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Research Article

Pre-Extension Demonstration of Crude Beeswax Extraction Technology in Ilu Gelan District, West Shewa Zone, Oromia Regional State, Ethiopia

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Abstract

The current bee wax production system remains underdeveloped among smallholder beekeepers due to lack the necessary expertise and methods for processing crude bee wax in Ethiopia. The study was conducted in the Ilu Gelan district with the goal of raising knowledge about the importance of bee wax for income generation. The farmers' research extension group (FREG) was employed to demonstrate the method, with one FREG of 20 beekeepers at each appropriate site (kebele), for a total of 40 beekeepers. Crude beeswax materials, such as broken or dried combs and *sefef*, were used to produce pure bees wax blocks. Data were gathered from primary and secondary sources in both qualitative and quantitative forms. In-depth key informant interviews, focus groups discussion, and observations were used for qualitative data collection. Likewise checklists used for quantitative data. The qualitative data was examined using narrative response and content analysis approaches. Nonetheless, the quantitative data was analyzed using statistical tools for descriptive and inferential purposes. Overall, 58 participants obtained the knowledge required to act as future resources in the study area. The submerged crude beeswax rendering method yielded an average of 3.67 kg and 3.28 kg of pure beeswax from 10 kg of comb wax and *sefef*, respectively. A statistically significant ($P< 0.05$) yield difference was seen between submerged and sack jute methods of crude wax extraction using comb wax. Thus, through education and information sharing, it is essential to ensure technology's long-term survival in potential areas and with more beneficiaries through development efforts.

Keywords

Beekeeping, Beeswax, Submerged, Sack Jute, Demonstration

1. Introduction

Ethiopia has immense potential for honey and beeswax production due to favorable conditions [1-3]. Diversification and value-adding of bee products can help to boost local markets, allowing for additional production and expansion into a larger base of exports. India is the world's largest producer of beeswax, accounting for 25,770 tons or 39.4% of worldwide output in 2018 [4]. Ethiopia comes in second with 5694 tons or 8.2% of global production. This equates to 0.95 kilogram of beeswax per hive every year. Ethiopia is seen as a net exporter of honey and beeswax, according to export and import data obtained from FAOSTAT [4].

In addition to their many drawbacks, traditional hive sys-

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tems have advantages. Increase the amount of propolis and beeswax you produce because they can be sold for more money per kilogram than honey [5-7]. These advantages might be the reason traditional beehives continue to be the most common type in Ethiopia, even if transitional and modern systems produce more honey [8]. Up to 80% of the crude honey is used to make the traditional beverage; the remaining honey is sold as table honey [9-11]. Serda *et al*. [6] state that crude honey is used by *tej* breweries for *tej* brewing; as a by-product, beeswax is extracted from the honey and is of lower quality than other purification techniques. Since they sell the by-product to collectors and beeswax exporters, *tej*-houses are important participants in the beeswax sector [11].

Smallholding beekeepers are the principal sources of beeswax in Ethiopia, selling the majority of crude honey to *tej* brewers, therefore they produce the majority of marketable crude beeswax as a by-product of the beverage [12]. Up to 500,000 tons of honey and 50,000 tons of beeswax might be produced annually in the nation [13]. However, only 47,706 tons of honey and 5542 tons of beeswax are produced at this time [14]. Beekeepers are not processing and adding value to bees wax due to a lack of processing knowledge and market information. The high cost of pure beeswax and its shortage on the market contribute to low adoption of moveable frame bee hives. The production of honey may then be impacted by this circumstance. The Holeta Bee Research Center created submerged beeswax extraction techniques after realizing that beeswax was being mishandled, or squandered, and that no alternative viable methods available for its extraction. Therefore, it is necessary to have complete information on the production, processing, and utilization of beeswax, as well as the value-added products derived from it. The pre-extension demonstration of the submerged beeswax extraction technology was therefore carried out in order to utilize the research area's untapped beeswax potential in a participatory manner.

