

Multiple uses of *Ziziphus spina-christi* (L.) Desf as an Agroforestry Species in the Northeastern rift Valley of Ethiopia: Contributions to People's Resilience to Adapt to Chaining Environment

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ABSTRACT

Quantitative ethnoecological analysis of uses, management and yield of *Z.spina-christi* revealed that, it has multipurpose popular socioeconomic roles being preferred by local people of semiarid east Shewa, Ethiopia. Relative abundance and density of the species for 66 plots was 44% and 3 respectively. Average fruit yield was 200 kg per year and the price was 30.21 \$USD. Fruits were gathered from *Z. spina-christi* throughout the year including the critical months before harvest of annuals when food supply runs low. It is rich in carbohydrates, proteins, minerals and fats. The fruits have been accessible year-round with an overlap of acute food scarcity and years of good harvest. The present study has shown that *Z.spina-christi* is naturally available, cheap and locally accessible alternative for resolving part of the food shortage problem and for maintaining biodiversity. The consumption of *Z.spina-christi* was a necessary part of the strategies adopted by people in order to survive in a harsh and unforgiving environment. The potential nutritional contribution of the species to the people's diets remained in the informal production sector. Multipurpose uses of the wood, bark, leaves, roots and fruits the species were not supported by modern technology having been purely traditional utilization. The potential in household food, healthcare, livestock nutrition were not properly documented and utilized in the study area. Hence, the species is a key candidate for dry land agro forestry and enhancement of agro biodiversity for human food and other multiple uses.

Keywords: Nutrition, Shewa, Wild fruit, *Ziziphus spina-christi*

INTRODUCTION

Wild foods provide diversity of food substances such as proteins, carbohydrates, vitamins and minerals in the diet (Harris and Mohammed, 2003). They are also important at times of food shortage and important coping strategies (Asfaw and Tadesse, 2001; Harris and Mohammed, 2003). Increased consumption of wild-foods enables people to better cope with erratic, untimely rains and drought without facing severe food shortage, famine and general depletion of asset (Mathys, 2000; Saied *et al.*, 2008). Among widely used multipurpose wild plants is *Z.spina-christi* in family Rhamnaceae. In most cases preferred wild edible plants are rare due to population pressure coupled by agricultural expansion and exacerbated by climate change. Fruits of *Z. spina-chrsti* were important as a supplement to daily diet, and at times of food scarcity in drylands. There are diverse wild plants in semi arid east Shewa, Ethiopia. In spite of the potential of wild edible plants to household food security little attention has been given to their formal production (Guinidad and Lemessa, 2000). Lack of focused research on multipurpose use and management of *Z.spina-christi* has hindered its successful improvement and promotion in formal production system.

Description of the study species

***Ziziphus spina-christi* (L.) Desf. locally known as QURQURA in Oromo language and belongs to the family Rhamnaceae.** According to Fichtl (2008), the name "spina-christi" was derived from the legend that Jesus Christ was crowned with the branches of the species. *Ziziphus spina-christi* grows as a shrub, or more often a tree up to 10m in height. Bark is grey to brown and fissured. Leaves, 3-13 cm long petioles and 1.5-8.5 × 0.8-5 cm blades, flowers yellowish green with 2-5 mm long. Fruits 8-15 mm in diameter, yellow to red (Vollesen, 1989c:395; Plate 41); Teketay *et al.* (2010). **Branchlets** are whitish to pale yellow. **Thorns**, numerous spines, paired, one straight, one curved. **Leaves:** ovate to elliptic, finely toothed.

Flowers: yellowish green, arranged in many flowered cymes. **Fruit:** yellow to red, globose, up to 15 mm in diameter, edible. **Flowering:** trees are found in flower throughout the year. **Distribution:** The species is widely distributed in Ethiopia. Afar, Bale, Gamogofa, Gonder, Hararge, IluAbbabor, Shewa upland, Tigray and Wello Flora regions (Vollesen, 1989). Its native habitat is throughout the Sahel from Senegal in West Africa to Ethiopia and Eritrea in East Africa. It is widespread in the near and Middle East, and in the dry areas of northern Africa.

