

# Underutilized fruits of South Western Rajasthan used in medicinal, nutritional and economic security of tribal's: A case study

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## Abstract

The South Western Rajasthan is endowed of plant biodiversity with special mention of semi-arid underutilized fruit and vegetables. The present study emphasized that in ancient times these fruits and vegetables were largely used by the natives of tribal area as a prime source of natural medicine and food using their traditional wisdom. They used them in the form of fresh fruits, dry fruits, fruit juice, fruit powder, *arak*, *chutney*, paste, lotion, pickle, nutritive wine, drugs, *triphal* and *chyavanprash* etc. But in present scenario, because of changing food habits, taste and prevalence of several food myths and taboos the new generation of tribals discontinued consuming underutilized fruits and vegetables. Because they are unaware about the importance of consuming underutilized fruits and vegetables in daily diet. It has resulted into malnutrition among those people who discontinued consuming locally available underutilized fruits and vegetables along with multiple nutrient deficiency disorders. Significantly high prevalence of nutrients deficiency and occurrence of clinical symptoms of protein energy malnutrition (14.4%), anaemia (33.0%), iodine deficiency disorder (17.0%), vitamin A deficiency (22.0), vitamin C deficiency (12.40%), calcium deficiency (18.0%) and zinc deficiency (19.20%) were observed in non-consuming groups of tribals. It was also evident from the study that the consuming group has more traditional wisdom for therapeutic uses of available underutilized fruits and vegetables. Also the study results revealed that the underutilized horticultural crops have the potential to give economic security to tribals by giving employment and by fetching good returns from their sale in raw form as well as value added products.

**Keywords:** Underutilized fruits, nutritional security, tribals, traditional foods, non-consuming group.

## Introduction

Aravali range is a treasure of underutilized horticultural crops, and if exploited properly has the potential of transforming the economy of this tribal dominated region of Rajasthan because the crops are of explicit quality with great nutritional, medicinal, organoleptic, economic and traditional importance. Some of the important underutilized fruit crops are *Pilu*, *Jamun*, *Sitaphal*, *Mahuva*, *Mulberry*, *Kainth*, *Ber*, *Ker*, *Karonda*, *Khirmi*, *Date palm*, *Tamarind*, *Bael*, *Aonla* etc., medicinal plants are *Safed musli*, *Mulathi*, *Googal*, *Aloe vera*, etc. and vegetable crops are *Clusterbean*, *Kachri*, *Khimp*, *Khejri* pod, *Kakri* (*Balam khera*) which are the main source of livelihood for the poor tribals and can play an important role in overcoming the problem of malnutrition (Gajananan *et al.*, 2010). In ancient times these horticultural crops were used as major source of medicine and nutritive food by tribal population. These people were well acquainted with different ways of

using available fruit and vegetable for curing various diseases and act as source of nutrition. Also, earlier tribal had knowledge about processing (drying, modified mixed dry product, healthy liquor, *arak*, paste, lotion and fresh stored products) of fruits and vegetables which were otherwise available in plenty during a particular season. Besides their nutritional importance and as a source of household income, this fruit diversity also has a cultural and social value and contributes to the stability of ecosystems (Arora, 1998; Nandal and Bhardwaj, 2013a). But in changed scenario the tribals (*adivasis*) are suffering from various deficiency diseases due to faulty eating habits, cultural myths and taboos for foods, improper dietary composition, poverty, ignorance, lack of awareness leading to malnutrition and health insecurity. In present times the tribal population has reduced use of these valuable planting materials in daily life. The main reason for this is lack of awareness about their potential and low erratic bearing habit of these fruit plants.

Besides, some of these fruits are not acceptable in the market in fresh form due to their acidic nature and stringent taste. Hence, there is a need to

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concentrate on research efforts in diversification and popularization of such underutilized fruit crops for medicinal, nutritional and economic security of tribal population. Thus, product development and diversification of value added products have become very important for underutilized fruit production. The country is successful in evolving appropriate processing technologies for the profitable utilization and value addition of these fruits. As a result products like jam, jelly, preserve, beverages, pickle, dehydrated fruits and vegetables have been developed and they are having good commercial potential as well as beneficial in solving nutritional deficiency problems in tribal areas (Gopalan *et al.*, 1989; Goyal and Sharma, 2009). The importance of these lesser known fruits is increasing day by day because health conscious people realized the importance of new useful terms such as caloric sweetness, insecticide compounds and medicinal value. Most of the underutilized fruits are rich source of vitamins (ascorbic acid, thiamine, niacin, pyridoxine, folacin), minerals, fat, protein and dietary fibre (Gopalan *et al.*, 1989; Nandal and Bhardwaj, 2013b).

