds are used to cure digestion and urinary problems and also in vermifuge activities. The fruits of *lasoda* (*Cordia myxa* Roxb.) for biliousness, cough and internal haemorrhage. The bark paste of *lasora* is used for treatment on spider bites and eruptive boils. The fruits of *lasora* is traditionally used as a demulcent, expectorant, diuretic and antihelmintic, anti-inflammatory, hypertensive, anti-ulcer, anti-bacterial, etc. The moringa bark, sap, roots, leaves, seeds and flowers are used as source of traditional medicine to treat some diseases and disorders in human being and animals also. Moringa seeds kacke and oil is used to purify the water to produce potable water for animal or human consumption. Thus, these examples reveal that the traditional techniques/ methods of treating the various health problems through the various traditional medicines derived from the vegetables and fruits grown in hot arid regions which disclose the wide scope of horticulture in the regions.

## 6. Conclusion

Presently, the Indian agriculture is confronted with a number of challenges including instability of productivity and diminishing sustainability of natural resources. These issues have evoked growing interest in the study of indigenous knowledge systems that are based upon the local resources and felt needs of the locale. Indigenous technical knowledge plays a crucial role in sustainable grassroots innovations. Such grassroots innovation largely differs across different sectors with respect to the characteristics, sources, actors involved, etc. The knowledge base needed for different grassroots innovations is different, which in turn decides the involvement of particular set of actors. The local people and communities are not well aware about the value of their indigenous knowledge which has been passing from generation after generation. In today's context, there is an urgent need to evaluate and popularize indigenous innovation. Government schemes, R & D activities should reach indigenous innovators. As most of the traditional knowledge and technologies are undocumented, there is also a need for more research in this field. Otherwise, this valuable knowledge will be extinct in the near future. An appropriate coalition between the traditional and modern knowledge and technological systems has immense potential for the sustainable development of horticulture / agriculture particularly in hot arid regions of the country for the benefits and over all development of the region. The ITKs related to horticultural production should be verified scientifically and refined to strengthening them and to exploit their potentiality for sustainable development of horticulture /agriculture in arid regions of the country. Since, information on ITK is seldom documented, it often happens that such information are lost, if not passed on from generation to generation or protected and practiced by the local people. Hence, in today's concept of IPR regime, it is all the more imperative to document and protect our valuable ITK for posterity. In the context of horticultural sustainability, ITK is also required to be properly documented for the benefit of researchers, planners and development officials. Validation of ITK is a logical step to qualify and quantity effectiveness of the practices. Suitable modifications of the local practices, through research and development will help to develop appropriate and acceptable technologies that are more suited to our farming situations. The farmers should be motivated, supported and guided to conserve and utilize such important traditional knowledge/technologies for the horticultural development in hot arid regions of the country like western part of Rajasthan.

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किसानों का हमसफर  
भारतीय कृषि अनुसंधान परिषद

*Agri*search with a *h*uman touch