Habitat: Found from sea level up to 1900 m in wooded grassland, on limestone slopes and on alluvial soils, in *Acacia* woodland, in and along dry river beds, on cultivated land and in gardens. It grows where the annual rainfall is between 50 and 350 mm (Fitchl, 2008). It also grows in woody grassland on limestone slopes, *Acacia* bushland on alluvial soils in and along riverbeds, edges of cultivations and gardens; altitude: 0-2400 m (Teketay *et al.* 2010). However, it is not abundant where resource degradation is compounded with the population pressure and climate change.

The wide distribution of *Ziziphus spina-christi* within the country and in the continent makes it a subject of urgent study. *Ziziphus spina-christi* is one of the widely used wild edible plants in Ethiopia. It is important at times of food shortage (Guinand and Lemessa, 2001). Knowledge of wild foods varies according to localities and lifestyles of people (Balemie, and Kebebew, 2006). The distribution area of the species is shrinking with the land use changes. Wild foods are important as a supplement to daily diet, and at times of food scarcity. They also provide an opportunity to generate income when they are traded (*Eden Foundation, 1992; Fentahun and Hager, 2009*). The tree and its various parts have been an important source for pharmaceuticals since antiquity in the Middle East. However, there was

inadequate documentation and dissemination of the multiple uses of *Z. spina-christi* in semi rid east Shewa, Ethiopia. Hence, the use of *Z. spina-christi* is an important coping strategy for rural communities. Therefore, there is a need to complement formal and local use and management practices for improvement of fruit production of the species. Therefore, this study has focused on analysis of the multipurpose uses, management and quantify fruit yield of *Z. spina-christi* in semiarid part of east Shewa, Ethiopia.

MATERIALS AND METHODS

Study area

The study was conducted in the semiarid zone of east Shewa in Fantalle and Boosat (weredas) districts located between 7°12'-9°14'N latitudes and 38°57'-39°32'E longitudes in the northern part of Great East African Rift Valley in Ethiopia from October, 2009 through April, 2010. The area lies in the Somalia-Maasi center of plant endemism (White, 1983) described as the *Acacia - Commiphora* woodland vegetation type (Demissew and Friis, 2009). The climate of the area is harsh with erratic and variable rainfall. The highest mean annual rain fall of semi arid east Shewa was 171.05 mm and lowest is 23.04mm. The highest mean monthly rainfall 243.11 (July and August) and the lowest mean monthly

rainfall is, 5.78 mm November respectively. The main rainy season is from June to September known as 'Kiremt' and low rainfall from February to May known as 'Belg'. The highest mean maximum temperature is 36.73° C in June and the lowest (31.24°C) in December. Economic activities of the area can be described as the agropastoral type with Boosat Wereda (administrative level in Ethiopia equivalent to the district) marked with mixed agriculture of livestock and crop production (BPED, 2000). Fantalle wereda is more of livestock production with transhumant and rudimentary crop agriculture practiced in favourable years. The vegetation of the area includes many wild edible plants. However, the vegetation is declining due to the effects of anthropogenic factors and climate change. This has affected both natural resources and the livelihoods of people in the study area.

METHODS

Quantitative ethnoecological study of *Z.spina-christi*, in Boosat and Fantalle districts of east Shewa, Ethiopia was carried out from October, 2009 through September, 2010. The study was made in six study sites (2x3) (Digalu Tiyo, Trii Biretii and Xadacha) from Boosat and

(Galcha, Qobo and Dheebiti) Fantalle districts. Data on multipurpose use and managements by local people were gathered by semi-structured interview of 120 randomly chosen household heads and key-informants interviews. Focus group discussions with key informants and repeated direct field explorations by the researchers were also undertaken to generate data on uses, management and preferences of *Z.spina-christi* (Martin, 1995; Cotton, 1996; Balemie and Kebebew, 2006). Species relative abundance and density was determined from 66 plots of 20 x 20 m (Cook and Stubbendieck, 1986). Seasonal abundance of fruits was recorded on monthly basis for 12 months. Annual average 6 trees mature fruit yield was determined by closing trees from any harvest except for yield estimation. To minimize the wild animals' effect except birds which cannot be avoided trees nearby homes in closed pastureland were used. Seasonal abundance of fruits was recorded on data sheet prepared for 12 months (October, 2009 to September, 2010).