### Materials and Methods

A field survey was conducted during the years 2012-2013 for exploring the use of underutilized fruits in preparation of traditional foods for medicinal, nutritional and economic security of tribals of South Western Rajasthan. During survey the information was recorded on effect of consuming underutilized fruits and vegetables on nutritional security and prevalence of nutritional deficiency disorders from two groups first group were 100 persons of underutilized fruit and vegetable consumers and second group of 100 persons were non-consumers. Each group has members of different age groups i.e. Children < 5 years, children > 5 years, men, women, pregnant women, from five tribal dominated villages (Kerlapadar, Muri, Aamli, Rajpura and Fatehpura) of district Sirohi. Further, the relevant information regarding nutritional value, value addition and processing potential of the underutilized fruits was obtained from 100 middle aged housewives (aging 30-50 years) through direct interview method. During the survey the information about traditional wisdom of tribals for therapeutic uses of different locally grown and available underutilized fruits have been recorded from two age groups of 100 persons i.e. 20-30 years and 60-70 years old and data was presented in percentage. The medicinal importance of underutilized fruit and vegetables was collected by direct interview method from 5 local *Vaid* and reputed experts with the help of a pre-tested questionnaire. Economics of plantation of underutilized fruits in tribal area of district Sirohi was determined by a team of four experts from the field of horticulture, economics, plant

physiology and forestry alongwith a progressive tribal farmer.

### Results and Discussion

#### *Nutritional deficiency diseases and occurrence of clinical signs and symptoms*

The observations recorded during survey clearly indicated that the per cent prevalence of nutritional deficiency and occurrence of clinical symptoms was significantly higher in non-consumer group of tribals than the consumer group (Table 1). The results indicated that the non-consumer group of tribal population was more prone to (children < 5 years-20 %, children > 5 years-15 %, men- 7 %, women- 13 %, pregnant women-17 %) in suffering from Protein Energy Malnutrition. Major nutrient deficiency clinical symptoms like growth retardation with poor physical growth, reduced immunity, lesser in height and weight than normal body weights were present in this group than the underutilized fruit consumer group (children < 5 years- 8%, children > 5 years- 3%, men- 1%, women- 4 %, pregnant women- 6%). During baseline health survey it was also reported that the 40 per cent women, 45 per cent of the pregnant women, 23 per cent men, 27 per cent children > 5 years and 30 per cent of children < 5 years age group of non-consumers were suffering from iron deficiency anaemia. Clear iron and folic acid deficiency symptoms like tiredness, paleness of conjunctive, spoon shaped nails, pitting oedema, paler skin, sore tongue, low blood pressure and regular headache were present in non-consumers of all age groups than consumer groups. It was also observed that 17.0 per cent population suffered from iodine deficiency symptoms (Swollen front of the neck, protruding eyes, severe mental retardation, stunted physical growth, enlarged head, deafness, hypothyroidism with fatigue, weight gain, weakness and depression) in non-consumer group whereas only 5.0 per cent in consumer group. Vitamin A deficiency was also prevalent in non-consumer group of tribals with 22.0 per cent suffering from xerophthalmia, night blindness and rough skin (Table 1). It was also evident that the adult tribals consuming underutilized fruit and vegetable in daily diet were free from vitamin A deficiency symptoms. Significantly high prevalence of vitamin C deficiency (12.40%), calcium deficiency (18.0%) and zinc deficiency (19.20%) were observed in non-consuming group of tribals. They suffered from different visual symptoms i.e weak teeth and bones, slow growth, skin lesions and were more susceptible to infections. Whereas the underutilized fruit and vegetables consuming group was more healthy, nutritionally secure and having high working capacity rather than the non-consuming group. Maximum tribal children were suffering from iron deficiency anaemia, protein energy

malnutrition and severely malnourished due to unawareness and ignorance about nutritional value of underutilized fruits and vegetables and their uptake in daily diets (Nandal and Bhardwaj, 2013b).

