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Assessment of Post-Harvest Handling Practices of Honey in Erer Zone, Somali Regional State, Ethiopia

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ABSTRACT

Honey is a natural food that honeybees make from nectar or other floral secretions. Although Ethiopia has been producing honey for a long time, the quality of the honey produced there, and in the study region in particular, is still poor because of improper handling practices. The objective of this study was to assess post-harvest handling practices of honey in the Erer zone, Somali regional state, Ethiopia. Two districts namely Lagahida and Fik were selected purposively based on beekeeping potential and three kebeles were selected from each district purposively based on honey production potential, and lastly a total of 156 beekeeping households were randomly selected for this study. The study revealed that sampled households used traditional beekeeping systems and hung their hives on trees away from the homestead in dense forests. Honey is harvested two times a year and the average honey yield from traditional and modern hives was 3.65 & 9.73 kg, respectively. The majority (79.5%) of the respondents used smoke and fire during honey harvesting and honey is harvested at night time and this affects honey quality because smoke and ashes from the fire ends up mixing with the harvested honey. The majority (76.95%) of the beekeepers collect and store honey in plastic containers. However, these containers are not appropriate and can spoil honey and may result in quality deterioration. The majority (80.8%) of the beekeepers do not strain honey and only 19.2% of them strain honey before it is sold by simple drainage to remove the beeswax using hand (13.4%) and sieve (5.8%). The beekeepers who do not strain honey reported that they lacked straining materials (29.5%), lack of knowledge of straining (9.6%), and lack of both knowledge & materials (41.7%). High cost of beekeeping equipment, pests & predators, water scarcity, shortage of bee forage, absconding & marketing problem were the major constraints of honey production in the area. The study concluded that the majority of the beekeepers practice traditional beekeeping systems and improper honey-handling practices. Therefore, awareness creation and training of beekeepers on proper handling measures of honey is very crucial in addition to the provision of improved beekeeping equipment which would significantly contribute to honey quality enhancement. Furthermore, investigations on the implications of poor handling practices on honey quality and from the perspective of public health are also required.

INTRODUCTION

The beekeeping sub-sector has been an integral part of agriculture in Ethiopia. It has been contributing to household income and national economy through export, and also acts as poverty alleviation. The country has huge apicultural resources that made it the leading honey and beeswax producer in Africa (Fikru, 2015). According to CSA (2021), a total of about 6.98 million hives were estimated to be found in the rural sedentary areas of the country. From these total hives, the greater part (96.98%) is reported to be traditional which is poor in quality and low in quantity of hive products. In addition, the estimate of total honey production during the reference period is about 129 million kilograms of which the greater portion is harvested from traditional hives.

Honey and bees wax are the major hive products which are widely utilized for different purpose throughout the country. The products may be used either for household consumption and/or sold to finance the purchase of basic household commodities such as coffee, salt, cooking oil, sugar, etc. The products are sometimes used as payments and gifts to others. The survey conducted by CSA (2021) indicated that of the total honey production, about 41.22% was used for household consumption, 54.68% was sold, and less than 1% of the honey production was used as payment (wage) in the Ethiopia. On the other hand, 44.13% of the wax produced in the country was used as household consumption while 25.22% was used for sale.

Honey is the most important primary product of beekeeping both from a quantitative and an economic point of view, the first bee product used by human kind in ancient times (Geno, 2005). Honey is a sweet and flavorful product which has been consumed as a high nutritive value food (Gomes *et al.*, 2010). It is also used for industrial purposes and it is an important commodity in the international market; serving as foreign exchange earner for many countries (CAC, 2001). It is essentially composed of a complex mixture of carbohydrates, of which fructose and glucose account for nearly 85–95%, and other minor substances, such as organic acids, amino acids, proteins, minerals, vitamins, and lipids (Gomes *et al.*, 2010). According to FAO (2010) report 45,300 metric tons of honey is produced per annum in Ethiopia, makes the country to rank first honey producer in Africa and

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ninth in the world. However, the majority of honey is crude and poorly managed. Honey is of good quality as long as it is in the hive, but faulty handling from the time of its harvest until it reaches to market is responsible for its inferior quality (Nuru, 2007). Several factors have contributed to its low quality among which high moisture content is the major quality problem in the country. Harvesting unripened honey, unsuitable honey storage container and storage places also attribute to high moisture content (Adgaba, 1991). The quality of honey relied to a great extent on the art of the producer in storing and blending the product. In the marketing of honey, consumers should have confidence that they are getting good quality for what they are paying so that the country able to earn foreign currency to revamp the national economy (Geno, 2005).