Note: Small size tree is not the maturity level, it is the size, we cannot collect from big trees only, the wild has mixture of the tree sizes that is why different size are used to get average .If only large size trees are considered it exaturate the yield.

Data analysis

Data generated were qualitatively and quantitatively analyzed and summarized in percentiles, average values and ranked. Values of 10 major uses of *Z.spina-christi* were calculated for the two districts by pooling together after taking values given by 14 individuals at each study site (N=14x6=84). Yield of a tree per year was calculated by averaging the yield of 3 different sized (small, medium, large) trees per study site and pooled average was calculated for final yield estimation of a tree per year. Average abundance and density was calculated for 66 plots (20x20m) (33 plots per district). Seasonal abundance of fruits was summarized against 12 months to show the seasonal availability of fruits. Hierarchical cluster analysis was carried out to compare knowledge of key informants' for use categories of the species.

Results and Discussion

Abundance and density of *Z.spina-christi* relative to 90 plant species identified in Boosat and Fantalle districts of the study area showed that it has abundance of 54.55% and 33.33 % respectively (Table 1). Overall density of 66 plots was 10.61% per ha. Field inspection has shown that, *Z.spina-christi* is abundantly found in enclosed pasture and traditional agroforestry systems in semiarid east Shewa. Direct observation across seasons, focus group discussions and key informants interviews revealed that *Z. spina-christi* is drought tolerant fruit tree species. Participatory observation and ecological studies in east Shewa (Ethiopia) confirmed the wide ecological amplitude of *Z.spina-christi*, being abundantly found from 930 -1550 m.a.s.l.

Table 1. Abundance and density of *Z. Spina-christi* from 66 plots of 20x20 m

Spp	Boosat	Fantalle	Boosat	Fantalle
	Av. Rel Freq	Av. Rel Freq	Av.Rel Dens	Av.Rel Dens
<i>Z. spina-christi</i>	55	33	3.91	1.47
Overall Averages		44		3

Seasonal availability of *Z. spina-christi*

Ziziphus spina-christi is an evergreen drought tolerant wild edible plant. Twelve months field record on availability of fruits has revealed that, it flowers and produces fruits throughout the year except that fruits are very few in the months of June to August (Table 2). Seasonal observation of the rare plant has revealed that *Ximenia americana* has drought resistant characteristics. In the study area, flowering takes place at the beginning of the main rainy season producing fruits towards the end of June and continues until October. Elderly key informants explained that in rain years, the second flowering takes place from mid March to April and gives fruits in May to September. Thus, *Ximenia americana* produces fruits in the short and main rain seasons. Hence, *X.americana* can be a good source of food with other multiple uses for humans and animals. This indicated the year round availability of the fruits of *Ziziphus spina-christi* for consumption by households. The species is climatically adapted to drylands which makes it suitable for cultivation in drylands. Hence, the species can be socially, nutritionally

and environmentally a candidate to semiarid agroforestry. Data on storability, processing is not much focused in this study, However, fruits are collected by hand picking or using long hooks to separate fruits from tall trees. Fruits are consumed and marketed fresh with about 15 days keeping in cooler containers. It needs further research.

The knowledge of abundance and densities of the species can be used for enhancing indigenous management systems by complementing with conventional knowledge. It should be noted that given the present climate change and its consequences, *Z.spina-christi* has been producing fruits abundantly. As key informants explained, *Z. spina-christi* has high adaptability to semiarid area like many *Acacia spp* because of abundant seed bank even in degraded land unlike *Ximenia americana* which is assumed to have little seed bank as it produces fewer fruits and seeds with highest palatability by humans and wild animals

The following figure shows that principal author trying to identify the species (Fig 1).



