Request for Proposal

Eliminating Waste and Improving Accuracy in the Bottling of Honey

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Abstract

This Request for Proposal addresses the opportunity for a redesign of the honey bottling process used by members of the Urban Toronto Beekeepers' Association. This is a community consisting of enthusiastic, local beekeepers who maintain between 1 and 100 hives [1]. They host meetings on the first Tuesday of every month in the University of Toronto Earth Sciences Building and are very welcoming to anyone seeking to learn more about beekeeping. Some members produce small amounts of honey for personal use, while others can produce 4200 lbs a year to sell at local farmers markets [1].

Figure A

These beekeepers currently bottle their honey through the use of a plastic honey gate installed a plastic gallon bucket (see Figure A). This container is filled directly from the extractor. The device is elevated and the gate at the base of the bucket is manually opened by unscrewing the wingnut to allow honey to pour into each bottle. Once the beekeeper decides the bottle is full, they shut the gate and tighten the wingnut across it.

This process results in two main problems. As the wingnut is being tightened, honey continues to drip onto the surface below. The close proximity of the wingnut to the opening often causes honey to be inadvertently transferred to the user's hands, and subsequently from their hands to other surfaces. This increases the mess of the bottling process, and thus causes inconveniences for the user.

The second issue that arises is that the amount of honey being poured into the bottle is measured by eye. This can result in variances in volume between bottles. This is an important issue for beekeepers who intend to sell their honey, as the net quantity of the honey must be within a certain tolerance of the advertised weight.

There are honey bottling machines that address these issues; however, they are unsuitable for local beekeepers due to their price and large scale. Such machines can cost upwards of $1000 [2]. This results in the opportunity to create an affordable design that reduces wasted honey and improves the accuracy of the volume delivered to a bottle. The design may include, but is not limited to, a redesigned valve, container, stand, and other bottling apparatus.

[1] Field Notes

[2] WaxMelters, Honey Bottler. [Online]. Available: http://www.waxmelters.com/Honey-Bottling-Storage-Beeswax-Liquifier-Melting-Tanks-s/96.html

Table of Contents

1. Introduction

Toronto is known for many things, but small-scale farming is probably not the activity most commonly associated with the bustling metropolis. It may be surprising to discover that there exists organizations like the Urban Toronto Beekeepers' Association and the Toronto Beekeeper's Cooperative that are comprised of hundreds of beekeepers who operate in and around the city. These individuals as well maintain between 1 and 100 hives. [1] According to the Canadian Honey Council, over 50,000 bees live in a single man made hive and produce more than 100 pounds of extra honey each year which is harvested by the beekeeper [3]. Before all of this "liquid gold" (as they say in the trade) can be distributed and enjoyed, it has to make its way from the hive to the bottle. There are a number of steps in between these two points that will be outlined in the 'Beekeeping Process' section (See 3.1).

Currently, members of the aforementioned organizations, from the hobbyists to the small business owners all use the same mechanism for bottling honey: a plastic bucket with a honey gate located at the bottom. This device will be further explained in the 'Analysis of Current Method' section (See 5.1). Unfortunately, this valve does not satisfactorily meet the needs of the beekeepers. Even for the long-time users, honey is wasted and each bottle cannot be measured out accurately. Although alternatives that address these issues do exist, they are extremely expensive and not realistic for small groups or individual beekeepers. Usually, they involve heavy machinery and therefore require a large amount of space. For urban beekeepers who do most of the bottling in their own homes (See Field Notes)[1], a new design is required that incorporates the functionalities that are currently lacking but also considers the resources available to these potential users.

The following Request for Proposal is intended to frame a design space suitable for a range of engineered solutions. Terminology specific to beekeeping will be outlined. Background information on this opportunity is provided which includes the general honey harvesting process as well as key points about the honey itself. The community to which this opportunity pertains and other groups with stake in this project will be described in further detail as well as their values. The current bottling process and alternatives will be explained and their advantages and disadvantages will be analysed. The design requirements, objectives, metrics, constraints, and criteria are all included to guide the design space. All of this information provides the framework for the challenge of designing a cost-effective bottling method that reduces waste, and improves accuracy.

2. Important Concepts

The following terms are outlined in this section either because they appear often throughout the rest of the Request for Proposal, they are important for the understanding of this opportunity, and/or they may not be immediately clear.

Honey Gate (Conventional)

A honey gate (Figure 2.1) is a plastic valve located near the bottom of a honey bucket and facilitates the outflow of the honey. The plastic flat cover pivots at a nut and bolt and has a steel wing nut at the closing point. This nut needs to be tightened to properly close and seal the honey gate. This is the mechanism currently used by small to medium size beekeeping operations and will be further analysed in Section 5.1: Analysis of Current Method.

Figure 2.1

Figure 2.2

Figure 2.3

Perfection Honey Gate

A perfection gate (Figure 2.2 and Figure 2.3) is a spring-loaded cut-off valve made of plastic or iron, designed to dispense honey without dripping. The size of the opening is controlled by moving a lever handle up and down. This device may be useful for reference but does not meet the objectives of this design project as explained in Section 5.2: Existing Alternative Designs.

Man Made Hive

Figure 2.4 illustrates the main components of a modern Langstroth hive. The deep hive bodies consist of frames of comb. The lower deep is used as the nursery or brood chamber for the baby bees, while the upper deep is used as

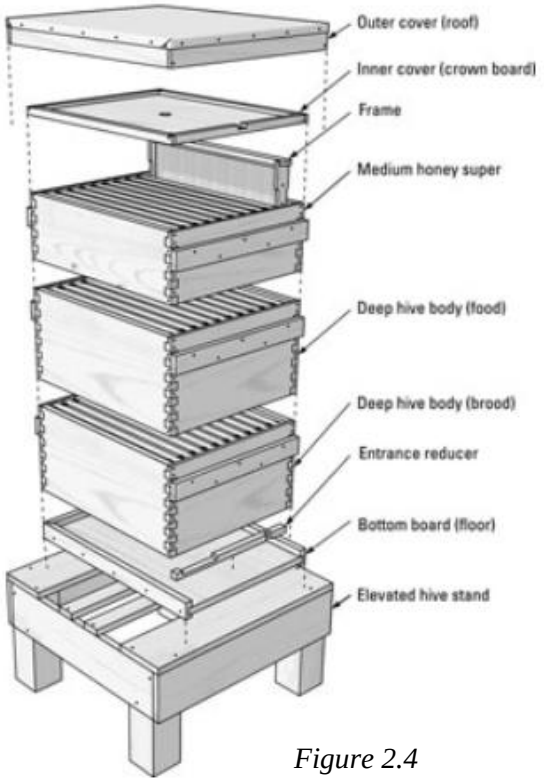

Figure 2.4

the food chamber where the bees store most of their honey and pollen. Surplus honey is collected in honey supers for beekeepers to harvest. Hives use removable wooden frames, containing a single sheet of beeswax foundation, on which the bees build their honeycomb. The frames are removed by the beekeeper for colony inspection or honey extraction. The man made hive is the starting point for the beekeeper's honey harvesting process. The events that transpire at the source precede the detailed outline of the Beekeeping Process (Section 3.1). [32]

Extractor

A machine where uncapped frames are placed and spun to extract the honey out of the combs using centrifugal force. The extracted honey collects in a reservoir inside the extractor and is immediately deposited into another receptacle[4]. This can be a storage container or the bottling device. Further explanation of the role of the Extractor is available in Section 3.2: Beekeeping Process.

