Performance Testing of Solar Wax Melters

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Abstract
Solar wax melter is a glass-covered box which uses the heat of the sun to melt bees wax for the purpose of separating it from honey and other materials. On the bases of its simplicity in operation, low-cost, and effectiveness, it is a useful device appropriate for all beekeeping management systems. For generating first hand information on the usefulness of the device, two melter models were tested; one is imported from abroad while the other was made at Bahir Dar Agricultural Mechanization Center. Test was conducted at the center (on station) and at Dangila town (on farm). According to the result, the imported model can melt two kilograms of crud wax in 3:05 hours time and deliver about 780-gram pure wax at an average temperature of 64.85 C^o. Similarly, the fabricated model can melt 4 kilograms of crud wax in 5: 40 hour time and deliver about 1.35 kg pure wax from it. On both models the tusk was handled by one-person at on-and-off working condition. On the other hand, when traditional melting method was investigated, it was observed that, by melting 22.75 kilograms of crud wax within 2:02 hours time, it delivered 11.5 kilogram of pure wax at a temperature of 87.65 ^OC. But the wax obtained by this method was not as attractive for bees as obtained from other models. Cost-Benefit ratio analysis was also used to compare the economical benefits of each melting method. Based on the overall test results solar wax melter with translucent plastic cover was found better than other melting methods in out put even if its benefit is a little less than the fabricated one. It is, therefore, recommended to introduce this technology.

Introduction

Wax is one of the products of bee keeping process. Its use is diverse; used in the manufacture of cosmetics, candles, medicines, floor polish, and leather waterproof. It is also important for making foundation sheet for improved hives. Ethiopia is 1st in Africa and 10th in world in production of wax. The country has more than 10 millions of honeybee colonies with estimated annual production potential of 24000-ton honey and 3000 metric tons wax. Out of the total wax production, the country exports 9%, this is about 270 metric tons annually. Even with this marginal amount the country is considered one of the 12 major exporters of wax products obtaining 360-480 million ETB annually (HBRC study paper 2002).

In the case of Amhara region, estimates show that there are around 610,830 bee colonies with an estimated annual production potential of 3054.15 tons of honey and about 763.54 tons of wax (SOS, 1993).

The quality of bees wax is to be judged from its color and purity. Light colored wax has the highest value. This can only be obtained by careful melting procedures using improved technologies (Beekeeping in the tropics, 1997). There were different attempts world wide to develop and introduce small-scale solar wax melters. In our country, some NGOs as Small Dairy Development Project (SDDP) and Selam Vocational Training Center have tried to import this technology to introduce for users. However, much has not being done so far and technologies are not yet tested and distributed to the end users widely.

Solar wax melters are useful, low-cost, and effective tools appropriate for all beekeeping management systems. A wax melter allows the beekeeper to begin the process of rendering the wax, thereby facilitating wax moth control. Furthermore, the solar wax melter can economically handle small quantities of wax encouraging the saving of beeswax. It is also handy for removing beeswax from excluders. The melter also produces high quality product and eliminates the need for sometimes-hazardous job of extracting wax in the home. Therefore, there is a need to assess and test existing small scale wax melters that could be easily utilized and introduced for beekeepers of the region. This project is therefore conducted for the purpose of evaluating the performance of available solar wax melters and develops necessary information regarding their use at small-scale level.

Materials and Methods

Two solar wax extractor models, one obtained from Amhara Region Bureau of Agriculture (imported type) (Figure1) and the other adopted from internet and fabricated in the center (Figure2), were used with two replications. The models were first tested at the center to observe their performance and determine their optimum holding capacity. Detail specification of tested materials is shown on table 1.

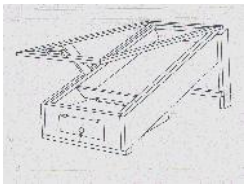

Figure1. Imported model wax Milter

Figure2. Photographic view of fabricated model wax Milter

Table1. Some technical information of tested solar wax Milters

	Solar wax melter models	Overall dimension	Weight (kg)	Production cost (Brr.Eth.)
1	Imported model	75cm x40cm x 15cm	12	185.00
2	Fabricated model	72cm x 60.96cm x 52.70cm	25	251.00

Bees wax is traditionally melted by mixing the wax with hot water in iron pot and then by squeezing the hot water and wax mixture with two persons. It is usually processed in 'Tej' houses as well as in established bee and bee product marketing Associations. When the wax is melted in this manner locally, its purity and quality for export market and for improved hive purpose is not consider. Wax normally melts at temperatures between 63 ^{0}C and 65 ^{0}C while milting water reaches temperature of 70^{0}C - 80^{0}C readily, resulting in overheating of the wax. Over heated or burnt wax is worthless. Besides, wax that has melted in iron or zinc pots looses its smell and color.