Fig 2. Principal author was identifying the species in Boosat district, east Shewa, Ethiopia

Table 2. Seasonal abundance of fruits of *Z.spina-christi*

	J	F	M	A	Ma	Ju	Jul	A	S	O	N	D
Months												
Abundance	+	+	+	+	+	0	0	0	+	+	+	+

+ = fruits adequately present, 0 = fruits were not adequate during the study year

Marketing and monetary values of fruits

Average yield of a mature *Z.spina-christi* tree was 200kg per year. Survey of 4 local markets (Metahara, Addis Ketema, Welenchiti and Bole) has shown the price of a kg of fruits is 2.5 Ethiopian Birr (ETB).

Hence, annual average income a household can generate from fruits of a tree is 500 ETB (Table 3). The owner of 5 trees can get 2500 ETB which can be used for various household expenses provided the fruits are appropriately collected, handled and timely and marketed is available.

Table 3. Average (Av) annual yield of a tree/ year and prices of fruits

WEP	Av yield in kg and prices					
<i>Z.spina-christi</i>	Av fruit	Price	Price	USD	Av fruit	Price
	yield/year	/kg	of		yield/year	/kg
		fruit	200			fruit
		ETB	kg			ETB
	200	2.5	500	30.21	200	2.5

ETB= Ethiopian Birr

Diversified Uses of *Ziziphus spina-christi*

Food and feed values

In the study area, 100% of informants explained that, the ripe fruits are eaten fresh and as supplementary diet at normal times and as a meal during shortage of food. Fruits are edible and found in local markets. All age groups eat the fruits nowadays as opposed to early times when

it was eaten by children mostly. Direct observation by the researchers and key informants has revealed that the fruits were found abundantly in local markets. The plant has multiple uses other than food. Ten major uses were given value by key informants of the two districts and pooled together. Food and wood values were equally valued highest (5) each (Table 4).

Table 4. Average pooled summary of use categories of *Z.spina-christi*

WEP	F	M	Fe	Sh	Er	Fw	Sp	Fg	Fi	Hh	T. Av
Z .spina-	5	4.5	5	5	5	5	4.5	5	4.8	4.8	48.7

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F=food,M=Medicine,Fe=Fence,Sh=Shade,Er=erosioncontrol,Fw=fuelwood,Sp=spiritual,Fg=forage, Fi= farm implements, Hh=household utensils(5= most, 0= not) preferred.

Hierarcahal cluster analysis result indicated that value given for the use categories varies from study site to study site (Fig 2 a nd b). The result indicated that

different people value the same use category differently and subsequently indicating the diversity of knoweledge on the utilization of the species.

Rescaled Distance Cluster Combine

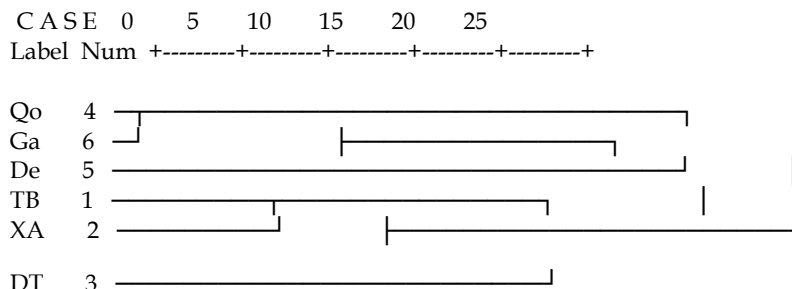


Fig 2 a. Dendrogram using Average Linkage (Between Groups) values given by people study sites.