Viscosity

Viscosity is a measure of a fluid’s resistance to flow due to its internal friction[5]. Working with honey requires different considerations than other fluids. The specific physical characteristics of honey are discussed in Section 3.2.1, which include viscosity. These details are important for any proposed solutions to this design challenge.

Nectar Flow

Nectar flow is referred to the time of the year with good weather and when major nectar sources are blooming. This varies depending on different regions[6]. Nectar flow dictates the beekeepers' schedule and when they would be bottling honey. See section 3.1 for more information on the timeline for honey harvesting and bottling.

3. Background

The information presented in this section is intended to provide insight into some of the central devices and processes that may be integrated into a design solution. It includes a description from start to finish of the beekeeper's production procedure to allow for understanding of the steps before the honey is ready for bottling. This is necessary to grasp as the frame of this challenge is not limited to only one step. The entire process is available for critical review. The qualitative properties of honey and the bottles in use should be included in the design process in order to ensure compatibility with the potential user's current experience.

3.1. Beekeeping Process

Honey extraction occurs at the end of summer, or after a substantial nectar flow. Beekeepers use various methods to evacuate the bees from the honey super frames, including shaking the frames or using a leaf blower. Beekeepers then remove some of the supers from the top hive body (Figure 3.1.1)[8]. The bees seal the honeycombs with wax after they are filled with honey. To remove these wax cappings, beekeepers may use a hot knife or uncapping fork with an uncapping tank to collect the wax (Figure 3.1.2)[9]. This does minimal damage to the honeycombs so that the bees do less work when refilling them.

Figure 3.1.1

Figure 3.1.2

The honeycombs are then placed in a extractor and spun (Figure 3.1.3)[10]. The honey is poured out of the extractor, through a strainer to remove leftover wax, wood chips, and bees into containers from which it is bottled (Figure 3.1.4)[11]. Some beekeepers choose to leave the honey to sit for a few days before bottling so that air bubbles to come to the surface[12].

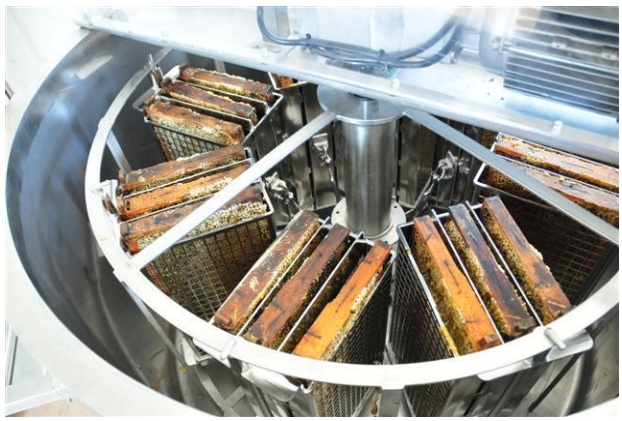

Figure 3.1.3

Figure 3.1.4

The complete set of equipment for honey production is displayed in Figure 3.1.5. This is not only an overview of the devices in use but also an approximation of the amount of space needed for the current bottling process.

Figure 3.1.5

3.2 Science of Honey

In order to design a solution for the bottling of honey, it is vital to first understand the substance itself and how it acts in a physical environment. It would be a mistake to treat it or think of it as a commonplace fluid. The honey in and of itself proposes limitations which form part of the basis of this design challenge. The following information should be taken into consideration in the design process in order to produce a solution that not only works in theory but, more importantly, in practice.

3.2.1 Characteristics of the Fluid

Some qualitative characteristics of honey, such as the aroma, taste and colour vary depending on seasonal and geographical factors[13]. However, the physical and chemical properties throughout this range remain the same. Honey is a viscous and syrupy liquid. Viscosity is defined as "the internal frictional resistance of a liquid to the application of a pressure or a shearing stress."[14] Honey has a viscosity of 10 000 centipoise (equal to a megaPascal second) at room temperature (70°F), as determined by "Rheomat T 15" [13]. The viscosity is one of the substance's distinguishing characteristics (and possibly one of its most troublesome) and the resulting behaviour should be integrated into the design and prototyping.

The viscosity of honey is heavily dependent on the density and water content[14]. According to the Textbook of Pharmacognosy and Phytochemistry, honey has a relatively high density (ratio of mass to volume) of 1.47[13]. This can be diluted with water by the beekeepers to reduce the density to 1.35[13]. The high density should be taken into consideration for the design of any device that may support or contain the honey. In *Honey – Its Characteristics, Sensory Aspects, and Applications*, it is stated that the water content of honey is 15 – 20%[15]. Any deviation from this range will result in increased crystallization or fermentation[15]. Raw honey is subject to small impurities such as pollen, wax, and other water soluble substances[15].

3.2.2 Pasteurization

Pasteurized honey is subjected to flash heating to a high temperature, super filtered through a 1- to 5-micron filter and quickly cooled. This process removes a lot of the raw components of honey such as essential nutrients, beeswax and royal jelly[16]. See '4.3 Community Values' for information on why this is pertinent for the design challenge.

3.2.3 Crystallization

The honey crystallization refers to the transformation of honey from liquid form to a mix of solid and liquid. Due to the fact that honey is supersaturated with sugar, crystallization can happen anytime after a few weeks to a few month after the extraction process. Crystallization is more likely to occur when the temperature is below 14 degree Celsius[17]. The crystallization rate also depends on

the types of honey[16]. Crystallization of honey can cause problems to beekeepers not only because it makes the bottling process more difficult but also makes the honey less visually appealing. Most beekeepers in the community prefer to bottle non-crystallized honey.

3.3 Honey Bottles and Jars

Conventional honey bottles are measured in weight. The most common bottle sizes used by the community are 150g, 250g and 500g glass jars with aluminum caps[1]. Since honey is hydroscopic, it is required for the bottle to have a cap which is air-sealed. The bottle must resist corrosion since honey is acidic. Glass jars are commonly used by local beekeepers. Plastic bottles with press-in lids are also used for bottling small amounts of honey [15].

4. Community

The opportunity presented in this document is one that will allow the design team to understand and improve the lived experience of the community of small- to medium-scale urban Toronto beekeepers. The communities that were directly interacted with and will be focused on are two beekeeping organizations, Urban Toronto Beekeepers' Association and Toronto Bee Rescue- Toronto Bee Rescue being a smaller community under Urban Toronto Beekeepers' Association, as will be explained in this section.

4.1 Urban Toronto Beekeepers' Association

Urban Toronto Beekeepers' Association is an organization in Toronto whose goal is to educate and assist new urban beekeepers and anyone interested in learning about bees and beekeeping. Their motto is "Sustainable Beekeeping through Education and Mentorship" [18].

4.1.1. Demographics

Urban Toronto Beekeepers' Association consists of 936 members including local beekeepers, bee enthusiasts and educators [18]. The beekeepers of this organization range from hobby beekeepers who own 1-2 hives, to medium scale beekeepers who own more than 80 hives [1]. Even though the level of beekeeping ranges across the group, all beekeepers are extremely passionate about what they do.

