

Determination of the proportion of pure beeswax recovered from crude beeswax resources at local honey wine making houses in Ethiopia

Abstract

Ethiopia is among the top four beeswax producing countries and this is considerably attributed to the predominantly traditional system of beekeeping production, which has relatively higher beeswax products per hive. In terms of foreign market, honey and beeswax, are among the main livestock products of the country exported to the international market. Based on the existing situation of the country, there are different sources of crude beeswax which include but not limited to left over from honey wine making houses, old and broken combs and the residue of honey purification process. The main source of crude beeswax that used for the processors and export companies is the crude beeswax produced and collected from the local honey wine making houses. Due to the absence of enough information on the recovered percentage of pure wax in particular after processing of bees wax collected from honey wine making house left over, there is always a dispute between the internal revenue and custom authority and beeswax exporters on the level of pure beeswax extracted from the crude source for taxation purpose. Therefore, the objective of this research was to investigate the percentage of pure beeswax recovered from crude beeswax extraction when the wax resource is from local honey wine making house left over.

To implement the proposed research the representative crude beeswax samples were collected across honey and beeswax potential regions at 42 sites of the four regions which were bulked into 17 samples by homogenization and the samples were extracted by using two techniques, manual and mechanical methods. The percentage of pure wax recovered from 5kg of crude beeswax from local honey wine making houses left over was varied from 30 to 37.0% with mean of 33.5% using manual extraction methods and 12 to 32% with mean of 22% using mechanical method. The average percentage of pure wax recovered from crude wax from local honey wine houses left over by using both extraction methods is 33.5% and 22%, respectively with an average value of 27.75%. On the other hand, the chemical parameters results indicated that, all of the values for all the samples fall under acceptable ranges and standards except the total volatile matter which is greater than the required standard level. Therefore, based on these findings, it is proposed that the bees wax processors and exporters to pay the required tax based on the indicative research result and type of extraction method used. Further studies on identification of the optimum temperature and time required in heating crude beeswax for extraction process and study on other beeswax sources should also be evaluated for the rate of extraction of pure beeswax as compared to the current one which will give a broad spectrum about the extraction rate of beeswax in the country.

Keywords: beeswax, extraction, honey wine, recovered

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Yeshitela Eshete,¹ Demelash Zelalem,¹ Hana Tadesse,¹ Tigist Lemma,¹ Tekeba Eshetie,¹ Taye Negera²

¹Ethiopia Meat and Dairy Industry Development Institute, Ethiopia

²Holetta Apiculture Research Center, Ethiopia

Correspondence: Tekeba Eshetie, Ethiopia Meat and Dairy Industry Development Institute, Meat, Honey and Feed Processing Industry National Coordinator, PO box 1573, Bishoftu, Ethiopia, Tel +251919354278, Email tekebanega@gmail.com, tekebanega@yahoo.com

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Introduction

Beeswax is a natural wax produced by honey bees of the genus *Apis*. The wax is formed by worker bees which secrete it into “scales” from eight wax-producing mirror glands on the inner sides of the ventral shield or plate of each segments of the body on the abdominal segments. Beeswax is a valuable product that can provide a worthwhile income in addition to honey. One kilogram of beeswax is worth more than one kilogram of honey.¹

Ethiopia has plenty of honey and bees wax ready to meet the growing demand of both products.² The country has the potential of producing up to 500,000 tons of honey and 50,000 tons of beeswax per annum.² Due to high population growth, urbanization and economic

growth there is large and growing demand for honey and other bee products worldwide since it has nutritional and/or medicinal values.³

Beeswax largely collected from honey that produced from traditional hives rather than the modern hives. The bulk of the supply of beeswax obtained as residual from “Tej” production, a mild alcoholic beverage popular throughout Ethiopia. The quality of beeswax could deteriorate and its natural composition could alter because of adulteration and prolonged overheating. Under local conditions deterioration of beeswax quality due to overheating from processing is highly likely to happen; some of the processing facilities are not suitable to regulate the optimum temperature during processing.⁴ Because of its high demand and shortage in the world market, its adulteration with cheaper materials became a challenge for

its quality and marketing. In Africa, adulteration of beeswax with dark and sticky *Trigona* (Meliponidae) wax has been reported.⁵ Such wax is of little value in most industrial and beekeeping applications, since the resins are difficult to remove.² Beeswax should only be stored in its rendered, clean form. Before rendering, it will quickly be attacked by wax moths, which are able to destroy large quantities of wax in short periods of time.⁶