Qo= Qobo, Ga= Galcha, De = Dheebiti, TB=Tri biretti, XA= Tadacha, DT= Digalu Tiyo

Study sites	Proximity Matrix					
	Euclidean Distance					
	1:TB	2:XA	3:DT	4:Qo	5:De	6:Ga
1:TB	.000					
2:XA	2.449	.000				
3:DT	4.359	3.000	.000			
4:Qo	5.657	5.477	4.583	.000		
5:De	5.657	4.690	4.583	4.000	.000	
6:Ga	5.292	5.099	3.873	1.414	4.243	.000

Fig 2 b. Dissimilarity matrix for values given for 7 use categories of *Z.spina-christi*

MULTIPLE USES OF THE WOOD

According to key informants discussions and direct observation the wood is termite resistant and widely liked for its fuel wood (firewood and charcoal). Its durability makes it used for posts/ poles, local carpentry, and local construction of houses, spears and knives shafts, furniture making, household utensils and tool handles. Branches are used for fencing and for farm implement. Gebauer et al. (2007) cited in Saied et al. (2008) has also reported similar result by the research done in Sudan indicating the medicinal and nutritional values of the species. This indicates that the species has similar multiple uses in arid and semiarid arid countries.

The use of wood and wood products does not exceed the various local uses in the present study area. This indicated the underutilization of the species. (Fichtl, 2008) reported that people often planted

the species as an ornamental and for shade. It is also used as a living fence and sometimes as a boundary marker, dry and live fencing and ornamental purposes. The high suitability for making furniture, tools, posts, poles and construction work were noted. The wood is heavy and durable, and serves for artistic woodwork, while the branches and trunk were used as firewood and high quality charcoal. The tree and its parts appear to have been in use in Pharaonic industry (carpentry), diet, and in medicine (Dafni *et al.*, 2005). The use of food in semi arid people of east Shewa did not include much improvement than purely traditional.

Medicinal Uses

The use of fruits, leaves, roots and bark of *Z.spina-christi* in traditional medicine was identified by 80.8% of informants. The bark is claimed to be used to treat hepatitis known as "DHIBE SINBIRA" by Oromo language. According to explanation of key informants, pieces of crushed the bark are

concocted with crushed leaves of *X. americana*, *Ocimum urticifolium* and bark of *Terminalia brownii*. The boiled mixture is filtered and 3 glasses could be served every 2 days for a week. This preliminary information can be a clue to do more investigation before recommending the medicinal uses.

Medicinal uses identified in the present study area were far fewer compared to the experience of the Middle East and other countries in the use of *Z.spina-christi* for traditional medicine applications can be optimized using this species. It indicates the species is underutilized in healthcare systems. Fichtl (2008) reported that traditional medicinal uses. Accordingly, this author elaborated on the various medicinal applications of the species where it is narrated that, the leaves and barks were used to cure dandruff and stomach disorders. The seeds were also used to cure throat infections and as a conditioner to encourage hair growth. The roots are used to treat headaches and tonsillitis. According to Alireza (2003) *Z.spina-christi* is a tree indigenous to the south of Iran. The leaves of this plant, which are locally known as "Sedr" and "Konar," have been used for washing the hair and body. Plant leaves are also used in Iranian folk medicine as an antiseptic, antifungal and anti-inflammatory agent, and for healing skin diseases such as atopic dermatitis (Nafisy, 1989 cited in Alireza, 2003).

Ethnobotanical studies in Israel by Dafni et al. (2005) also reported the multiple uses and holyness of the species. *Ziziphus spina-christi* and *Z. jujube* have been used throughout India and Asia and Africa. All parts of the plant were used, from the fruit pulp and seed to the leaves, bark and flowers. Ailments such as diarrhoea, dysentery, ulcers, eye infections, coughing, asthma and vomiting can be treated with infusions, pastes and powders (Azam-Ali et al., 2006). It also has antifungal activity and can be used against fungal infections. Middle East has already used the species for various livelihoods. This value added utilization of the species was lacking in east Shewa, Ethiopia. It indicated direction of future work for proper utilization of traditional uses of the *Z.spina-christi* in Ethiopia and semi arid Africa.