The composition and quality of honey in general are greatly influenced by geographical and environmental factors and the types of flowers utilized by bees (Getachew *et al.*, 2014). The quality of honey is mainly determined by its sensorial, chemical, physical, and microbiological characteristics (Gomes *et al.*, 2010). The quality and properties of honey are also related to honey maturity, production methods, climatic conditions, processing and storage conditions, nectar sources of the honey, type of hive used, and the methods of collection and storage of honey (Negera, 2005; Szczęsna *et al.*, 2011; Waś, 2011).

The quality issue is the main concern for export commodities, and the volumes of export honey in Ethiopia have declined since the last decade. This is due to the deterioration in the quality of the honey during harvesting, post-harvest handling, and marketing (Beyene and David, 2007). The quality of Ethiopian honey is generally poor as the greater portion is harvested from traditional beehives (CSA, 2021). Faulty handling from the time of its harvest until it reaches the market is responsible for its inferior quality. The type of hive used in the method of harvesting and storing honey play a vital role in the determination of the quality of honey (Beyene and Verschuur, 2014).

Despite the large number of honeybee colonies and diversified honeybee floral resources, the production of honey is far below its potential in Ethiopia. This may be due to the fact that the apiculture sector has received little research and development attention, and because honey produced in the different agroecologies of the country has not been characterized to date. The physicochemical properties of honey produced in different geographical locations of Ethiopia have been reported by several researchers (Gobessa *et al.*, 2012; Gebremedhin *et al.*, 2013; Zábrodská and Vorlová, 2015). However, in the Somali region in general and the Erer zone, in particular, such primary information is lacking despite the potentiality of forest beekeeping and the production of large volumes of honey per annum. In the Erer zone, the majority of households keep bees and honey serves as a source of cash income for many households. Thus, in order to produce and improve the quality of honey that meets the demands of national and international markets and quality criteria, information about the quality of honey produced in the area is important. Therefore, the objective of this study was to assess post-harvest handling practices of honey in the Erer zone, Somali Region, Ethiopia.

MATERIALS AND METHODS

Description of the Study Area

This study was conducted in the Lagahida and Fik districts of Erer Zone, Somali Regional State. Fik district is bordered on the south by Hamero, on the western by Qubi, on the west by Mayamuluka, on the north by the Jigjiga Zone, on the east by the Jarar Zone, and on the southeast by Sagag. The elevation of this woreda is 1035 m. It has a weather of 32 OC and 27% humidity. It has a latitude and longitude of 8°8'16" N and 42°17'36" E. Lagahida district is bordered on the south by Salahad, on the west by the Oromia region, on the north by Mayumuluka, and on the east by the Erer which separates it from Hamero.

Study Design and Sampling Procedure

This study was conducted to collect relevant information on post-harvest handling practices of honey, honey collection materials, honey storage materials, honey straining, and honey straining materials in the study area. A multi-stage sampling technique was employed. At the first stage, two districts namely Lagahida and Fik were selected from the eight districts of the zone purposively based on beekeeping and honey production potential in consultation with district offices of Livestock and Pastoral Development experts respective to the study area. In the second stage, a total of six kebeles (three from each district), which have high beekeeping and honey production potential were selected randomly. Lastly, a total of 156 beekeeping households (2 districts *3 kebeles *26 households) were selected for the survey part of this study based on their willingness to participate.

Data Collection and Analysis

Semi-structured questionnaires, field observations, interviews with key informants, and focus group discussions were applied to collect the relevant data for this study. The data was analyzed using SPPS (Version 26.0) and presented by tables using descriptive statistics like percentages, mean and frequency.