The melting point of beeswax is not constant since the composition varies slightly with its origin.⁷ It has relatively low melting point range of 62°C to 64°C (144°F to 147°F), and if beeswax is heated above 85°C (185°F) discoloration occurs.¹ Beeswax from Ethiopia has higher demand and also earns higher price in EU, which is mainly used for blending low quality beeswax from different sources.⁴

Beeswax is supplied to the export and domestic market for various applications. Of the total production of wax produced, the major part is utilized for the traditional production of candle, which is called “twaf”.⁴ Studies made by IPS some years back indicate that about 750 tons of bees wax is utilized for the production of ‘twaf’ consumed mainly by about 25,000 Ethiopian Orthodox Churches. In addition more than 220 tons of wax is consumed by existing candle producing enterprises.⁴ The reliable data on the domestic production of beeswax are not available since it is produced at small-scale levels, mostly homemade. Wax is used in hundreds of applications around the world. According to the above source global consumption of wax is expected to grow at an average annual growth rate of more than 2% from 2010 to 2020 but the supply is becoming insufficient. Hence, this indicates that there is a wide export market for the product if it is supplied in the required quality and quantity. During the first Growth and Transformation Plan (GTP) period, Ethiopia exported a total of 5641.4 tons from honey and wax and collected 26.773 million USD.⁸

Longer heating or higher temperatures lead to greater degradation and loss of hydrocarbons.⁹ These changes also influence the physical characteristics of the wax.¹⁰ Thus, excessive heating during rendering or further processing changes the wax structurally and alters the beneficial characteristics. Investigation for the causes of beeswax quality deterioration is very important to identify weather due to adulteration or inappropriate heating during processing.

Although the country has a large potential to produce beeswax and huge global demand, there is always unmet demand and limited benefits. The beeswax resources that processors and exporters companies used to extract was collected mainly from the local honey wine making houses. However, there is not enough information on the percentage or amount of pure wax recovered from the crude beeswax resources. As a result there is a series dispute between wax export companies and Ethiopian custom authority during taxation. Due to this disagreement, sometimes there is a delay in beeswax export schedule and the exporter companies raised as it is due to lack of good governance. Therefore, this research is conducted to investigate the percentage of pure bees wax recovered from the crude beeswax sources from local honey wine making houses.

Specific objectives

- i. To determine the amount of pure wax recovered from crude bees wax resources that collected from local honey wine making houses.
- ii. To determine the quality of the extracted bees wax products
- iii. To avail the generated information to the concerned stakeholders
- iv. Evaluation of honey wax extraction methods

Materials and methods

This research has been conducted with the collection of representative crude beeswax samples from four bees-wax production potential regions in Ethiopia. The representative samples were collected from 42 sites found in Amhara, Oromia, SNNP and Tigray Regions which can represent the potential areas of local honey wine making houses in the country.

After collection of the samples, it was dried and prepared through scientific way in order to make it available for processing or extraction. Homogenization and coding are among actions done before extraction processing proceed. All of the samples collected from 42 sites of the four regions were bulked into 17 samples during homogenizing process. The samples were categorized into manual and mechanical methods to examine the efficiency of two methods of extraction. Five kg of crude beeswax samples were used for both mechanical and manual extraction methods.

The samples were collected from the local honey wine making houses which they were prepared to sale for their clients. These samples were collected in plastic bags of size of 2kg and grouped into fiber made sack of 50kg size. It was brought to Holeta Apiculture Research Center for further preparation and extraction processes. Then the samples were grouped for manual and mechanical extraction methods.

Chemical quality parameters of the collected samples

The purified bees wax samples was investigated for chemical quality parameters of melting point, saponification cloud point, acid value, ash value and total volatile matter. The analyses were conducted based on the protocol of national & international standards at Ethiopian Conformity Assessment Enterprise laboratory. Pure beeswax recovery percentage variation were identified between the mechanical and manual methods of crude beeswax extraction, the significance of the variation is analyzed independently.