#### **Nutritional values of underutilized fruits**

Underutilized fruits and vegetables viz., *aonla*, dates, *sitaphal*, *ber*, *rayan*, *pilu*, *ker*, *Aloe vera*, *kachri*, *khimp*, *khejri* pods, *phog*, *bael* and tamarind contribute significantly in maintaining tribal population nutrition, especially as very good source of vitamins {ascorbic acid (vitamin C), carotenoids (vitamin A), thiamine (vitamin B<sub>1</sub>), riboflavin (vitamin B<sub>2</sub>), niacin (vitamin B<sub>3</sub>), pyridoxine (vitamin B<sub>6</sub>), folacin}, minerals, fat, protein and dietary fibre (Wargovich, 2000; Nandal and Bhardwaj, 2013a). Some underutilized fruits like wood apple (7.10 mg100g<sup>-1</sup> pulp), *phog* (6.05 mg100g<sup>-1</sup> pulp) are very good source of protein, Tamarind (17.01 mg100g<sup>-1</sup> pulp) and *karonda* (39.14 mg100g<sup>-1</sup> pulp) are richest source of iron, *kumquat* (2575 IU) and drumstick (190 IU) are excellent source of vitamin A, *aonla* (500-625 mg100g<sup>-1</sup> pulp), *ber* (85 mg100g<sup>-1</sup> pulp) and chinese jujube (188-544 mg100g<sup>-1</sup> pulp) are very good source of vitamin C, *phog* (11.81-11.90 mg100g<sup>-1</sup> pulp) and wood apple (3.70-3.75 mg100g<sup>-1</sup> pulp) have good amount of fat, *bael* (31.80 mg100g<sup>-1</sup> pulp), tamarind (67.40 mg100g<sup>-1</sup> pulp) and date palm (70 mg100g<sup>-1</sup> pulp) are very good source of carbohydrate, *khimp* (156.30 mg100g<sup>-1</sup> pods) and *phog* (211.14 mg100g<sup>-1</sup> seeds) are richest source of calcium. Underutilized fruits such as *ber*, *bael*, *ker*, *phog*, *khimp*, *khejri* pod and *kachri* are more nutritious than other commercial fruits (Anonymous, 2010). The cluster bean (*Cyamopsis tetragonoloba* L.) is an important vegetable, it is rich source of protein (3.2 g), fibre (3.2 g), carbohydrate (10.8 g), calcium (130 mg), phosphorus (57 mg) and iron (0.6 mg) in per 100 g of fresh pods. The mature fruits of *kachri* (*Cucumis callosus*) are available abundantly in south western Rajasthan, it is one of the components of the delicious vegetable popularly known as *panchcuta*. It has 1.28 g fat, 1.21 g fibre, 43 Kcal energy and 29.81 mg vitamin C in 100g<sup>-1</sup> of fresh fruit. *Ker* (*Capparis decidua*) also a lesser known fruit of Rajasthan is very good source of protein (4.24 g), fat (2.0 g), fibre (4.24 g), carbohydrate (18.2 g), energy (107 Kcal) and vitamin C (50 mg) in 100 g<sup>-1</sup> of fresh fruit. *Khimp* pod (*Leptadenia pyrotechnia*) are rich in protein (3.13 g), fat (1.84 g), fibre (23.18 g), energy (68 Kcal), vitamin C (39.0 mg), iron (3.48 mg), calcium (156 mg) and phosphorus (317 mg) in 100 g of fresh pods. The unripe green pods of *khejri* (*Prosopis cineraria* Druce) commonly known as *sangri* and it is very good source of digestive protein (5.1 g), fiber (6.7 g), carbohydrate (14.15 g) and energy (82 Kcal) in 100 g of fresh pods. The seeds of *phog* (*Calligonum polygonoides* Linn) are rich in protein