2. Materials and Methods

2.1. Description of the Study Area

The study was carried out in the Dirki and Saden Ilu kebeles of Ilu Gelan district between 2022 and 2023. Ilu Gelan District is located in the West Shewa Zone of Oromia Regional State, central Ethiopia. The area is located on the main road between Addis Ababa and Nekemte, some 200 kilometers to the West of Addis Abeba. Ijaji is the district's central town, located at 08° 59′51" N and 37° 19′49" E, with an elevation of 1812 m a. s. l. The district is separated into three distinct climate zones: highland, midland, and lowland [15]. The average maximum and lowest temperatures in the district are 32 and 25 degrees Celsius, respectively. The district represents potential area for traditional beekeeping practices and traditional beverage (*tej*) making.

2.2. Experimental Design

Materials were pieces of combs, capping, clean water, pan for wax melting, cotton cloth bag, aluminum bowl to soak wax. Crude beeswax, such as combs obtained from hives that had been broken or shattered, and *sefef*, was collected from *tej* makers. The submerged beeswax extraction method was used to process raw beeswax against Sack jute method.

2.3. Research Approach to Technology Uptake Pathway

Before beginning activity execution, a memorandum of agreement was signed with the Bureau of Agriculture office to ensure that everyone was on the same page about the project's goals and expectations. Beekeepers, researchers, government officials, and honey marketers were all active participants in the project's coordination. Through this endeavor, linkages were created with all relevant parties.

The farmer demonstration groups, or FREGs, were normally formed, with one FREG consisting of 20 beekeepers at each suitable location (kebele); totally 40 beekeepers. Afterward, extension agents and beekeepers acquired theory-based practical training as a future resource for people. Finally, field days was employed for knowledge sharing in wider areas and large communities.

2.4. Methods of Data Collection

Data were acquired from primary and secondary sources in both qualitative and quantitative forms. A range of methodologies were used to collect both qualitative and quantitative data, including in-depth key informant interviews, focus groups, and observations for qualitative data, as well as a semi-structured questionnaire (checklists) for beekeepers interviews. Secondary data came from published and unpublished documents.

2.5. Statistical Data Analysis

The narrative of response and content analysis approaches were used to scrutinize the qualitative data collected from focus group discussions, observations, and key informant interviews. Nonetheless, the collected quantitative data was examined using statistical tools for descriptive (frequency %) and inferential analysis (mean).

3. Results and Discussion

3.1. Training on Beeswax Rendering

Developing smallholder beekeepers' knowledge and abilities in beeswax resource collecting, handling, processing, quality assurance, and marketing is vital. Before the demonstration of beeswax processing using submerged method,

beekeepers were asked if they had a thorough knowledge or not. Then, smallholder beekeepers and bee experts received twice as much practical instruction. The technology's use was demonstrated using a method-based demonstration approach. Knowledge exams were administered to technology participants to ensure that they understood how to use it. The majority got the necessary basic knowledge of beeswax rendering. The project attracted more women because the technology is appropriate for female beekeepers. Overall, 58 participants gained the necessary knowledge to serve as future resources in the region (Table 1). Training participants were allowed to make foundation sheets out of processed beeswax (Figure 1). Its implications could have various advantages, such as supplying printed wax sheets to neighboring beekeepers and using them for their moveable frame hives.

Table 1. *Training participants by sex composition.*

No	District	kebele	Training participants						Total
			Farmers		Development agents		Bee experts		
			Male	Female	Male	Female	Male	Female	
1	Ilu Gelan	Saden Ilu	4	16	4	2	4	2	32
		Derki	6	14	4	2			26
	Total		10	30	8	4	4	2	58