4.1.2. Lived Experience

Small-scale and hobby beekeepers in this organization keep the honey they harvest for personal use or to gift to neighbours, family or friends, while the medium scale beekeepers sell their honey on the local farmer's market and elsewhere. Hobby beekeepers use non-standard jars such as pickle jars, jelly jars or any other container that is available at home. Therefore, accurately measuring out a specific amount of honey is not of concern to them. However, beekeepers who sell their honey use standardized jars and want to bottle honey as accurately as their bucket would allow them. Since the current system involved manual measuring, honey is not measured out as accurately as the beekeepers would prefer. [1]

Nonetheless, both scales of beekeepers use the same bottling equipment. Since there is currently no middle ground between the very low-tech plastic honey bottling bucket and the industrial bottling tank, all of them opt for the inexpensive equipment which is the plastic bucket. A common issue across most of the beekeepers in this organization is that the honey gate they use causes honey to drip, making the process more messy. Bottling honey also requires constant attention from the bottler

since the honey gate must be manually closed in order to stop the honey flow. Any distraction away from the honey bucket can result in an overflowing honey gate. [1]
These factors make the honey bottling process more difficult and inconvenient for the beekeeper. However, this is something that all urban beekeepers experience and are forced to deal with because of the lack of other alternatives [1]. These beekeepers can benefit from a more effective, but inexpensive product, one that is in between the current options [1].

4.2 Toronto Bee Rescue

Toronto Bee Rescue is an urban beekeeping organization dedicated to the humane removal and relocation of honey bee colonies from manmade structures and unsuitable locations in nature, within the Greater Toronto Area. After the bees are relocated, they are farmed in manmade beehives at a suitable location where they can thrive and produce honey for the local community. [19]

Peter Chorabik is the owner of this organization and also a member of Urban Toronto Beekeepers' Association. He currently owns 86 man-made beehives across the GTA from which he harvested a cumulative total of 4200 lbs of honey in 2015. He mostly uses 250g and 500g jars and sometimes gets orders for 160g jars. During a conversation with Peter, he expressed that it is more difficult to fill smaller bottles using his current equipment because smaller bottles require more care in manual measuring and it also means filling more bottles. This can sometimes be a tedious process. Since Peter deals with such a large amount of honey and sells it on the local farmer's market, he has a need for equipment that is more mess-free, accurate and preferably faster [1]. It can be noted that Peter stores his beekeeping equipment in his basement, garage and outbuilding on a farm. [1]

Toronto Bee Rescue is a smaller representation of Urban Toronto Beekeepers' Association since Peter is a member of it and shares the same values as them. For this reason, both organizations are primary stakeholders for this opportunity.

4.3 Community Values

Beekeepers of Urban Toronto Beekeepers' Association and Toronto Bee Rescue are interested in producing raw, unpasteurized and natural honey. To them, honey is precious and therefore they prefer to save as much honey as possible in the process. The current equipment they use contributes to honey waste which will be explained more throughout this document. Some beekeepers find it difficult to bottle honey efficiently within a short period of time. More importantly, many of the beekeepers wish to have a cleaner process of honey production but the current tools do not suffice. Small-scale beekeepers stress that the product they use must be inexpensive. [1] Both organizations are very enthusiastic about collaborating with a design team to address this bottling issue. Sophistication of the product in terms of using high technology is not required as long as it meets the needs of the beekeepers [1].

5. Bottling Process

This section elaborates on the conventional bottling method and other existing alternative methods by providing analysis of the bottling process and addressing the potential design space. All of these designs can be used as reference for designing a solution. However, none of them currently satisfy the objectives outlined in Section 6.

5.1. Analysis of Current Method

The current bottling method utilized by the majority of beekeepers in the Urban Toronto Beekeepers Association involves the use of a plastic bucket with a honey gate located on the side of the bucket two centimeters from the bottom (see Figure 5.1.1)[20]. This current gate is comprised of a flat plastic piece that pivots at one end and slides over the opening. For a complete seal, a wingnut located opposite the hinge must be tightened. (see Figure 5.1.2)[21] This unit retails for approximate $30, or $10 for just the gate [22].

The bottling process is completely manual. When the gate is open, honey drips from the opening to a bottle underneath. The valve's placement two centimeters from the bottom makes it difficult for the last remaining amount of honey to be bottled [1].The valve's relatively low positioning on the container means many bottle sizes cannot be placed on the same surface as the bucket to be filled (see Figure 5.1.3)[23]. The bucket must be placed so that the valve overhangs a surface and the honey flows into a bottle held or placed below.

Figure 5.1.1

Figure 5.1.2

Figure 5.1.3

The beekeeper changes bottles or closes the gate manually based on their judgment of if the bottle is full. The jars being filled vary in volume and shape. Beekeepers sell honey in a variety of sizes (150g, 250g, 500g)[1]. Other beekeepers, who extract the honey for personal use, will fill any container they have available. [1] As such the beekeeper must watch the honey fill the various bottles to decide when to shut the gate and stop the flow. If a beekeeper becomes distracted, they may be unable to close the gate in time, resulting in inadvertent overflow.

To close the gate, not only must the gate slide over the opening but the wingnut must be tightened. While the wingnut is being tightened, honey is dripping from the gap between the gate and the opening. This dripping honey can get onto the surface below the container, the beekeeper's hands, or on the bottle. Once they honey is on the beekeeper's hands, it is easy to transfer it to other surfaces making the entire process more messy. It is important that the outside of the bottles remain free from honey in order for any necessary labels to be affixed. After the bottle is filled, and the next bottle is positioned beneath the gate, the wingnut must then be loosened. As such, the wingnut must be tightened two times per bottle.

5.2 Existing Alternative Designs

A) Plastic Perfection Honey Gate

The plastic perfection gate is an existing solution to prevent dripping. The plastic perfection consists of a spring-loaded cut off valve and an arc shape exit. It is compatible with conventional plastic bucket. Although the plastic perfection gate tackles the no dripping problem, it does not offer other desired features for the bottling process such as better measurement of honey filled, flow improvement. The price of the plastic perfection gate is about $50 (see Figure 5.2.1)[24]. According to the engagement with the beekeepers, this design is not commonly used by local beekeepers.

Figure 5.2.1

B) Industrial Honey-Bottling Tank

The industrial honey-bottling tank is made of stainless steel with immersion heater embedded (Figure 5.2.2)[2]. This device is commonly used by industrial honey producer in the bottling process. It is able to heat the honey to ensure fluent flow of honey. The honey is transferred into a bottling machine, which automatically bottles the honey according to the amount of honey per bottle. Figure 5.2.3 shows an example of the automatic bottling machine which accurately bottle the same amount of honey for a desired bottle size. The price for the bottling tank is around $1000 [2]. The price of the automatic bottling machine is about 4000EUR[25]. Small to medium urban beekeepers who have less than 100 hives cannot afford to purchase such system of devices because they do not require large-scale honey production[1].

Figure 5.2.2 *Figure 5.2.3*

C) 10-Gallon Steel Bottler

Another reference design is the 10-gallon bottler made of steel (Figure 5.2.4)[26]. It is contains a 120V immersion heater that can be used to provide fluent flow of honey. The digital thermometer is used to precisely controls and monitors the honey to ensure the optimal temperature for bottling. The bottler is used in large-scale honey production. The bottler is equipped with a honey gate that allows no dripping to happen (Figure 5.2.5)[27]. This kind of valve is only compatible with expensive metal containers and not with conventional plastic buckets. These devices are not affordable to small to medium scale beekeepers because the total price is upwards of $1000 [26].

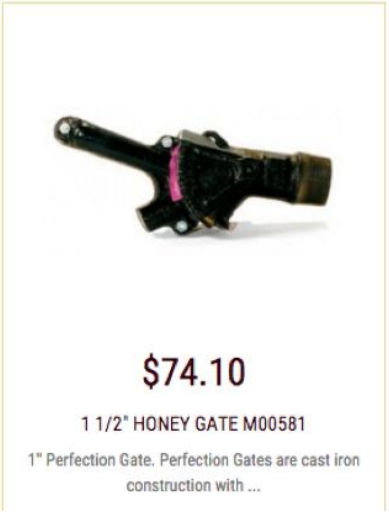

Figure 5.2.4 *Figure 5.2.5*

The major problem with the current existing industrial bottling method is affordability. According to the conversation with a number of beekeepers in Urban Toronto Beekeepers Association, the existing automatic bottler does not match their scale of honey production. For example, the 10 gallon bottler is able to process 10 gallon honey at a time but the beekeepers usually bottle less amount of honey each time. As a result, the price of the bottle is not affordable considering their scale of production.