RESULTS AND DISCUSSION

Characteristics of the Beekeepers

Table 1 shows the characteristics of the beekeepers in the study area. The majority of the respondents (91.7%) were men, with the remaining (8.3%) being women. This indicated that a higher proportion of beekeeping activities are left for males, with no female participation. The study indicated that beekeeping activities in the area are totally undertaken by males because the area is dominated by the traditional method of beekeeping practice. A very limited number of female participations in beekeeping activities

in the present study is in agreement with the findings of Lomiso (2019), Shenkute *et al.* (2012), Chala *et al.* (2011), and Alemu (2010). The limited number of females in beekeeping might be due to traditional beekeeping activity which is done by hanging traditional hives on the top of long trees in dense forests by climbing on the tree. This is because climbing trees for hanging traditional hives might be difficult for females. Harvesting is also done by climbing to the top of the tree, which is a very difficult task for females.

The overall average age of the interviewed beekeepers was 40.85±8.20 years. People in the aforementioned age do have the ability, skill, and strength to climb large trees and uplift the hive to hang on branches of large trees. This result demonstrates people in the most productive age engage in beekeeping activity, and that beekeeping is an important economic activity that can be performed by all age groups, i.e., by younger and old people. The present result is in line with the findings of Lomiso (2019), Tessega (2009), Kebede (2011), and Shenkute *et al.* (2012) who reported the predominance of active and productive heads of households. Out of the total number of interviewed beekeepers, approximately 80.8% were illiterate, while the remaining (19.2%) could read and write. Traditional practices predominate in the study area because the majority of the respondents hardily understand and accept new technologies. The educational level of farming households is critical for understanding extension packages and the adoption of improved technologies, which in turn determines the community's development. Gichora (2003) stated that for more advanced beekeeping, a good understanding of bee biology and behavior is required for better colony management. Formal education is important for farmers to adopt modern inputs and technologies in the beekeeping sector. Thus, farmers (beekeepers) need to get basic education for the reasons of adopting new technologies. Education is an important factor that if lacking can negatively impact future improved beekeeping and livestock production.

The present result of the study indicated that most respondents in the study area can hardly adopt the extension services and bee-related technologies provided. This higher illiteracy level may also not enable respondents to access relevant information that will stimulate honey production. The higher illiteracy level (83.3%) in the present study is in line with the report of Mahamed *et al.*, (2022) who reported more than 80.8% of the sampled beekeepers of the Erer zone of the Somali region were illiterate.

Table 1: Characteristics of the sampled beekeepers

Variables	Districts (%)		
	Lagahida (n=78)	**Fik (n=78)**	**Overall (n=156)**
Sex			
Male	91.1	92.3	91.7
Female	8.9	7.7	8.3
Age (years, mean±SD)	41.88±8.06	39.83±8.27	40.85±8.20
Educational level			
Illiterate	85.9	80.8	83.3
Literate	14.1	19.2	16.7

SD= standard deviation

Beekeeping System and Beehive Placement

Table 2 shows the types of beekeeping practiced by respondents and the placement of beehives in the study area. According to the investigation, two distinct types of beekeeping were used by the sample respondents in the study area based on their level of technological advancement. As a result, a large proportion of respondents (85.9%) practiced only traditional beekeeping, and the remaining (14.1%) practiced both traditional and movable frame hive beekeeping concurrently. It has also been observed that beekeepers constructed traditional hives using locally available materials and indigenous knowledge and skills. The current study is in line with the report of Getachew (2018) who indicated that a large proportion of sampled households in the Gesha district of Keffa zone practiced traditional beekeeping. The findings of the investigation are also consistent with other findings done in the Central, Northern, and South Western parts of Ethiopia, where traditional beekeeping systems predominate in rural areas (Reda *et al.*, 2018; Gratzer *et al.*, 2021). According to the study, the majority of beekeepers (86.5%) in the study area hang their beehives from trees away from the homestead in dense forest areas. A considerable portion of the respondents (9.6%) kept their beehive in the backyard. Only a small percentage of respondents (3.8%) kept their beehives in the backyard as well as hanging from trees. The predominant honey production system in the study area is based on traditional beekeeping techniques dominated by forest and backyard beekeeping. Beekeepers in the study area prefer to hang their beehives in dense forests far away from residential areas, where there is plenty of bee forage and bee swarms are plentiful and with no human and animal disturbances. The current finding is consistent with the report of Fikru *et al.*, (2015), who discovered that beekeepers in the Jigjiga zone hang their beehives on

trees and used a traditional beekeeping system. The result of the current study is also substantiated by Getachew (2018) who reported that about 55% of beekeepers in the Gesha district of Southwest Ethiopia placed their beehives on branches of the tree in the dense forest far away from their residential areas whereas the 23.1% of the respondents' hang on trees near the homestead and about 1.9% of beekeepers kept beehives in an enclosed area. Hanging and keeping beehives in dense forests which are mostly far away from residential areas might have limited beehive visits to only one or two times until harvesting and unawares about the condition of the site.