Source: Own data 2024

Figure 1. *Practical training for bee wax rendering.*

3.2. Bees Wax Sources and Practices in the Study Area

The common raw products for bees wax production in Ethiopia are crude honey, combs, capping, and *sefef* (by-product of *tej* breweries). The crude beeswax like dried comb, or broken comb and *sefef* were employed for this study due to the presence abundance of sources in the region. Comb was collected from dried comb, or broken comb from beehives (Figure 2a). *Tej*, or honey wine, is an important part of Ethiopian culture and is comparable to mead. For the purpose of brewing *tej*, *tej* breweries use crude honey; as a by-product of this process, beeswax (*sefef*) was separated, although its quality is poorer than that of other purification methods [6]. The bulk of crude honey comes from smallholder beekeepers who only receive a small portion of the beeswax money that came with beekeeping. Most beekeepers discarded unrefined beeswax. They were unaware of the importance of beeswax, coupled with a lack of techniques and knowledge to extract crude beeswax in the area. This is due to a lack of "good beekeeping practice" among beekeepers [16]. As per CSA [8], the majority of Ethiopian beekeepers (96%) continue to engage in traditional beekeeping methods. This phenomenon makes it possible to produce large amounts of beeswax from conventional hives. The yield of beeswax from traditional hives is 8–10% of the honey yield, while modern hives yield only 0.5–2% [17]. It suggests that Ethiopia has more to offer the world's beeswax production than it now does. Negash and Greiling [18] anticipated the yearly potential to be ten times bigger, or fifty tons.

3.3. Rendering Crude Beeswax

The quality of beeswax is determined by the production methods and raw materials utilized. During the study, smallholder beekeepers were shown how to extract crude bees using the submerged and sack jute beeswax extraction method with 10 kg each of *sefef* (Figure 2b) and combs (Figure 2a). The submerged beeswax extraction process is ideal for smallholder beekeepers and yields more wax than sack jute crude beeswax extraction method. A number of procedures were used to render beeswax. Capping, chunks of wax, and relatively white to yellow colored combs were separated from old combs since the newer combs produce better-quality wax than old comb. Older, darker combs with massive pollen packs produce less beeswax [19].

a. Sourcing of comb wax

b. Sefef- by-product of *tej* breweries

Figure 2. *Bees wax sourcing and sorting.*

To soften comb, first sort comb beeswax until it is clear of dirt, dead bees, or their excrement. Similarly, contaminants such as trash, dead bees, and dirt particles were eliminated from *sefef*. Then, soak it in water for 24 hours to remove contaminants. High-quality beeswax was then obtained by washing it in pure water to get rid of contaminants. The combs or *sefef* were then broken into small pieces and put inside a clean bag cloth (Figure 3a). The wax-tied cotton cloth was left to soak in a pan of clean water until twice as full as before, and the wax mixture was gradually heated while being stirred constantly until the wax melted (Figure 3 b). The wax began to filter through the bag cloth, rising to the surface. Melted wax (cream) is poured from the boiler into the aluminum bowl after it has been stirred with a stick to cause the wax to float to the top [20]. This process was repeated repeatedly until all of the wax had melted (Figure 3c & 3d). Ultimately, the mixture of water and wax was allowed to cool, the wax cake was taken out, and all relevant

information was gathered [21].

Figure 3. *Bee wax melting and processing.*

The submerged and sack jute crude beeswax rendering process produced an average of 3.67 kg and 3.28 kg of pure beeswax from 10 kg of comb wax, respectively. In contrast, 2.33 kg and 2.14 kg of pure beeswax were recovered from 10 kg of *sefef*. Table 2 indicates a statistically significant difference in yield between submerged and sack jute methods ($p < 0.05$) using comb. Whereas no statistical difference was observed between submerged and sack jute method using *Sefef*. The color of processed wax obtained from comb was comparatively brownish and bright yellow, owing to colorants derived from pigments, propolis, and pollen [22, 19]. It also has a pleasing taste. It suggests that comb produces more beeswax and of higher quality than *sefef*. Furthermore, most beekeepers benefit from comb wax production if they use the method. The submerged bee wax extraction method is simple to anyone who is capable, as it can be operated by one person, as opposed to the sack jute extraction method, which requires more strong persons to squeeze out melted wax. The traditional beeswax pressing method (sack jute) causes to a 47% (33.1 kg) loss of pure beeswax [19]. However, melting all of the crude wax takes longer using submerged method than sack jute.