The following Pugh chart is used to analyze the existing bottling methods for low to medium scale beekeepers in honey production.

	Reference Design				
Objective	Plastic Bucket with Wingnut Honey Gate(Conventional Tools)	Honey-bottling/ Wax Melter	Automatic Bottling Machine	10 Gallon Bottler with Perfection Honey	Plastic Perfection Gate
*Price	0	-	-	-	0
*Dripping Control	0	+	+	+	+
Flow Control of Honey	0	+	+	+	0
Scale of Honey Production	0	-	-	-	0
*Accurate Measurement for Amount of Honey	0	+	+	+	0
Amount of Honey left/ Wasted	0	+	+	+	0
Ease of Use (less labor required)	0	+	+	+	0
Time used to fill a bottle	0	+	+	+	0

** refers to important values of the community. The design product needs to match those features indicated by *.[1]*

The Pugh chart shows that although the 10 Gallon bottle, the bottling tank and the automatic filling machine provide more efficient and convenient bottling process, they are high in cost and do not match the production scale of the Urban Toronto Beekeepers. The perfection honey gate provides a potential inspiration of solution to dripping control of honey but it does not include other desired features such as accurate measurement of honey, reducing wasted honey.

6. Design Requirements

The objectives outlined and explained in this section were established through consultation with multiple members of the community and were identified as the key requirements in a bottling process redesign. These objectives should help to frame the design space and provide a basis for narrowing down possible solutions.

6.1. High Level Objectives

- Generate an affordable design to reduce dripping honey, increase the accuracy of the volume delivered to a bottle, and reduce time per bottle.
- The design may include, but is not limited to, a redesigned valve, container, stand, and other bottling apparatus.

6.2 Detailed Objectives

Objective:	Metric:
A design that reduces the amount of honey that is wasted during the bottling process; particularly, a design that 1. stops honey from dripping when a full bottle is removed and before an empty bottle is placed into position, and 2. reduces the amount of honey remaining in the container	‣ the amount [g] of honey that is not inside a bottle at the end of the bottling process ‣ or the difference in volume [g] between the initial amount of honey and the amount of honey in the bottles at the end of the bottling process ‣ the depth [cm] of honey remaining in the container
Constraints:	Criteria:
‣ less than two cm of honey remaining in the bottom of the bucket	‣ less undesired honey dripping is better ‣ a lower amount of wasted honey is better
Justification:	
Honey dripping is the biggest complaint from the community [1]. It is imperative that honey dripping is reduced.	

Objective:	Metric:
A design that improves the accuracy of the bottling process, that is it ensures a consistent volume of honey is filled into each bottle, for a variety of bottle sizes.	‣ difference between the actual volume of honey filled [g] and the desired volume of honey [g] for that specific bottle ‣ the number of different bottles for which a specific volume is accurately poured
Constraints:	Criteria:
‣ the difference between the actual volume and the desired volume must be within the allowed tolerances declared in the Processed Products Establishment Inspection Manual [28] ‣ 150g, 250 g, and 500 g bottles must be able to be filled accurately	‣ a lower the difference between actual volume versus desired volume is better ‣ a greater the number of different bottles able to be filled accurately is better
Justification:	
‣ Many beekeepers in the community sell their honey. As such, they are required to maintain a certain level of accuracy in the labelled net quantity of their product according to the Consumer Packaging and Labelling Act (CPLA). They will be relying on the new design to achieve this accuracy. [29] ‣ 150g, 250g, and 500g bottles are standard honey bottle sizes in the Canadian Guide to Food Labelling and Advertising (CGFLA) standards and the most common sizes used by Peter Chorabik. [30]	

Objective:	Metric:
A design that increases the efficiency of the process by reducing the time spent per bottle	‣ time spent per bottle in minutes, starting when the bottle is placed into position to when the bottle is removed and closed
Constraints:	Criteria:
‣ no more than the current shortest amount of time taken per bottle, 5 minutes [1]	‣ less time per bottle is better
Justification:	
The redesign should be just as time efficient, and preferably more efficient, than the current method.	

Objective:	Metric:
A design that reduces the amount of honey that gets on the outside of the bottles and on the bottler's hands.	‣ presence of honey on surfaces that touched by the beekeepers hands (including the sides of the bottle or any part of the valve that must be closed manually)
Constraints:	Criteria:
‣ there should be none to very little honey on surfaces the beekeeper is required to touch during the bottling process	‣ the less honey on these surfaces the better
Justification:	
Once honey gets on to the beekeepers' hands it is easily transferred to more surfaces. As well, honey on the outside of the bottle makes it difficult to affix labels to the bottle and increases the overall mess of the process. Reducing the mess means less cleanup required by the beekeepers, and makes the process more user friendly. [1]	

Objective:	Metric:
A design that is affordable to local, independent beekeepers.	‣ the cost in Canadian Dollars of all equipment used in the new design
Constraints:	Criteria:
‣ the cost must be less than $150	‣ a lower cost is better
Justification:	
A low cost is greatly valued by the community. The device currently used retails for $30; however, members expressed their willingness to pay more for a drip-free accurate device [1]. Peter Chorabik, one of the larger producers of honey in the association and a member who sells his honey at a local farmer's market, stated that $150 is the maximum he would be willing to pay for a redesigned valve.	

6.3 Additional Constraints

- The design must not compromise the integrity of the honey. That is, it must comply with the Canadian Honey Council Producer Manual for Good Practice Section 2.3: Food Safety Hazards[31].This includes but is not limited to preventing contamination by residue of chemicals, extraneous material, and pathogenic bacteria.

- At no point in the process, can the honey be heated to a temperature greater than 35 ºC. At higher temperatures, the honey is considered pasteurized and local beekeepers only produce raw, unpasteurized honey [1].

7. Conclusion

The current bottling process utilized by many beekeepers apart of the Urban Toronto Beekeepers' Association has two main drawbacks: wasted honey as a result of dripping and inaccuracy in the measurements. All existing products that address these issues are unsuitable for small, urban beekeepers because of their extremely high cost and large scale. Most members of the Urban Toronto Beekeeper's Association maintain between 1 and 100 hives, producing honey for either personal use or local farmers markets. As such an affordable redesign of the bottling process so that dripping is eliminated, the accuracy in volume delivered to the bottle is increased, and the time per bottle is reduced, has the potential to improve many local beekeeper's bottling experience.

8. References:

[1] Field Notes.