(6.05 g), fat (11.81 g), fibre (15.73 g), carbohydrate (57.31 g), energy (360 Kcal), vitamin C (4.30 mg), iron (3.52 mg), calcium (211 mg) and phosphorus (427 mg) in 100 g of fresh weight of seeds. Most of the tribal food resources are available in plenty during a particular season but all have not been utilized to desired extent due to many reasons like unawareness, taste and unavailability of standardized processing and value addition methods (Anonymous, 2010). Thus, people residing in tribal areas hardly get considerable advantage from the abundantly available resources. The solution of the problem lies only in evolving the techniques of value addition, providing market and educating the tribals about nutritional quality of underutilized commodities. Processing and value addition of underutilized fruits and vegetables into more useful, easily digestible, tasty and convenient products ultimately improves the economic value of underutilized commodities and provide nutritional security to the tribals.

#### **Therapeutic uses of underutilized fruits**

There is considerable traditional wisdom regarding various therapeutic uses of underutilized fruits. But in present time new generation (20-30 years youth) of tribals is ignorant about the medicinal uses and methods of clinical application of underutilized fruits, whereas the old age (60-70 years) tribal persons have very good knowledge about therapeutic application and methods of use (Table 2). The data presented in table 2 showed that the older tribal population have very good traditional wisdom about therapeutic uses of underutilized fruits like *aonla* (69%), date palm (60%), *sitaphal* (80%), *ber* (55%), *rayan* (86%), *jamun* (60%), *pilu* (90%), *ker* (60%), *dhorthkumari* (80%), *kachri* (40%), *khimp* (30%), *khejri* (90%) and *tarbuj* (60%), whereas the new generation has very less traditional wisdom about different uses of underutilized fruits in tribal area. Underutilized fruits are major source of raw material for drugs and traditional medicines. It is widely accepted that underutilized fruits are of explicit quality with great nutritional, medicinal, organoleptic, economic and traditional importance. Numbers of underutilized fruits are used in pharmaceutical drugs as source of valuable remedies for treating dreaded modern ailments such as cancer, diabetes, jaundice, asthma, and nutritional deficiency (Wargovich, 2000; Anonymous, 2010; Nandal and Bhardwaj, 2013b). *Bael* is used in 60 patented drugs. *Aonla* is the component of most famous *ayurvedic* medicine *chyavanprash*. *Ber* is used in *joshanda*, *jamun* seed in diabetes and black mulberry in docking of AIDS virus on human cell. Fruits, nuts and vegetables in the daily diet have been strongly associated with reduced risk for some forms of cancer, heart disease, stroke and other chronic diseases (Hyson,

2002; Goldberg, 2003; Nandal and Bhardwaj, 2013a). Some components of fruits and vegetables (phytochemicals) are strong antioxidants and function to modify the metabolic activation and detoxification/disposition of carcinogens, or even influence processes that alter the course of the tumor cell (Wargovich, 2000; Nandal and Bhardwaj, 2013b). The stem and bark of *Khejri* is used for curing boils, leprosy, dysentery, asthma, piles and tumours (Saroj, 2004). Daily use of *aloe* juice shows significant improvement in glycaemic control, lipid profile and BMI of Type -2 diabetes (Deepti *et al.*, 2007; Nandal and Bhardwaj, 2012). A list of underutilized fruits having therapeutic uses and traditionally used by tribals for health security is given in table 2.