Table 2. *Mean yield of bees wax from sefef and comb using submerged and Sack jute.*

Extraction method	Beeswax materials (kg)			
	Comb	T-test	Sefef	T-test
Submerged	3.67	2.042*	2.33	3.61^{NS}
Sack jute	3.28		2.14	

* Significant at $P<0.05$, NS refers to non significant

3.4. Beeswax Marketing

Much of Ethiopian bee wax production is fragmented, with individual entity producing in small batches for processing for either mainstream local markets or export. Surplus pure beeswax production for market purposes remains underdeveloped among smallholder beekeepers due to several reasons. In certain places, beeswax production is not recognized as an income-generating business. The vast majority

of beekeepers sold crude honey to *tej* producers, who partially processed beeswax. Furthermore, beekeepers faced challenges in terms of expertise and techniques for processing crude bee wax. As a result, the project was initiated to address the issues. The 'Bounty of the Basket' initiative supports Ethiopia's honey production using modern procedures that require pure beeswax. Adoption of pure bee wax production heals beekeepers fail to use moveable frame hives due to a scarcity of pure beeswax. A kilogram of pure blocks of beeswax costs approximately 550-650 ETB (10-12 USD, 2023) in local markets. A scarcity of pure beeswax contributes to the high price on the local market, while other aspects remain constant. It means that teaching the majority of smallholder beekeepers to make beeswax can assist to counteract high inflation. It also provides additional income throughout the interim time, especially for low-income groups (youth and women). Domestic demand for beeswax is significant, particularly during religious festivals to make '*tuaf*' and candle.

Furthermore, they create opportunities for local bee wax collectors and suppliers to sell to the global market. Ethiopian honey and beeswax have the potential to be very attractive to export markets due to their minimal pesticide consumption [23]. Field observations reveal that smallholders rarely engage in fraud or adulteration of beeswax with low-cost ingredients. As a result, investing in smallholder beekeepers to manufacture beeswax could help diversify beekeeper income while also increasing Ethiopia's potential to export beeswax.

3.5. Exit Strategies for Ensuring Technology Sustainability

In general, technologies and knowledge that would boost beeswax production and farmer revenue would be given to a wider range of stakeholders. Thus, beekeepers in beeswax potential locations, beeswax collectors and suppliers will benefit from increased bee products. As a result, it is critical to ensure the long-term viability of technology in wider areas and with more beneficiaries. Farmers, non-governmental organizations, and relevant government agencies, for example, who work in potential areas where technology could be expanded, got training. Additionally, beeswax producers were encouraged to maintain their high-quality, high-volume honey output. Targeted beekeepers were also given advice on how and where to sell their extra bees wax.

4. Conclusion and Recommendation

The current bee wax production system remains underdeveloped among smallholder beekeepers, as the majority do not consider beeswax as a source of revenue and lack the necessary expertise and methods for processing crude bee wax. As a result, a significant amount of crude beeswax is wasted by smallholder beekeepers. Knowledge and information sharing with smallholder beekeepers increases bee wax production, diversifies beekeepers' income, and generates foreign exchange. Beekeeping extension services assist clients in gaining insights into how to produce high-quality, high-volume bee wax. Smallholders rarely commit fraud or adulteration of beeswax with low-cost substances. Improvement has occurred among target beekeepers. The submerged bee wax extraction method is cheap since it produces greater output of good quality. Adopting the submerged bee wax process is crucial for increasing production and income. Therefore, it is vital to secure the long-term survival of technology in broader potential areas and with more beneficiaries through training and knowledge exchange. Regional bureaus of agriculture, non-governmental organizations, and relevant government agencies, for example, can encourage technology scale up in possible areas for expansion.

Abbreviations

CSA	Central Statistics Agency
EEPA	Ethiopian Export Promotion Agency
FAOSTAT	United Nations Food and Agriculture Organization Statistics
FRED	Farmers' Research Extension Group
ILRI	International Livestock Research Institute
MoA	Ministry of Agriculture Ministry of Agriculture
SNV	Netherlands Development Organization
USD	United States Dollar

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Author Contributions

Lalisa Wendimu Biyena is the sole author. The author read and approved the final manuscript.

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declared no conflicts of interest.

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Biography

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