[2] WaxMelters, Honey Bottler.[Online].
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Appendix A:

[1] Field Notes
Wynchwood Farmer's Market, January 23

threats to bees
- small hive beetle, invasive species
- mites, drink the bees blood
- racoons, skunks, bears, not a problem in the city

swarm prevention
- something to monitor when the bees are going to swarm, the number of bees enter vs the number exiting
- monitoring whether the queen returns to the hive after mating flight

bottling mechanism
- measures a specific volume
- no drip
- no threads
- harder to accurately fill the smaller bottles
- vacuum seals the top to prevent drips but this reduces the speed of pouring
- warms up the honey for bottling removes crystallization
- approximately 1 - 1.5 hour to bottle the gallon bucket into large 500 g bottles
- 1 gallon equals aprox 5.5 kg which is 11 bottles
- so between 5 to 8 minutes for large bottles
- filling smaller bottles takes longer time due to transitioning between bottles
- would like something that quickens the process, possibly more automated

book - bee democracy
bee hives have to be 30m from property line

Peter has 86 hives
Royal York Hotel keeps bees and uses the honey in their restaurants

<u>Urban Toronto Beekeepers' Association and UofT B.E.E.S., February 2</u>

How do you get the same amount of honey in different bottles?
- doing it for a long time/practice makes it easier to eyeball an approximate amount
- commercially, precise mechanisms are used to sell on market, but small/hobby beekeepers do not require that

How do you get the honey from the bottom of the bucket?
- rubber spatula

Bottling process
- "manual production line"
- yanking the valve by hand to start/stop filling
- approximately an hour to bottle all the honey from one bucket

- small beekeepers bottle right away, there is no heating involved

Current honey bottling bucket

- very low tech equipment is “key”
    - as long as it works, sophisticated equipment is not required
    - it is also preferred since it is inexpensive and sufficient for hobby beekeepers
- accuracy in measuring out the honey in each jar is not of concern since small beekeepers usually bottle the honey for friends/family and the jars they use are not uniform (pickle jars, jelly jars, etc)
    - this might be more of an issue for beekeepers selling honey on the market
        - beekeepers with >40 hives
- currently, there is no middle ground between the manual bucket and the commercial bucket which can go up to as much as $8000
    - “something in between might be good”
    - “there is nothing in between that suits the hobbyists”
- butterfly screw/ wing nut causes the drippage problem
    - beekeepers get good at knowing when to shut the valve, but screwing back the nut takes time, during which the drippage occurs
- dripping honey can get onto their hands and be transferred to other surfaces
- very essy process, uses towlels to clean up
- drippage/honey waste is not a major problem → people just deal with it/don’t talk about it. However, the problem does exist and a better, inexpensive equipment is definitely of interest

New Honey Bottling Bucket

- may monitor the volume of honey and stop the honey flow when the monitor reads a certain volume
    - volume over weight since honey from different seasons/type can weigh different
    - if device shuts off at a certain volume, this also stops excess drippage
    - if the doorbell rings, or I get distracted, the honey can overflow the bottle and make a mess
- able to adjust honey flow for various volumes of jars
- may be a vertical system instead of the current one that is horizontal, to stop the drippage
    - Note: horizontal is preferred since it is easier to sit on a table
- may have a reservoir for honey before it is bottled
- heated valve → just enough to help the honey flow
    - cannot be heated past approximately 35 º C because honey can become pasteurized and stripped of organic nutrients
    - if heated too much, honey:
        - can lose enzymes/nutrients
        - cannot get crystallized again
        - can lose chemical properties
    - heating is the commercial way of bottling honey since it is the easiest method
        - independent beekeepers do not prefer this because they want their honey to be organic

Other Opportunities

- climate change is a problem

    - moisture kills bees more than low temperature
- scraping the honeycomb is messy
    - currently, this is done using hot knives
- crystallization of honey in the bucket/ in the hives

Additional Info

- 4-5 hives produce couple hundred pounds of honey in a year
- Mentioned sources/reference designs:
    - propolis-etc.ca
    - Flow Hive
    - beesource.com

Leader of the Urban Toronto Beekeepers Association

- is willing to pay more for better equipment
- believes in investing in good quality equipment but still not willing to pay hundreds of dollars

President of University of Toronto B.E.E.S.

- “honey is precious”
- “gotta save every drop”
- “liquid gold”
- “every drop is precious because honey is so limited in supply”
- “ethically, it is irresponsible to waste any of the honey that the bees literally devote their lives making”

Follow Up Questions Inbox x

4Ward Design Collective <4ward.designcollective@gmail.com> 8:09 PM (21 hours ago)
to info

Hi Peter,

Thank you for meeting with us at the Farmer's Market. We have chosen to focus on the no drip honey valve idea. We are working on writing our proposal and and have a few questions. Any input you could provide would be greatly appreciated.

1. What is the most you would be willing to pay for an automatic shutoff, no drip valve that accurately measures out various volumes of honey?
2. Where do you store your beekeeping equipment?/How much space do you have to store a bottler?
3. How much honey do you produce, and how many hives do you have?
4. What are the standard bottle sizes you use?

Thank you very much,
Mollie Bianchi

info
info@torontobeerescue.ca
Show details

info@torontobeerescue.ca 8:14 AM (9 hours ago)
to me

Good Morning

Here are my answers to your questions.
1. $150 if it was able to work quickly as well
2. I store my equipment if my basement, garage and out building on a farm
3. I have 86 hives and produced 4200 lbs of honey last year
4. I use 250g jars and 500g jars. However I also get orders for smaller jars like 160g (the smaller the bottle the tougher it is to fill and the more bottles to fill)

Peter Chorabik
Toronto Bee Rescue
(416) 809-5669
info@torontobeerescue.ca

[2] WaxMelters, Honey Bottler. [Online].
Available: http://www.waxmelters.com/Honey-Bottling-Storage-Beeswax-Liquifier-Melting-Tanks-s/96.html

Honey Bottler & Beeswax Melter 100
Usually Ships in 2 to 3 Business Days
Price: $1,095.00
In Stock Add to cart

Honey Bottler & Beeswax Melter 100 is the BeeKeeping Industry's Fastest, Even Heating, Energy Efficient, Digitally Controlled 100lb Beeswax Melter & Honey Bottler Storage Tank
more info

[3] Canadian Honey Council. *Honey Industry/Beekeeping* [Online]. Available: http://www.honeycouncil.ca/industry.php

Did You Know?

A single bee colony can produce more than 100 pounds (45 kg) of extra honey and this is what is harvested by the beekeeper! [learn more cool facts]

Over 50,000 bees live in a hive! [more honey bee trivia...]

[4] Bees.techno-science.ca, "Extracting, Bees A Honey of an Idea", 2015. [Online]. Available: http://bees.techno-science.ca/english/bees/the-beekeeper/extracting.php.

[5] Princeton.edu, "DEFINITION OF VISCOSITY". [Online]. Available: https://www.princeton.edu/~gasdyn/Research/T-C_Research_Folder/Viscosity_def.html.

What is viscosity?

This question is often best answered by example. Imagine a styrofoam cup with a hole in the bottom. If I t
viscosity is large compared to other liquids' viscosities. If I fill the same cup with water, for example, the c

Viscosity is a measure of a fluid's resistance to flow. It describes the internal friction of a moving fluid. A

[6] Kelley Beekeeping, "What's a nectar flow and how do I know if there's one going on?", 2016. [Online]. Available: https://www.kelleybees.com/Blog/8/FAQs/54/What-s-a-nectar-flow-and-how-do-I-know-if-there-s-one-going-on.

What's a nectar flow and how do I know if there's one going on?

Nectar flow is when one or more major nectar sources are blooming and the weather is cooperating, allowing bees to collect the nectar. There's a great resource that lists when native plants are blooming for a particular region, based on historical data. (In this unusually temperate year, this may not be that accurate.) Bee Forage Regions: http://honeybeenet.gsfc.nasa.gov/Honeybees/Forage.htm

[7] Blackiston, Howland. "Chapter 8: Different Seasons, Different Activities", "Chapter 14: Getting Ready for the Golden Harvest", and "Chapter 15: Honey Harvest Day" in *Beekeeping for Dummies*, 2nd edition. Hoboken: Wiley Publishing, Inc., 2009, ch. 8, 14, and 15, pg. 145 - 159 and 249 - 275.