The Arabian countries use the fruits of *Z. jujube*, *Z. mauritiana* and *Z. spina-christi* to ensure health. The leaves of the plant kill diarrhoea-causing parasites and worms in the intestinal tract. The fruits are said to cure coughs, resolve any other lung complaints, soothe the internal organs and reduce water retention. In Saudi Arabia, fruits of *Z. spina-christi* when in sufficient strength act as a laxative. Stem bark is used to relieve toothache and fevers (Azam-Ali et al., 2006). Leaves of *Z. spina -christi* are used in traditional medicine in Egypt for the treatment of abscesses, boils and

swollen eyes and its wood ash for the treatment of snakebite (Abdul-Galil and El-Jissary, 1991 cited Azam-Ali *et al.* 2006). The root, stem bark and leaves are used in various medicinal preparations in tropical Africa, particularly in the Kapisiki country (Dalziel, 1937; Heyne, 1950; Williamson, 1957; Depommier, 1988 cited in Azam-Ali *et al.*, 2006).

Ecosystem services of *Ziziphus spina-christi*

Key informants explained that, in addition to food value *Ziziphus spina-christi* provides environmental services as shade by protecting radiation from humans, livestock and wildlife, soil improvement and conservation acting as mulch and enhancing water infiltration to soil. Fruits were eaten by birds and contribute to poultry production and the by products can fertilize the soil. This contributes to the growth of *Z.spina-christi* thereby optimize nutrient cycling. It protects soil erosion by being a hindrance to flash erosion due to erratic and torrential rainfall experienced in the study area. This is also known from other dryland areas. Because of these services farmers have started to keep their privately owned *Z.spina-christi* plants in and around their farm in case of crop farmers, closure areas ('KALO' in Oromo language) of pastoralists land use systems. At present east Shewa has sufficient land for cultivation of wild edible plants including the most preferred *Z.spina-christi*.

Human resource is also available to manage its cultivation.

In the study area, *Z.spina-christi* has tangible and intangible values. *Ziziphus spina-christi* has multiple environmental benefits as they provide year round protection to the soil. The strong root system also helps to maintain soil structure and therefore conserves the soil. *Ziziphus spina-christi* trees can grow under conditions of extreme stress from drought, salinity and water logging and can therefore be grown on degraded or marginal lands (Balemie and Kebebew, 2006). It has been used in the soil conservation of dune lands, where it stabilizes the soil by the storage and recycling of plant nutrients. The tree has also been used as a live fence and windbreak in India (Azam-Ali *et al.*, 2006). There were similar practices in the present study area. Wild edible plants are multipurpose biodiversity components to be reconsidered in research and development (Gemedo-Dalle *et al.*, 2005). Hence, these services must be sustained by conservation of WEPs. By equivocal assessment of the specie's environmental benefits, it can be used in restoration of salt affected soils by irrigation agriculture in semiarid areas due to expansion of large scale agriculture. It can contribute to the environment resilience by reducing drought and climate threats on ecosystems due to desertification as the species is drought tolerant and can thrive in extreme environments.

Importance to honey production

Honey production was limited to very few people in semi arid east Shewa. It cannot be listed as livelihood source except very few people near mount Boosat Guddo. *Z. spina-christi* produces flowers throughout the year; there is no dense stand of trees in the study area to satisfy the need for honey production. Fichtl (2008) has explained the Apicultural value of *Z. spina-christi* as one of the most important nectar and pollen sources. Honeybees forage on the abundant nectar and pollen and in dense stands the bees will produce a significant surplus of honey. In most cases the pollen and nectar of a single tree will strengthen colonies and significantly stimulate brood rearing. Fichtl (2008) recommended for planting to increase honey production. Cultivation is practiced in many parts of Yemen; households keep an average of 25-50 trees in and around their irrigated fields for bee keeping, fruit production and other uses (KIT, 2002 cited in Azam-Ali *et al.*, 2006). These various options were underutilized in the present study area. Hence, the planting and management of trees has multipurpose multiple functions in honey production, livestock production, human food and medicinal uses. This also implicates the need for having integrated production system, which is coming true in some parts of the research area. The year round flowering and abundance of *Z. spina-christi* in dry season when many trees do not

bear flowers is important characteristics and merit to bridge the bee feed shortage for honey production through maintaining viable colonies of in semiarid areas.