#### **Economic value of underutilized fruits**

Underutilized fruits are the source of sustainable income in tribal areas. But the tribal farmers knew about the economic value of only some underutilized fruits like *aonla* (70%), *sitaphal* (95%), *ber* (87%), *rayan* (92%), *pilu* (55%) and *tamarind* (70%). Whereas economics of some underutilized fruits is higher but popularity is very less like *date palm* (30%), *ker* (30%), *Aloe vera* (20%), *khimp* (25%), *phog* (12%) and *bael* (22%) (Table 3). Number of plant parts produce like root, leaves, flowers, fruits, gum etc. have high economic value in market. Many economically useful fruits, vegetables and medicinally viable plants like *aonla*, *ber*, *custard apple*, *jamun*, *tamarind*, *bael*, *ker*, *lasoda*, *khejri*, *karonda*, *dates*, *tumba*, *kumtia*, *kachari*, *pilu* etc. were either propagated or naturally available in the tribal areas of Rajasthan (Anonymous, 2011; Nandal and Bhardwaj, 2013a). The tribal especially women and children collected these fruits and useful plant parts from widely scattered trees and bushes in the region repeatedly during the harvesting season. A part of their collection was retained with them for their own consumption in raw or dried form and surplus was sold to the local traders or along road sides (Anonymous, 2011; Nandal and Bhardwaj, 2013a). The market of underutilized fruit in turn was influenced by a number of factors like consumer preference, processability, value addition, export, domestic consumption, foreign demand which again was based on knowledge about the health promoting qualities and nutritional value of the crops (Chundawat, 2003).

#### **Value addition of underutilized fruits**

Accurate statistics in regard to quantity production and processing was unavailable for underutilized fruits because a sizeable quantity of the fruits produced were self-consumed, exchanged or sold locally which remained unreported. The majority of fruit species in Rajasthan were not cultivated on a

large-scale or commercial basis, but rather grow wild or planted in home gardens or field boundaries. The results presented in table 4 showed that the maximum tribal women (85%), knew about preservation of the fruit and vegetable by dehydration method. Whereas 60 per cent women were also familiar about pickling of fruit and vegetable and 45 per cent have good knowledge about preparation of fruit and vegetable chutney. All advance technologies of fruit and vegetable preservation like making preserve (1.0%), glazed fruits (0.0%), sauce (5.0%), frozen puree (0.0%), canning (2.0%) and confectionary (0.0%) were less popular among tribal women. Normally, the fruits were collected from the wild forest and sold fresh on a seasonal basis, with limited processing (Azam-Ali, 2003). The volume processing was very high for all the species, as it refers to primary processing, which mainly involves the removal of pulp and drying. The socio-economic status of rural families can be improved through value addition of underutilized fruits (Anonymous, 2011; Nandal and Bhardwaj, 2013a). It can facilitate optimum utilization of available resources and can have great future in waste land fruit production. *Pachcutta* was most common processed product of underutilized fruits (Pareek and Samadia, 1998). The establishment of agro-processing industries in rural and tribal areas was necessary not only to meet the ever increasing demand for processed products but also to enhance real farm income in future (Anonymous, 2011). Value addition will also generate required employment potential for tribal workers. Processing of underutilized fruits and vegetables into more useful and convenient products, ultimately improves the economic value of any product, which is the most vital component of value addition (Goyal and Sharma, 2006) (Table 4). *Ber* pulp was used for making drinks (Kiradoo and Goyal, 2005), fresh *ker* fruits used as vegetable and pickle, immature fruits were also dried for subsequent use as vegetable in off season (Sen, 2003).

All the underutilized fruits and vegetables available in South-Western Rajasthan had great nutritional, medicinal and sensory appeal. There is a considerable traditional wisdom available on various therapeutic uses of underutilized fruits along with a great potential in the field of processing and value addition. In the present socio-economic scenario, when the tribals are facing the problems of hidden hunger, macro and micro-nutrient deficiencies, poverty, unemployment. The wise and proper utilization of underutilized horticultural crops can prove to be a promising solution after realizing their health and employment potential. The underutilized crops can be a rich and easily available source of macro and minor nutrients in sufficient amounts to prevent and cure deficiency disorders. They are the source of ayurvedic medicine because of having therapeutic properties.



They can fetch self employment opportunities through marketing of raw fruits and vegetables. Along with it, employment can be generated by value added product preparation through processing. Also, a good future scope lies in the field of value addition in view of abundant availability, palatability, quality and

therapeutic uses of underutilized fruits and vegetables. Hence it can be concluded that exploitation of underutilized fruits and vegetables can provide a solution to nutrition, livelihood and economic security of tribals by using available traditional wisdom as well as modern food processing technology.