Lazy, Hazy, Crazy Days of Summer

Nectar flow usually reaches its peak during summer. That's also when the population of the colony usually reaches its peak. When that's the case, your

colonies are quite self sufficient, boiling with worker bees tirelessly collecting pollen, gathering nectar, and making honey. Note, however, that the queen's rate of egg laying drops a bit during the late summer.

On hot and humid nights, you may see a huge curtain of bees hanging on the exterior of the hive. Don't worry. They're simply cooling off on the front porch. Consider providing better ventilation for the colony by adding ventilation holes.

Late in summer the colony's growth begins to diminish. Drones still are around, but outside activity begins slowing down when the nectar flow slows. Bees seem to be restless and become protective of their honey.

Falling Leaves Point to Autumn Chores

Most nectar and pollen sources become scarce as days become shorter and weather cools in autumn. All in all, as the season slows down, so do the activities within your hive: The queen's egg laying is dramatically reduced, drones begin to disappear from the hive, and hive population drops significantly.

Your bees begin bringing in propolis, using it to chink up cracks in the hive that may leak the winter's cold wind. The colony is hunkering down for the winter, so you must help your bees get ready.

Watch out for robbing during this time (other bees would love to steal honey from your hives). For more about robbing and how to prevent it, see Chapter 9.

Your autumn "to-do" list

When helping your bees prepare for the upcoming hardships of winter months, you must

- Inspect your bees (look inside the hive) and make certain that the queen is there. As mentioned in Chapter 7, the easiest way is finding eggs. One egg per cell means the queen is present.

- Determine whether the bees have enough honey. Your bees need plenty of food (capped honey) for the winter. Make certain that the upper deep hive body is full of honey. Honey is essential for your bees' survival, because it's the fuel that stokes their stoves. Without it they're certain to perish.

  In cooler, northern climates, hives need about 60 pounds or more of honey as they head into winter. You'll need less honey reserves (30 to 40 pounds) if your winters are short (or nonexistent).

- Wrap the hive in black tar paper (the kind used by roofers, see Figure 8-1) if you're in a climate where the winter gets below freezing for more than several weeks. Make sure that you don't cover the entrance or any upper ventilation holes. The black tar paper absorbs heat from the winter sun, and helps the colony better regulate temperatures during cold spells. It also acts as a windbreak.

  I put a double thickness of tar paper over the top of the hive. Placing a rock on top ensures that cold winds don't lift the tar paper off. I also cut a hole in the wrapping to accommodate the ventilation hole I drilled in the upper deep hive body (see Figure 8-1).

Figure 8-1: Wrapping your hive in tar paper helps protect your colony from harsh winter winds and absorb the warmth of the sun. The rock on top keeps the paper from blowing off. The metal mouse guard keeps unwanted visitors outside the hive.

Clustering in a Winter Wonderland

What goes on in a beehive during winter? The queen is surrounded by thousand of her workers — kept warm in the midst of the winter cluster. The winter cluster starts in the brood chamber when ambient temperatures reach 54 to 57 degrees F. When cold weather comes, the cluster forms in the center of the two hive bodies. It covers the *top* bars of the frames in the lower chamber and extends over and beyond the *bottom* bars of the frames in the food chamber (see Figure 8-2).

Although the temperature outside may be freezing, the center of the winter cluster remains a constant 92 degrees F. The bees generate heat by "shivering" their wing muscles.

No drones are in the hive during winter, but some worker brood begin appearing late in the winter. Meanwhile, the bees consume about 50 to 60 pounds of honey in the hive during winter months. They eat while they are in the cluster, moving around as a cluster whenever the temperature gets above 40 to 45 degrees F. They can move to a new area of honey only when the weather is warm enough for them to break cluster.

The Right Equipment for the Job

Once you decide what style of honey you want your bees to make (extracted, comb, chunk, or creamed) you need to get hold of the appropriate kind of equipment. This section discusses the various types that you'll need depending upon the style of honey you want to harvest.

Honey extractors

Essentially, an extractor is a device that spins honey from the comb using centrifugal force (see Figure 14-1). Extractors come in different sizes and styles to meet virtually every need and budget. Hand-crank models or ones with electric motors are available. Small ones for the hobbyist with a few hives, huge ones for the bee baron with many hives, and everything in between can be found. Budget extractors are made entirely of plastic, and rugged ones are fabricated from food-grade stainless steel. Keep in mind, however, that a good-quality, stainless-steel extractor will far outlast a cheap one made of plastic. So get the best one that your budget allows. Look for a model that accommodates at least four frames at a time. Backyard beekeepers can expect to pay $295 to $495 for a new quality extractor. Less for a used one. Even more for ones with electric motors.

Figure 14-1: This hand-crank, stainless-steel extractor extracts up to six shallow frames at a time.

You may not have to buy an extractor. Some local beekeepers, beekeeping clubs, and nature centers rent out extractors. So be sure to call around and see what options you have. Ultimately, you may want to invest in your own. My advice: If you're able to, rent or borrow an extractor during your first season. From the experience you gain, you'll be better able to choose the model and style of extractor that best meets your needs.

Uncapping knife

The wax cappings on the honeycomb form an airtight seal on the cells containing honey — like a lid on a jar. Before honey can be extracted, the "lids" must be removed. The easiest way is by using an uncapping knife. These electrically heated knives slice quickly and cleanly through the cappings (see Figure 14-2).

Alternatively, you can use a large serrated bread knife. Heat it by dipping in hot water (be sure to wipe the knife dry before you use it to prevent any water from getting into your honey).

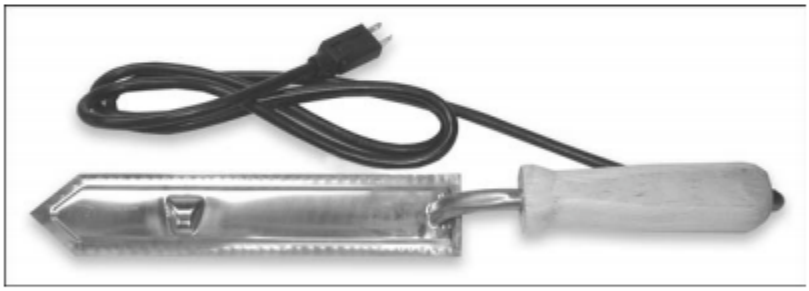


Figure 14-2: An electrically heated uncapping knife makes short order of slicing wax cappings off honeycomb.

Honey strainer

The extracted honey needs to be strained before you bottle it. This step removes the little bits of wax, wood, and the occasional sticky bee. Any kind of conventional kitchen strainer or fine-sieved colander will suffice. Nice, stainless-steel honey strainers (see Figure 14-3) are made just for this purpose and are available from your beekeeping supplier.

Or you can use a disposable paint strainer (available at your local paint supply store). It does the trick just fine, and fits nicely over a five gallon plastic bucket.

Figure 14-3: A double, stainless-steel honey strainer (like this one) is an effective way to clean up your honey before bottling it.

Other handy gadgets for extracting honey

Here are a few of the optional items that are available for extracting honey. None are essential, but all are useful niceties.

Double uncapping tank

The double uncapping tank is a nifty device that is used to collect the wax cappings as you slice them off the comb. The upper tank captures the cappings (this wax eventually can be rendered into candles, furniture polish, cosmetics, and so on). The tank below is separated by a wire rack, and collects the honey that slowly drips off the cappings. Some say the sweetest honey comes from the cappings! The model shown in Figure 14-4 also has a honey valve in the lower tank.

Figure 14-4: A double uncapping tank helps you harvest wax cappings. It reclaims the honey that drains from the cappings.

Uncapping fork

An uncapping fork is used to scratch open cappings on the honeycomb (see Figure 14-5). It can be used in place of or as a supplement to an uncapping knife (the fork opens stubborn cells missed by the knife).