Pre-heating of the insides of solar milters was observed necessary before wax is admitted to milting box and each model was pre-heated for about 15 minutes before any test is conducted. The amount of wax loaded to each melter was limited by their floor area, keeping equal depth for each (10 cm depth/thickness layer of the wax in the pan). Based on this observation and their volumetric size, two kilogram of wax for imported one and four kilogram for the fabricated one is optimum amount and used throughout the test runs.

Labor used for these melters was one person at on- and-off working condition. After sufficient preliminary tests were done in the center, the technologies were tested on-farm at Dangila and BahirDar town with users (Bee Product and Market Associations Centers). Participants were first trained on how to use the solar melters. Participants also put their suggestions regarding the melters based on their purity, time, labor, simplicity and out put per day. Personal observations, participant comments and suggestions were also collected and included in the report. In addition, data from local melting method on the respective associations has been taken.

The temperature inside the milters before the wax is added and after the wax is completely melted was measured by portable digital thermometer. Knowing that bees would like to land on the wax which has attractive smell and acceptable wax quality than that which has lower quality, the attractiveness of the wax was tested by observing bee's reaction towards the product. Values of accessories material used for each melting method were estimated from current price study, service life estimated and depreciation or service cost calculated. Lastly, cost-benefit analysis has been carried out using benefit-cost ratio method by considering all involved costs, material, accessories, and labor costs.

Results and Discussions

After complete melting is carried out, the inside temperature in the melters was 33.15 ^{o}C for imported model, 28.25 ^{o}C for fabricated model, and 95.0 ^{o}C for local melting methods. This clearly shows that the temperature in traditional milting system is so high to cause some quality and material loss in this system.

Table 2 On-farm test result using the three wax extracting methods

No.	Tested parameters	Treatments tested		
		Imported wax melter	Fabricated wax melter	Traditional melting method
1	Crude wax used for the test (kg)	2	4	22.75
2	Milting time (hr)	3.08	5.67	2.17
3	Pure wax extracted (%)	39%	34%	50%
4	Impure wax after extraction (%)	36%	59%	14%
5	Amount of volatile (%)	25%	7%	36%
6	Temperature of the melted wax (^{o}C)	64.85	64.00	87.60

According to the test result (table 2), the imported model can melt two kilograms of crud wax in 3:05 hours time averagely and has given about 780 gm pure wax, which is 39% of the total with an average temperature of 64.85 ^{O}C. While the fabricated model can melt four kilo- grams of crud wax in 5: 40 hour time and delivered about 1.35 kg (34%) pure wax. One person was required at on-and-off working condition on both models.

In the case of traditional melting method, it was observed that when melting an average of 22.75 kg of crude wax, 2:10 hours were required and 11.5 kilo-grams (almost 50%) has been recovered as pure wax. However, three laborers were needed with continuous and un-interrupted follow up until the melting is finished. The wage paid for the laborers in the traditional system was two birr for a kilogram of pure wax extracted in the form of contractual payment.

As observed during traditional wax milting procedures, the crude wax was added into the milting barrel filled with hot water which is pre-heated for about 42.5 minutes. The water temperature rose to an average value of 95 ^{o}C and lowered to 87.65 ^{o}C after the wax is added. This process takes about 2:10 hours. The wax stays on the fire until the workers complete squeezing the melted wax. Squeezing takes about fifty minutes, on the average, to complete the given amount of wax. This has shown that local melting method consumes much fuel wood, about 1.25 average man loads, costing eight Ethiopian Birr.

The wax melted in this method has no attraction for honeybees as compared to that of the wax milted by solar melters. It was observed that quite few bees landed on this wax while many bees have landed on the solar milted wax. The color of traditionally melted wax was brown and its smell was that of burnet candle.

One big and eight small plastic bowls, plastic jog for fetching the molten wax, one half barrel, bucket for holding water, around five 'fertilizer bags' and fuel wood are important accessories used during local melting methods. Besides, three persons, one for pouring the molten wax on to the bag and the other two for squeezing it, were required throughout the squeezing time. The estimated service year of the materials (barrel) and accessories is given in the table below (Table3). Estimated service life of the solar melter is also indicated on the table.