Traditional management of the species for improved uses

The key informants explained that local people are showing increased tendencies of managing *Ziziphus spina-christi* to get more benefit from it. Pruning was one management practice by crop farmers and pastoralists as observed in practice during the study period by the researchers. Local people prune the trees for better branches, leaves, fruits and forage quality. Enhanced fruit and leaf production enhances food and forage values both to humans and livestock. The tree has high coppicing characteristics; pruning enhances growth of branches and fruit production.

The uses of leaves and fruits were limited to browse by cattle, goat and camel if left to the wild. Some individuals deliberately plant and own some trees in traditional groforestry and KALO areas. They managed it to sustainably use the species.

Implications to food security

Ziziphus spina-christi can be compared with other farm crops. The fruits have complementarities to crop and livestock products. Direct use of fruits as food, income generation from sale of fruits, fuel wood, and household utensils made of the

wood to use the money to buy additional food items and get services. Dafni *et al.* (2005) and Fichtl (2008) reported that, the seeds inside the fruits are roasted to be eaten. The fleshy part can be dried and pulverised to be baked under the heat of the sun. The leaves are browsed by camels, goats and sheep. Fruits are also added to the leaves for better forage values. The forage value also contributes to livestock production thereby enhancing food security.

The fruits were sometimes made into bread, which may also have been used for dressings when warm. Egyptian peasants made similar bread as late as the beginning of the 20th century (Manniche, 1989 cited in Dafni *et al.*, 2005). Sun-dried fruits were powdered and mixed with water to make cakes similar to gingerbread (Azam-Ali *et al.*, 2006). The fruit is sweet, and, if one pours wine over it, they say that it becomes sweeter and that it makes the wine sweeter" (Theophrastus, 1961. In: Inquiry into plants, cited in Dafni *et al.*, 2005).

If properly managed, better production of fruits and other multipurpose use can be enhanced. In the Sudan, *Z. spina-christi* is intercropped with sorghum and maximally used in West Africa. As the species is naturally drought tolerant, it contributes to coping and adaptation strategies to climate variability and change in semi arid areas. Regassa *et al.*, (2014) have recommended further research on the toxicity and

nutritional composition of these plants to ensure safety of consumption and economic benefits on the possibility of adapting, growing and intentionally managing some of the commonly consumed wild and semi-wild edible plants in Chelia District, West-Central Ethiopia. The present study and Regassa *et al.*, (2014) indicated the need of more emphasis to wild edible plants to harness their potential.

CONCLUSIONS

Fruits of *Z. spina-christi* are important supplement to daily diet in normal time and at times of scarcity. The fruits are naturally available, cheap and accessible alternatives to resolve part of the food shortage problem. Fruits were available throughout the year. Consumption of the fruits contributes to the effort of filling gaps before harvest of annual crops. Wood, branches and leaves have multiple uses for humans and livestock as provisionary values and ecosystem services. Hence, *Z. spina-christi* has preferred food and multipurpose uses and rich in major food substances. Therefore, the present study has highlighted that that *Z. spina-christi* can be considered in agrobiodiversity and agroforestry practices in semiarid areas. The fruits can contribute to people's coping efforts with food shortages and increase resilience to adapt to changing ecosystem.

RECOMMENDATIONS

Sustainable utilization of the species need be enhanced by policy which includes it in formal production system. Appropriate conservation, cultivation and integration into dryland agricultural practices for diversification of food sources and maintenance of biodiversity are recommended. Traditional knowledge based uses and management practices of the species need be complemented with extension services and practices.

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