Sampling method

The sample collection was carried out for twenty five consecutive days. The representative samples were taken up from the bulk crude beeswax products that were found at randomly selected local honey wine making house warehouses. For this study, 71 representative crude beeswax samples with an average weight of 1.2kg were collected from different local honey wine making houses in four regional state of Ethiopia. During sample collection further information's on the bees-wax production, handling, and marketing situation were identified.

Data management and statically analysis

Descriptive statistics were used to analyze the data and to compare their mean values.

Result and discussion

Level of bees wax recovery using different methods

During the study period the samples of crude beeswax was collected from different local honey wine making houses (teji) and the prices of the *crude wax* at the local market of the study areas were varied from place to place. The variation ranges from Birr 40.00/kg to Birr 70.00/kg of crude beeswax with mean of Birr 55.00/kg. The reasons for the rising of the price could be due to the recent involvement of cooperatives and unions in purchasing of crude bees

wax, the initiation of some investors to involve in collecting and processing of crude beeswax into a pure wax and involvement illegal traders.

The quality of crude beeswax resources that produced at local wine making houses was vary from place to place and most of the crude beeswax were identified as low quality this is due to an appropriate post harvest management and handling practice. The percentage of pure wax obtained from 5kg of crude beeswax was varied from 30 to 37.0% with mean of 33.5% using manual extraction method, depending on the quality of crude beeswax (Table 1). Using mechanical method of extraction the percentage of pure wax recovered from 5kg crude beeswax was also varied from 12 to 32% with mean of 22% it depends on the efficiency of the device used for extraction, the quality of crude beeswax and the amount of *crude beeswax* used for per extraction (Table 2). The cumulative average percentage of pure bees wax recovered from crude beeswax by using manual and mechanical method of extraction was 27.75%.

Table 1 Pure wax recovery from crude beeswax with manual extraction method

Region	Sample code	Initial wt/kg	Final wt/kg	Ave. level of recovery
Amahara	1	5	1.5	
	2	5	1.62	
	3	5	1.55	
			1.56	31.2
Oromia	1	5	1.59	
	2	5	1.6	
	3	5	1.64	
			1.61	32.2
Tigray	1	5	1.6	
	2	5	1.61	
	3	5	1.64	
			1.61	32.2
SNNP	1	5	1.85	37

Quality parameter analysis of the extracted beeswax

The melting point of the extracted beeswax samples were varied from 64.48°C to 64.65°C with mean of 64.5°C (Table 3). In this test out of 17 samples all of them met the acceptable range of beeswax melting point (61-66°C). The Saponification cloud point test results of collected samples were varied from 93 to 94.42 with mean of 93.6 (Table 3). The result for 17 samples tested for saponification cloud point indicated that all are within the acceptable range (80-105). The acid values of the tested samples were varied from 20.2-20.86 with mean value of 20.5 which is also within the acceptable range when it comes to beeswax quality parameters. The ester values of the test results were varied from 72.79- to 73.5 with mean of 73.1 (Table 3). In these test all samples met the standard of ester values, which range 70-80. The total volatile matter of the tested samples were varied from 1.19-1.98 with mean value of 1.51. As opposed to other chemical parameters, the results for all tested samples for total volatile matter indicated that, they all fail to meet the standard requirement which is 0.75 is the max value (Table 3).

Table 2 Pure wax recovery from crude beeswax with mechanical (device) wax extraction method

Region average	Sample code	Initial wt / kg	Final wt/kg	Ave. level of recovery
Amahara	1	5	0.6	
	2	5	1.3	
	3	5	1.1	
			1	20
Oromia	1	5	0.9	
	2	5	1.6	
	3	5	1.2	
			1.2	24
SNNP	1	5	1.5	30

The ash values of the test results were varied from 0.051-0.064 with mean of 0.05 (Table 3). In these test all of the 17 samples met the standard ash values, which is 0.20 max requirements. All of the extracted pure beeswax samples and tested to investigate chemical quality parameters was met the national and international quality standards, except the total volatile matter as indicated in (Table 3-5).¹¹⁻¹⁵