Figure 14-5: An uncapping fork is a useful tool for opening cappings missed by your uncapping knife.

Bottling bucket

Five-gallon bottling buckets are made with food-grade plastic and include a honey gate. They come with airtight lids and are handy for storing and bottling honey. Each pail holds nearly 60 pounds of honey. I always keep a few of them on hand (see Figure 14-6).

Figure 14-6: The honey gate valve on this five gallon bucket makes bottling your honey a breeze.

Knowing When to Harvest

Generally speaking, beekeepers harvest their honey at the conclusion of a substantial nectar flow and when the hive is filled with cured and *capped* honey (see Figure 15-1). Conditions and circumstances vary greatly across the country. Here in Connecticut, early one spring, I had an unusually large flow of nectar from a large honey locust tree. My bees filled their honey supers before June. I harvested this rare and delicate white honey in late May. I put the supers back on and got another harvest in the late summer. More typically, I will wait until late summer to harvest my crop (usually mid-September). Where I live (in the northeastern United States) the last major nectar flow (from the asters) is over by September. First-year beekeepers are lucky if they get a small harvest of honey by late summer. That's because a new colony needs a full season to build up a large enough population to gather a surplus of honey.

Getting the Bees Out of the Honey Supers

Regardless what style of honey you decide to harvest, you must remove the bees from the honey supers before you can extract or remove the honey. You've heard the old adage, "Too many cooks spoil the broth!" Well, you certainly don't need to bring several thousand bees into your kitchen!

You must leave the bees 60 to 70 pounds of honey for their own use during winter months (less in those climates that don't experience cold winters). But anything they collect more than that is yours for the taking.

To estimate how many pounds of honey are in your hive, figure that each deep frame of capped honey weighs about 7 pounds. If you have ten deep frames of capped honey, you have 70 pounds!

Removing bees from honey supers can be accomplished in many different ways. This section discusses a few of the more popular methods that beekeepers employ. Before attempting any of these methods, be sure to smoke your bees the way you normally would when opening the hive for inspection. (See Chapter 6 for information on how to use your smoker properly.)

The bees are protective of their honey during this season. Besides donning your veil, now's the time to wear your gloves. If you have somebody helping you, be sure they are also adequately protected.

Shakin' 'em out

This bee-removal method involves removing frames (one by one) from honey supers and then shaking the bees off in front of the hive's entrance (see Figure 15-2). The cleared frames are put into an empty super. Be sure that you cover the super with a towel or board to prevent bees from robbing you of honey. Alternatively, you can use a bee brush (see Chapter 4) to gently brush bees off the frames.

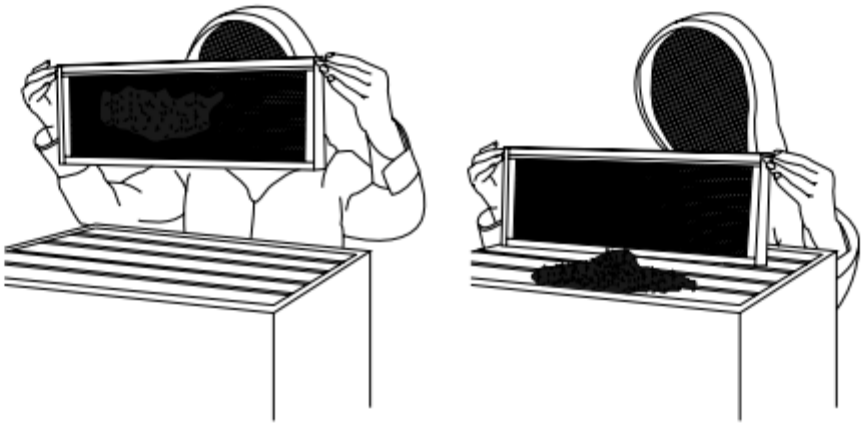


Figure 15-2: Shaking the bees out of the honey supers.

Note that the cells on comb tend to slant downward slightly — to better hold liquid nectar. Therefore, when brushing bees, you should always brush bees gently *upward* (never downward). This little tip helps prevent you from injuring or killing bees that are partly in a cell when you're brushing.

Shaking and brushing bees off frames aren't the best options for the new beekeeper, because they can be quite time consuming, particularly when you have a lot of supers to clear. Besides the action can get pretty intense around the hive during this procedure. The bees are desperate to get back into those honey frames, and, because of their frenzy, you can become engulfed in a fury of bees. Don't worry — just continue to do your thing. The bees can't really hurt you, provided you're wearing protective gear.

Blowin' 'em out

One fast way to remove bees from supers is by blowing them out, but they don't like it much. Honey supers are removed from the hive (bees and all) and stood on end. By placing them 15 to 20 feet away from the hive's entrance and using a special bee blower (or a conventional leaf blower), the bees are blasted from the frames at 200 miles an hour. Although it works, to be sure, the bees wind up disoriented and *very* irritated. Oh goodie. Again, I wouldn't recommend this method for the novice beekeeper.

A bee blower is basically the same as a conventional leaf blower, just packaged differently and usually more expensive.

For a description of the various tools used in the honey-extraction process (uncapping knife, honey extractor, bucket of warm water, a towel, and so forth) see Chapter 14.

Follow this procedure when extracting honey from your frames:

1. **One by one, remove each frame of capped honey from the super.**

   Hold the frame vertically over the uncapping tank and tip it slightly forward. This helps the cappings fall away from the comb as you slice them.

2. **Use your electric uncapping knife to remove the wax cappings and expose the cells of honey.**

   A gentle side-to-side slicing motion works best, like slicing bread. Start a quarter of the way from the bottom of the comb, slicing upward (see Figure 15-6). Keep your fingers out of harm's way in the event the knife slips. Complete the job with a downward thrust of the knife to uncap the cells on the lower 25 percent of the frame.

3. **Use an uncapping fork (also called *cappings scratcher*) to get any cells missed by the knife.**

   Flip the frame over, and use the same technique to do the opposite side.

   I discuss what you should do with the wax cappings, particularly if you want to use them for craft purposes, later in this chapter.

4. **When the frame is uncapped, place it vertically in your extractor (see Figure 15-7).**

   An *extractor* is a device that spins the honey from the cells and into a holding tank.

   Once you've uncapped enough frames to fill your extractor, put the lid on and start cranking. Start spinning slowly at first, building some speed as you progress. Don't spin the frames as fast as you can, because extreme centrifugal force may damage the delicate wax comb. After spinning for five to six minutes, turn all the frames to expose the opposite sides to the outer wall of the extractor. After another five to six minutes of spinning, the comb will be empty. The frames can be returned to the shallow super.

5. **As the extractor fills with honey, it becomes increasingly difficult to turn the crank (the rising level of honey prevents the frames from spinning freely), so you need to drain off some of the harvest.**

   Open the valve at the bottom of the extractor and allow the honey to filter through a honey strainer and into your bottling bucket.

6. **Use the valve in the bottling bucket to fill the jars you've designed for your honey.**

   Brand it with your label, and you're done! Time to clean up.

[8] Phil Craft Hive Craft. “Use your hive tool to remove the first frame”. Image. Available: http://philcrafthivecraft.com/?p=1177
[9] Cox Honey Farm. “Uncap the Honey Comb”. Image. Available: http://www.coxshoney.com/general/honey-harvest-process
[10] Cox Honey Farm. “Extract the Honey from the Honeycomb Frames”. Image. Available: http://www.coxshoney.com/general/honey-harvest-process
[11] Laurie Constantino. “Draining Honey from Extractor”. Image. Available: http://www.laurieconstantino.com/beverly-barker-queen-of-the-bees/

[12] Garden Geekery, "First Honey Harvest—Part 3: Bottling", 2016. [Online]. Available: http://gardengeekery.com/2013/09/23/first-honey-harvest-part-3-bottling/.