Table 2: Type of beehive and placement of the beehives

Variables	Districts (%)		
	Lagahida (n=78)	Fik (n=78)	Overall (n=156)
Type of beehive			
Traditional beehive	89.7	82.1	85.9
Traditional and modern beehive	10.3	17.9	14.1
Placement of the beehive			
Hanging from trees	89.7	83.3	86.5
Backyard	7.7	11.5	9.6
Both	2.6	5.2	3.8

Honey Production

Table 3 shows the average annual honey yield per hive from traditional and modern bee hives in the study area. The average honey yield from the traditional beehives was significantly higher ($P<0.05$) for Lagahida district (4.21±0.68) kg//hive and lower for Fik district (3.10±0.45) kg/hive. The average honey yield from modern beehives, on the other hand, was slightly higher ($P<0.05$) for Fik (10.86±1.74) kg/hive and lower for Lagahida (8.60±1.56) kg/hive. The variation in average annual honey yield per hive from traditional beekeeping in the localities might be attributed to differences in beehive volume and beekeeper skill. The honey value obtained from traditional hives in the current study (3.65 kg) is less than the national average yield (5 kg) and the result reported by Abebe *et al.*, (2007), which states that the average amount of honey harvested per traditional hive in the West, South West, and North Shewa zones is 6.2 kg. Yirga *et al.*, (2012) reported that productivity and overall production increases with the level of management, experience, and area potentiality. On the other hand, the honey obtained from modern hives in the current study (9.73kg) was higher than the 7.14 kg found by Fikru *et al.*, (2015) for the Jigjiga zone of the Somali region. However, it was significantly lower than the average yield of 20 and 22 kg in the Keffa zone, SNNPRS, and in Jimma and Illubabor Zone of Oromia Regional State, respectively (Kiros and Tsegay, 2017; Getachew, 2018).

Table 3: Honey yield (kg) in the study area

Type of beehive	Lagahida	Fik	Overall	P-value
Traditional beehive	4.21±0.68[a]	3.10±0.45[b]	3.65±0.56	0.001
Modern beehive	8.60±1.56[b]	10.86±1.74[a]	9.73±1.65	0.02

Honey Harvesting Practices

Table 4 summarizes the honey harvesting practices of the sampled households in the study area. The majority (79.5%) of the respondents used smoke and fire during honey harvesting (Table 4). Firewood and grasses found around the beehives being harvested were used as smoking materials. The reason for this might be due to the fact that these hives are placed on very tall trees making their harvesting difficult.

The majority (98.1%) of the beekeepers reported that honey harvesting is done at night. This affects honey quality because smoke and ashes from the fire end up mixing with the harvested honey. The present result is in line with the findings of Lomiso (2019), Kebede (2011) and Shenkute *et al.*, (2012) who reported the smoke and fire employed while harvesting honey may dust the honey with ash and the honey may absorb the smoke which causes contamination to the honey. Furthermore, the study revealed that honey is harvested mainly two times a year. The finding of this study is in agreement with Fikru *et al.*, (2015) who reported that, in Ethiopia, there are generally two honey harvesting seasons, the major one lasting from October to November and the second one being from April to June.

Table 4: Honey harvesting practices (%) in the study area

Variables	Districts (%)		
	Lagahida (n=78)	Fik (n=78)	Overall (n=156)
Methods of harvesting			
Smoking	25.6	15.4	20.5

Smoking and fire	74.4	84.6	79.5
Time of harvesting			
Night time	97.4	98.7	98.1
Day time	2.6	1.3	1.9
Harvesting frequency			
Once/year	38.5	30.8	34.6
Times/year	61.5	69.2	65.4

Major Constraints of Honey Production

According to respondents, the major constraints of honey production in the study area are the high cost of modern hives and accessories, pests and predators of honey bees, water scarcity, shortage of bee forage, honeybee absconding, and marketing problem (Table 5). The present study is supported by Yirga *et al.*, (2012), who reported that bee pests, predators, and absconding are major constraints affecting the beekeeping sub-sector in northern Ethiopia. The current study is also consistent with the study of Fikru *et al.*, (2015), who reported that during the field survey, the interviewed beekeepers in Jigjiga zone responded that some bee equipment, such as modern bee hives, wax printers, and honey extractors, are very expensive, and thus beekeepers cannot afford to buy and use of these equipment.