Table 1. Major nutritional deficiency diseases, their symptoms and prevalence in tribal areas of district Sirohi

| Name of Disease                   | Symptoms of disease   | Prevalence of nutritional deficiency and occurrence of visual symptoms (N=200) |     |                      |     |         |     |           |      |                  |      |        |      |
|-----------------------------------|---|--|-----|----------------------|-----|---------|-----|-----------|------|------------------|------|--------|------|
|                                   |   | Children < 5 years %   |     | Children > 5 years % |     | Men (%) |     | Women (%) |      | Pregnant Women % |      | Mean % |      |
|                                   |   | NC   | C   | NC                   | C   | NC      | C   | NC        | C    | NC               | C    | NC     | C    |
| Protein Energy Malnutrition (PEM) | Growth retardation with poor physical growth, reduced immunity, lesser in height and weight than expected, kwashiorkor (presence of oedema) and nutritional marasmus (severe wasting)           | 20.0   | 8.0 | 15.0                 | 3.0 | 7.0     | 1.0 | 13.0      | 4.0  | 17.0             | 6.0  | 14.4   | 4.4  |
| Iron deficiency anaemia           | Pale skin, fatigue, brittle fingernails, sore tongue, brittle hair, shortness of breath, rapid heartbeat, unusual food cravings, low blood pressure, low immunity, headache, decreased appetite | 30.0   | 9.0 | 27.0                 | 8.0 | 23      | 9.0 | 40        | 13.0 | 45               | 15.0 | 33.0   | 10.8 |
| Iodine Deficiency Disorder (IDD)  | Swollen front of the neck, protruding eyes, severe mental retardation, stunted physical growth, enlarged head, deafness, hypothyroidism with fatigue, weight gain, weakness and depression      | 22.0   | 7.0 | 17.0                 | 4.0 | 12.0    | 4.0 | 11.0      | 3.0  | 23.0             | 9.0  | 17.0   | 5.4  |
| Vitamin A Deficiency              | Xerophthalmia and Night Blindness-inflammation of the cornea, eye lesions, dry eyes, bitots spots ;dry and rough skin; decreased immunity; growth retardation and loss of appetite              | 23.0   | 3.0 | 22.0                 | 7.0 | 17.0    | 0.0 | 23.0      | 0.0  | 25.0             | 5.0  | 22.0   | 3.0  |
| Vitamin C Deficiency              | Scurvy with skin bruises and bleeding, swollen or painful joints, decreased immunity, poor digestion, soft gums, slow healing wounds and fractures, loss of appetite                            | 12.0   | 5.0 | 13.0                 | 3.0 | 10.0    | 2.0 | 12.0      | 2.0  | 15.0             | 7.0  | 12.4   | 3.8  |
| Calcium Deficiency                | Weak teeth that easily fall out, lack of sleep, premenstrual cramps, high blood pressure, osteoporosis in adults  | 15.0   | 3.0 | 15.0                 | 4.0 | 10.0    | 2.0 | 20.0      | 7.0  | 30.0             | 9.0  | 18.0   | 5.0  |
| Zinc Deficiency                   | Slow growth in children, loss of hair, skin lesions, peeling skin, slow healing of wounds, frequent and recurring infections, severe diarrhoea  | 12.0   | 3.0 | 20.0                 | 7.0 | 17.0    | 4.0 | 22.0      | 9.0  | 25.0             | 9.0  | 19.2   | 6.4  |

(N=200) = 100 NC (Non-consumer of underutilized fruits) + 100 C (Consumer of underutilized fruits)

Table 2. Frequency of awareness about traditional wisdom for therapeutic uses of underutilized fruits and vegetables in different age group of tribals.