According to the data shown in the table above, the imported model has shown 15% more efficiency than the fabricated one. This difference was due to the nature of the glazing used in the melters. The imported model is covered with non-crystalline polystyrene plastic glass, which has excellent transparency and greater refractive index (1.59) than soda lime/common glasses glazing. However, the fabricated one was covered with common glass, which has lower transparency and refractive index (1.51) than the imported one.

Table3 Estimated service life of the materials and accessories

Materials and accessories	Cost (Br)	Total service delivery through out the life	Depreciation per service delivery or service cost (Br)
Imported wax melter	185.00	300 (10yr & 30 services/ yr)	0.62
Fabricated wax melter	251.00	150 (5yr & 30 services/yr)	1.67
Barrel	120.00	5 service only	24.00
Big plastic bowl	60.00	20 service	3.00
Medium plastic bowl (# 8)	200.00	20 service	10.00
Plastic jog	6.00	6 service	1.00
Bucket	30.00	90 service	0.33
Bag (fertilizer) # 6	12.00	3 service	4.00

Remark: - *Solar wax melters use only a plastic jog as an accessory.*

Table 4 Benefit-cost ratio for each melting method (based on unit base)

Types of melters	1 Unit cost	2 Benefit per unit	3 Benefit-cost ratio 2÷1	4 Net benefit (2) - (1)
Imported wax melter	14.58	42.00	2.88:1	27.42
Fabricated wax melter	13.56	42.00	3.10:1	28.44
Traditional wax melting method	16.49	40.00	2.43:1	23.51

Table 4 shows the cost-benefit comparison of the three melting methods. The result indicates that fabricated wax melter has the greatest B-C ratio. And based on this decision-making rule, this method has been chosen as the most preferred of the three melting methods. In the same table, the present value of the net benefits of each of the three melters is also shown. Applying the present value decision rule would result in the choice of fabricated wax melter and imported wax melting method would be ranked second. Local

melting method will be the list. However, in the case of solar wax melters and their efficiency one can choose the imported one because this melter is more efficient than the fabricated one as discussed previously. The difference in benefit is due to the holding capacity only. If the capacity of the imported melter was equal as the fabricated one and were made in the center it would be much beneficial than fabricated one.

Farmers' comments and suggestions

Participant beekeepers forwarded their comments and suggestions regarding wax-melting methods. They said that solar wax melters are preferred for many of their qualities; are safe for working, no accident or hazed possibility, melt quality wax, require little accessories and little attention. They also commented that, as they do not require skilled manpower, these technologies are more effective in house hold level if they are available at reduced price. However, as farmers commented, these melters are not time effective as they melt less amount per day relative to local method.

Likewise, regarding local melting method, the place where wax extraction is carried out is on open-stoves (three stone stove). In such stoves the fire burns in all direction, consuming much fuel wood, becoming difficult, if not impossible, to control the temperature ranges as precisely as needed. As the wax will cool down immediately, becoming harder for squeezing, the crude material stays on fire until the wax is believed to be completely extracted. Farmers are aware that this makes the work tedious, and due to the flame burning during fetching the molten wax and while stirring, this system is more dangerous. The fire may also flame up if molten wax pours in to it accidentally. Furthermore, workers who melt the wax using local method know nothing about wax quality and the amount of temperature it needs. Beekeepers and wax processors do not know the importance and value of quality wax in the current market and important quality parameters other than separating debris.

Conclusion and recommendation

The study indicated that pure wax attracts honeybees and has higher values. This pure wax can only be obtained by improved technologies from which the solar wax melter is the one. It enables to melt little amount of wax in less cost and labor at household level especially for modern hives (foundation sheet). Besides quality wax can easily compete in global market and can earn more benefit than large amount of worthless product. Other social benefit as lowering of health hazardous, reduced deforestation, and labor hour saving will have enormous impact on individual and social well being. On the other hand, the wax extracted from traditional melting method is brown in color and is less attractive for bees. For such reason users, especially those who are aware of wax quality parameters did not support the local melting method. Therefore, it can be recommended that:

1. The imported wax melter should be available in the market or, by assessing non-crystalline polystyrene plastic glass in the market, should be produce in the center and demonstrate to the users with optimum melting capacity.

2. Training in selecting, handling and processing of good quality wax should be provide to beekeepers in collaborating with Bureau of Agriculture and Rural Development and other concerned organizations.

Reference

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