As a result, there is a scarcity of appropriate technologies for production, collection, processing, packing, and storage in the area. Because the majority of the farmers in the study area lacked resources, they were unable to purchase and implement modern bee technologies to increase honey yield.

Table 5: Major constraints of honey production in the study area

Constraint(s)	**District**							
	Lagahida				**Fik**			
	R1	**R2**	**R3**	**Index**	**R1**	**R2**	**R3**	**Index**
High cost of modern beekeeping equipment	31	17	11	0.28	29	27	12	0.31
Pests and predator	12	19	14	0.21	16	10	17	0.19
Water scarcity	8	12	9	0.14	9	8	12	0.13
Shortage of bee forage	7	4	10	0.10	6	7	9	0.10
Absconding of bees	17	13	8	0.18	20	9	11	0.18
Marketing problem	3	6	9	0.08	2	7	6	0.07

Index= [(3 for rank 1) + (2 for rank 2) + (1 for rank 1)] divided by the sum of all weighed constraints as reported by respondents.

Postharvest Handling Practices of Honey

Honey storage duration

Table 6 shows the average duration of honey storage and reasons for storage in the study area. Accordingly, respondents stored honey for different duration of time for different purposes. The majority of the sampled beekeepers (50.6%) do not store their honey; they sell it immediately to their customers in less than one month time after harvest. The length of storage of honey by the sampled beekeepers ranged from less than a month to greater than one year. The beekeepers who store honey from one month to one year do so with the intention to get a higher price for their honey. These groups of beekeepers store the honey they produce till the price of honey rises. Beekeepers that have no critical financial problems keep their honey for an extended period of time to get a better price of honey in the off-season as noted by Abazinab *et al.*, (2017), Alemu *et al.*, (2015) and Yetimwork *et al.*, (2014). Once honey is produced it should be handled properly to maintain its quality for a longer time. Temperature and humidity are the most important environmental factors that can deteriorate the quality of honey. So, the type of container and honey storage place should be carefully selected. Bogdanov (2009) reported that the optimum temperature and relative humidity of honey storage rooms are 10-16oC and less than 65%, respectively. Honey storage containers should be made out of aluminum, stainless steel, and plastic materials (Bogdanov, 2009). The problems observed regarding plastic containers were that they become hot when the environmental temperature rises and that they can be damaged by rats. Moreover, Adgaba (1991) reported that all local containers used in Ethiopia are not appropriate to store consumable honey for a longer time.

Table 6: Honey storage duration and reasons for storage in the study area

Variables	**Districts (%)**		
	Lagahida (n=78)	**Fik (n=78)**	**Overall (n=156)**
Storage duration			

2 days – 3 weeks	48.7	52.5	50.6
1 – 6 months	37.2	34.6	35.9
7-12 months	14.1	12.9	13.5
Reasons of storage			
For better price	79.5	84.6	82.1
For food and medicine	20.5	15.4	17.9

Honey Collecting and Storage Materials

Due to tradition, culture, and availability of materials, containers of honey in Ethiopia vary from place to place (Tessega, 2009). Beekeepers in the study area used plastic containers and tin for honey collection and storage. About 76.95% of the respondents in the study area collect their honey in plastic containers when they harvest it. The second honey-collecting material reported by respondents in the study area was tin (23.05%) (Table 7). However, the aforementioned storage containers were technically not appropriate storage containers and some of the respondents were using unclean collecting or storing materials, like tin which can spoil the honey quality and result in quality deterioration.

Similarly, Lomiso (2019), Kebede (2011), and Shenkute *et al.* (2012) indicated that honey was also collected and stored in traditional containers such as clay pots, animal skin/hide, plastic sacks, and tin. They also reported that honey quality is reduced when stored in traditional containers. Such traditional containers will absorb moisture or may change the flavor of honey and deteriorate the quality of honey during storage. Moreover, Abazinab *et al.* (2017) identified plastic containers, silver metals, earthen pots, and gourd (kil) as the most important containers for honey storage used by beekeepers in Jimma zone of Southwestern, Ethiopia. In addition to this, Alemu *et al.*, (2015) identified gourd (Lagenaria siceraria), earthen pot, plastics, and animal skins as the most important honey storage materials used by the respondents of northern Ethiopia. Yetimwork *et al.* (2014) reported that plastic pots, tin cans, glass, and clay pots were used as major storage containers in the Tigray region.