Table 3 Comparison quality with in test result mean and standard requirement

Serial no	Parameters	Test result mean	Standard requirement
1	Melting point	64.5	61-66
2	Refractive index at 75	1.441	1.4400-1.4450
3	Ash% by mass	0.05	0.20MAX
4	Total volatile matter % by mass	1.58	0.75 MAX
5	Acid value	20.5	17-24
6	Sopnification value	93.6	85-105
7	Easter value	73.1	70-80
8	Fats and fatty acids	To pass the test	Pass

*All the samples tested at Ethiopia Conformity Assessment Enterprise (ECAE).

Table 4 Quality Comparison with in test result mean and standard requirement/manual extraction

Serial no	Parameters	Test result mean	Standard requirement
1	Melting point	64.65	61-66
2	Refractive index at 75	1.44089	1.4400-1.4450
3	Ash% by mass	0.051	0.20 Max
4	Total volatile matter %by mass	1.194	0.75 Max
5	ACID value	20.287	17-24
6	Sopnification value	93.102	85-105
7	Easter value	72.794	70-80
8	Fats and fatty acids	To pass the test	Pass

Table 5 Comparison quality with in test result mean and standard requirement mechanical extraction

Serial no	Parameters	Test result mean	Standard requirement
1	Melting point	64.48	61-66
2	Refractive index at75	1.441	1.4400-1.4450
3	Ash% by mass	0.064	0.20 Max
4	Total volatile matter %by mass	1.98	0.75 Max
5	Acid value	20.8	17-24
6	Saponification value	94.42	85-105
7	Ester value	73.5	70-80
8	Fats and fatty acids	To pass the test	Pass

Conclusion

Beeswax is valued according to its purity and sometimes its color - light wax (from new combs) is often more highly valued than dark wax (from old combs). The presence of pollen, propolis and impurities can cause the beeswax to become yellow. It will also darken with age so it is better used or sold as quickly as possible.

Processing and marketing of beeswax is an attractive business in Ethiopia. So processors and exporters should be encouraged to properly handle their beeswax for proper market need and its sustainability. The initiation in collecting, processing, storing and selling of beeswax by export companies is advantageous not only for the local honey wine making business, but also for all actors along the value chain including processors and exporters. The manual crude wax extraction method is time consuming and labor intensive but when it comes to the amount of pure wax recovered from the crude wax it is better than the mechanical crude wax extraction method. Whereas, the mechanical wax extraction method is less time consuming, low labor intensive as compared to manual extraction method.

According to this study, the percentage of pure wax obtained from 5kg crude beeswax was varied from 30 to 37.0% with mean value of 33.5% and the percentage of pure wax obtained when the manual extraction method was used but the value ranges from 12 to 32% with mean of 22% using when mechanical method of extraction applied. The variations of yield obtain between manual and mechanical wax extraction methods were significant. The presence of significant variation in wax yield between manual and mechanical method was due to the amount of residue, other foreign materials and handling of crude beeswax and of extraction, and efficiency of the device. The beeswax samples collected and tested for relevant beeswax quality properties met the requirements of national and international beeswax standards. However, the study revealed that all samples failed to meet total volatile matter of the national and international standard, which mainly due to inappropriate heating of the crude beeswax in high temperature.

Recommendations

a) From this investigation the average percentage of pure wax recovered from crude beeswax resource by using manual and mechanical method of extraction is 33.5% and 22%, respectively,

with cumulative average of 27. Hence, it is proposed that the bees wax processors exporters to pay the required tax based upon the indicative research result.

- b) To minimize the wastage of crude beeswax due to mishandling, awareness creation and training skills should be required on crude beeswax collection, storage, extraction and handling system development.
- c) Further studies on identification of the optimum temperature and time required in heating crude beeswax for extraction and purification should required.
- d) Research review to investigate the crud wax wastage due to mishandling in particular at local honey wine making houses is important.
- e) Other beeswax sources should also be evaluated for the rate of extraction of pure beeswax as compared to the current one which will give a broad spectrum about the extraction rate of beeswax in the country.

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None.

Conflict of interest

Author declares no conflict of interest.

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