| Common Name  | Botanical Name                       | Traditional wisdom for different uses  | Therapeutic uses   | Frequency of awareness (n=100) |             |
|--------------|--------------------------------------|--|--|--------------------------------|-------------|
|              |                                      |  |  | 20-30 years                    | 60-70 years |
| Aonla        | <i>Emblica officinalis</i>           | Triphala, dry fruits chyavanprash, Amal ki rasayan, Dhatri loha, Saptamrit   | Cures haemorrhage, Diarrhoea, dysentery, anaemia, cough  | 17.0                           | 69.0        |
| Date palm    | <i>Phoenix dactylifera</i>           | Dry fruits, <i>chuhara</i> , fruit powder, nutritive paste (date <i>pak</i> )                                      | Supply instant energy, natural laxative, nicotinic content cures intestinal disturbances, checks growth of pathological organisms  | 8.0                            | 60.0        |
| Sitaphal     | <i>Annona reticulata</i>             | Fresh fruits, fruit powder, fruit <i>pak</i> , fruit paste   | Storehouse of Vitamin C acts as antioxidant, Vitamin A present is good for hair, eyes, healthy skin, rich source of dietary fibre so helps in digestion, expectorant, coolant, stimulant, haematinic | 13.0                           | 80.0        |
| Ber          | <i>Ziziphus nummularia</i>           | <i>Chuhara</i> , dry and fresh fruits, drugs   | Helps in blood purification and improves digestion   | 15.0                           | 55.0        |
| Rayan        | <i>Mimusops hexandra</i>             | Dry and fresh fruits, nutritive drugs  | Cures anaemia, improves haemoglobin content in blood   | 5.0                            | 86.0        |
| Jamun        | <i>Syzygium cumini</i>               | Fermented drugs, fruit juice, fresh fruits, <i>Jaambukasav</i> , <i>Madhumehdaman churna</i>                       | Cures Stomach ache, anaemia, improves haemoglobin in blood, diabetes   | 40.0                           | 60.0        |
| Pilu         | <i>Salvadora oleoides</i>            | Nutritive drugs, fresh fruits, juice   | Helps in blood purification and digestion  | 5.0                            | 90.0        |
| Ker          | <i>Capparis deciduas</i>             | Dry and fresh fruits, roasted fruits, powder, <i>pachcutta</i>   | Cures biliousness, asthma, inflammations, fever, cough, stomach pain, vomiting, arthritis, diabetes and hypertension, laxative   | 15.0                           | 60.0        |
| Dhrth-kumari | <i>Aloe barbedensis</i> Mill         | Juice, <i>pak</i> , jam, powder, <i>arck</i> , <i>bhasm</i> , drugs, <i>Kumaryasav</i> , <i>Rajpravradhanivati</i> | Antioxidant, bactericidal, fungicidal, purgative, controls arthritis, diabetes and cholesterol level   | 10.0                           | 80.0        |
| Kachri       | <i>Cucumis callosus</i>              | Dry and fresh fruits, <i>pachcutta</i> , fruit powder  | Exert cooling effect on body, improves appetite, easy bowel movement, relieves stomach pain, vomiting and constipation   | 25.0                           | 40.0        |
| Khimp        | <i>Leptadenia pvrtechnica</i> Forsk. | Dry and fresh pods, pod powder, <i>bhasm</i> and <i>arck</i>   | Cures constipation, arthritis and good for health  | 2.0                            | 30.0        |
| Khejri pods  | <i>Prosopis cineraria</i>            | Dry and fresh pods, pod powder, pod <i>pak</i> , pod paste, <i>pachcutta</i>                                       | Help in blood purification, cures skin disease, respiratory problem and piles, cures ringworm infection, dyspepsia and fevers.   | 10.0                           | 90.00       |
| Tarbuj       | <i>Citrullus lanatus</i>             | Fresh fruits, juice and drugs  | Relieves constipation and diarrhoea, cardiac and kidney troubles.  | 20.0                           | 60.0        |
| Phog         | <i>Calligonum polygonoides</i>       | Fresh fruit pulp, dry powder and <i>phog-pak</i>   | Exert cooling effect on body and provide good health   | 1.0                            | 25.0        |
| Bael         | <i>Aegle marmalos</i>                | Fruit powder, pulp, fruit <i>pak</i> , paste, drugs, <i>Bilb giri</i>  | Appetizer, stomachic, cooling, restore vitality  | 20.0                           | 70.0        |