Tessega (2009) also reported that in the Amhara region beekeepers use plastic sacks, gourds, and animal skin for honey storage. Similarly, Chala (2010) reported that in Gomma districts the commonly used traditional storage containers by beekeepers are clay pots, and containers made of cucumber (kil).

However, according to the findings of Beyene and Verschuur (2014), poor post-harvest handling and inappropriate storage containers often result in poor honey quality.

Table 7: Honey collecting and storage materials (%) in the study area

Honey collecting materials	**Districts (%)**		
	Lagahida (n=78)	**Fik (n=78)**	**Overall (n=156)**
Plastic containers	82.1	71.8	76.95
Tin/barrel	17.9	28.2	23.05

Honey Straining Practices

For the straining process, respondents used straining materials to prevent dead bees and other particles from passing through the sieve to strain their honey to obtain pure honey for sale. The majority (80.8%) of the beekeepers do not strain honey. According to the survey result, only 19.2% of the sampled households strain their honey before sale by simple drainage to remove the beeswax by using hand (13.4%) and sometimes by using a sieve (5.8%) (Table 8). The current finding is in contrast with the finding of Subramanian *et al.*, (2007) who stated that straining is achieved using cloth or nylon bags, which are often cleaned to take away the suspended particles materials. The beekeepers who do not strain honey reported the reason that they lacked straining materials (29.5%), lack of knowledge of straining (9.6%), and lack of both knowledge and materials (41.7%) (Table 8). This is in line with the study of Shegaw and Edimew (2021) who reported that the main reasons for not straining honey among beekeepers in the Kafa zone of SNNPR were lack of awareness, skill/knowledge gap on how to strain, lack of straining materials, small production level, and consumers' preferences. Another study conducted by Bihonegn *et al.* (2017) in the south Wollo zone indicated that lack of awareness, lack of materials, consumers' preference, small production, and consideration as it will reduce the amount of honey were reported to be the major reasons for not processing honey in order of their importance. Similarly, considering as it will reduce the amount of honey (55%), lack of materials (24.5%) and lack of knowledge (20.5%) were listed as the core reasons for not straining honey in Haramaya district (Serda *et al.*, 2015). On the other hand, honey processing is not common in the study area, which indicates the need for extension and development programs.

This is in line with the study of Shegaw and Edimew (2021) who reported that very few beekeepers process their honey using honey extractors in the Kafa Zone of SNNPR and processing of honey at the beekeepers' level is not common in these areas.

Table 8: Honey straining practices (%) in the study area

Variables	Districts (%)		
	Lagahida (n=78)	Fik (n=78)	Overall (n=156)
Honey straining			
Yes	20.5	17.9	19.2
No	79.5	82.1	80.8
Honey straining materials			
Using hand	15.4	11.5	13.4
Sieve	5.1	6.4	5.8
Reasons for not straining			
Lack of straining materials	24.4	34.6	29.5
Lack of knowledge of how to strain	11.5	7.7	9.6
Lack of knowledge & straining materials	43.6	39.7	41.7

CONCLUSION

The majority of beekeepers in the study area practiced traditional beekeeping systems and beehives are hung from long trees in the dense forest far away from the homestead with little observation and management. Honey is collected and stored in plastic vessels and harvested at night time where ashes can mix with the harvested honey. In addition, the beekeepers do not strain honey to remove any floating impurities and unwanted substances. The beekeepers lacked training materials and knowledge of straining. High cost of modern hives and accessories, pests & predators, water scarcity, shortage of bee forage, absconding, and marketing problem are the major constraints of honey production in the study area. The study concluded that the majority of the beekeepers practiced traditional beekeeping systems and improper honey-handling practices. Thus, educating beekeepers about good honey-handling practices and providing them with the necessary training and improved beekeeping technologies is vital. Furthermore, investigations on the implications of poor handling practices on honey quality and from the perspective of public health are also required.

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