Table 3. Economics of plantation of underutilized fruits in tribal areas of district Sirohi

| S.N. | Name of fruit & vegetables | Number of plants ha <sup>-1</sup> | Average yield (qt plant <sup>-1</sup> ) | Average yield (qt.ha <sup>-1</sup> ) | Average market rate (Rs. qt <sup>-1</sup> ) | Expected income (Rs. ha <sup>-1</sup> ) | Frequency of awareness (%) (n= 100) |
|------|----------------------------|-----------------------------------|---|--------------------------------------|---|---|-------------------------------------|
| 1    | Aonla                      | 100                               | 40                                      | 40                                   | 400   | 16,000                                  | 70.0                                |
| 2    | Dates                      | 100                               | 35                                      | 35                                   | 2000  | 70,000                                  | 30.0                                |
| 3    | Sitaphal                   | 277                               | 30                                      | 83                                   | 1000  | 83,000                                  | 95.0                                |
| 4    | Ber                        | 156                               | 45                                      | 70                                   | 1000  | 70,000                                  | 87.0                                |
| 5    | Rayan                      | 100                               | 20                                      | 20                                   | 2500  | 50,000                                  | 92.0                                |
| 6    | Jamun                      | 100                               | 50                                      | 50                                   | 2500  | 125,000                                 | 45.0                                |
| 7    | Pilu                       | 156                               | 10                                      | 15                                   | 1500  | 22,500                                  | 55.0                                |
| 8    | Ker                        | 400                               | 10                                      | 40                                   | 2000  | 80,000                                  | 30.0                                |
| 9    | Aloe vera                  | 33000                             | 2 kg leaves                             | 660                                  | 200   | 1,32,000                                | 20.0                                |
| 10   | Kachri                     | -                                 | -                                       | 50                                   | 500   | 25,000                                  | 40.0                                |
| 11   | Khimp                      | -                                 | -                                       | 30                                   | 1000  | 30,000                                  | 25.0                                |
| 12   | Khejri pods                | 100                               | 25                                      | 25                                   | 2000  | 50,00                                   | 40.0                                |
| 13   | Phog                       | 400                               | 12                                      | 48                                   | 500   | 24,000                                  | 12.0                                |
| 14   | Bael                       | 100                               | 50                                      | 50                                   | 1500  | 75,000                                  | 22.0                                |
| 15   | Tamarind                   | 100                               | 80                                      | 80                                   | 1200  | 96,000                                  | 70.0                                |

Table 4. Frequency of awareness about processed/value added products of underutilized fruits and vegetables in tribal women.

| S.N. | Name of processed products | Name of underutilized fruits and vegetables  | Frequency of awareness (n= 100) |
|------|----------------------------|--|---------------------------------|
| 1    | Jam                        | Jamun, karonda, aonla, tamarind, sitaphal, bael, ber, mulberry, wood apple etc.  | 7.0                             |
| 2    | Jelly                      | Tamarind, jamun, karonda etc.  | 3.0                             |
| 3    | Preserve                   | Ber, aonla, bael, ker, sangari, karonda etc.   | 1.0                             |
| 4    | Candy                      | Aonla, ber, karonda, datepalm, tamarind etc.   | 7.0                             |
| 5    | Glazed fruits              | Tamarind, ber, aonla etc.  | 0.0                             |
| 6    | Juice/ beverage /squash    | Tamarind, bael, jamun, karonda, phalsa, ber, aonla, pomegranate, mulberry, wood apple etc.                                 | 15.0                            |
| 7    | Wine                       | Mahuva, wild apricot, date palm, karonda, ber, Indian fig etc.   | 10.0                            |
| 8    | Chutney                    | Karonda, tamarind, ker, aonla, wood apple etc.   | 45.0                            |
| 9    | Sauce                      | Karonda, tamarind, wood apple, pomegranate   | 5.0                             |
| 10   | Pickle                     | Aonla, karonda, ker, lasoda, sangari, kachri, khimp, immature mango, ber, tamarind etc.                                    | 60.0                            |
| 11   | Dehydration                | Bael, karonda, ker, phalsa, ber, kachari, sangari, khimp, mulberry, date palm, lasoda, tamarind, aonla, custard apple etc. | 85.0                            |
| 12   | Frozen puree               | Tamarind, bael, karonda, ker, phalsa, tamarind, custard apple etc.   | 0.0                             |
| 13   | Canning                    | Ber, aonla, jamun, ker etc.  | 2.0                             |
| 14   | Confectionary              | Aonla, tamarind, immature mango etc.   | 0.0                             |

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