After you extract the honey into buckets, it's best to wait a few days before bottling. You're inherently going to get lots of air bubbles during extraction, so letting it sit lets the bubbles rise and makes for clearer honey in your bottles. You'll probably also end up with a foamy film of air bubbles on top (see pictures from my previous post); once you drain your bucket down to the bottom, that foam will get into your bottles. There's nothing wrong with it—it just doesn't look very nice. You can scoop it off in various ways before you start bottling, but I found a really good tip somewhere on the interwebs: Take a piece of plastic wrap and press it lightly onto the top of the honey. Lift it off, and the foam comes with it. I was skeptical about it, but it worked like a charm. Took off almost all the foam in one go.

[13]B. Shah and A. Seth, *Textbook of pharmacognosy and phytochemistry*. New Delhi: Elsevier, 2010.

Australia, California, Chili, Great Britain and New Zealand.

Collection and Preparation

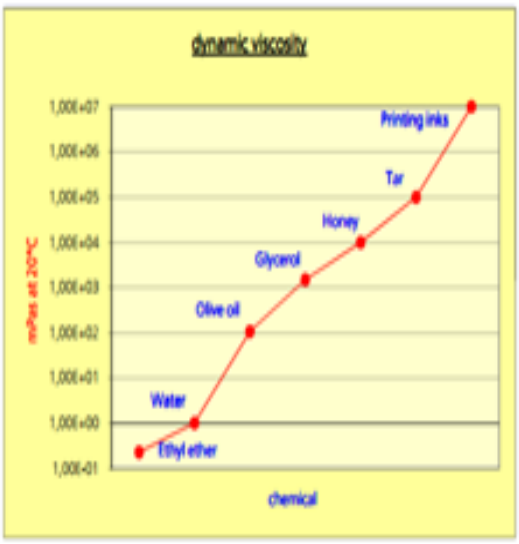
The nectar of the flowers is a watery solution containing 25% sucrose and 75% water. The worker bee sucks this nectar through its hollow tube of mouth (proboscis) and deposits in honey-sac located in abdomen. The enzyme invertase present in saliva of the bee converts nectar into invert sugar, which is partially utilized by the bee and the remaining is deposited into honey comb. Honey comb is smoked to remove the bees and honey is obtained by applying the pressure to it or allowing it to drain naturally. The honey of commerce is heated to 80°C and allowed to stand. The impurities which float over the surface are skimmed off and the liquid is diluted with water to

[14]Bürkle GmbH, Viscosity of Liquids 2011[Online]
Available: https://www.buerkle.de/media/files/Downloads/Viscosity_EN.pdf

Viscosity of liquids

The (dynamic) viscosity describes the flow behavior of liquids. It is defined as the internal frictional resistance of a liquid to the application of a pressure or a shearing stress. The dynamic viscosity η (Greek letter eta) is normally given in millipascal-seconds (mPas) and is usually determined by using a rotary viscometer.
Previously the viscosity was given in poises (or centipoises, 1 cP = 1 mPas).
In liquids the viscosity increases as the temperature decreases so that, in addition to the viscosity of the liquid, the temperature at which the viscosity was measured must also be mentioned!

Chemical	mPas at 20°C
Ethyl ether	0,23
Water	1,0087
Olive oil	107,5
Glycerol	1500
Honey	10000
Tar	100000
Printing inks	10000000



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[15]A.R. Aparna & D. Rajalakshmi (1999) Honey—its characteristics, sensory aspects, and applications, Food Reviews International, 15:4, 455-471
Available: http://www.tandfonline.com/doi/pdf/10.1080/87559129909541199

Physical Properties

Honey is a viscous and syrupy liquid, semi-translucent pale yellow or yellowish brown to dark brown in color with a sweet aromatic odor and sweet acrid taste. Microscopic impurities can reveal the type of impurities, the floral type, and the origin of honey (10). The degree of opaqueness is a quantitative characteristic of honey. The coloring matter present in honey includes chlorophyll, xanthophyll, anthocyanin, tannin, and carotene. The color of honey was determined earlier by comparators, but recently was determined by Lovi-Bond tintometer (17). It can be measured by absorption at 560 nm and the O.D. values may vary from 1–3 (18–20). The UV spectra is also characteristic of honey with peaks having λ maximum around 305–325 nm and thus any change in λ maximum can also be used to differentiate nectar honey from other honey. Apiary honey is either pale yellow, yellow amber, or dark amber with optical density ranging from 0.32 to 1 and a low pollen count

contrary to squeezed honey which is light amber with optical density ranging from 0.05 to 0.28 and a higher pollen content. Due to impurities like wax, pollen, and other small water insoluble particles. Squeezed honey and unprocessed honey is generally unclean, unhygienic, crystallizes quickly, and becomes easily fermented turning brown in color (9).

Honey has higher relative density ranging from 1.40–1.44 at 20°C depending on its water content. Therefore, relative density gives information about moisture content of honey. It is also reported that if relative humidity is 60%, then honeys containing less than 18.3% moisture will absorb water and those with higher moisture content will lose water to the air.

The viscosity of honey depends mostly on its water content and relative density. The viscosity of honeys determined by "Rheomat 15 T" was found to vary 100–500 poises (18,19,21). Rheopectic property of honey is due mainly to the presence of crystallized carbohydrates or suspended solids, whereas thixotropic property of honey is due to the presence of the proteins in it. Karvi honey, *carvia callosa*, from India and *Leptospermum scoparium* from New Zealand have been reported to possess thixotropic property.

The thermal conductivity of honey increases with temperature and decreases with water content. The property of electrical conductivity indicates the source of honey, whether it is nectar or honeydew (17).

COMPOSITION AND ANALYSIS

Chemical Composition

Moisture

The moisture content of honey is 15–20%. If the moisture content is less than 15%, which leads to greater viscosity and crystallization, several problems will have to be faced during subsequent processing (8,10,22,23). Poorly processed and unripe honey undergoes fermentation if moisture content exceeds 20%. This condition provides ideal growth of the osmophyllic yeasts like *Saccharolyces mellis, Fabian* and *quinet, S. rouxiiBoutroux, schizosaccharomyces octosporus Beijer*, which decomposes the sugars present in honey to carbon dioxide, acetic acid, and water. In ripe honey, if moisture is less than 22% then it is not liable to ferment, but fermentation occurs if honey is exposed to atmosphere. The ash content of honey is very low, it varies from 0.028 to 1%. The ash content depends on botanical origin and technique used for the determination. If the color of the honey is dark, it means that it contains more mineral salts and vice versa. Sulphur and chlorine content in honey promotes degree of pigmentation (10,16,19,24–37).

The proximate composition of honey is shown in Table 1. Honey is rich in carbohydrates with a calorific value of 319 kcal/100 g. The sugar content varies for differ-

Bottling and Storage of Honey

Honey is hygroscopic. It will absorb water if it is left exposed to moist air. (10) Since an increased water content will increase risk of fermentation, any container used for storing or marketing extracted honey should have an air-tight closure. Cans or caps used for storing or packing honey should be the standard, round, lever lid type, coated with lacquer on the inside and outside. Honey is acidic in nature, so a resistant coating is necessary on the inside to prevent inner corrosion and any subsequent spoilage of the contents. Generally, glass jars are preferred with a lacquered metal screw cap. The cap is provided with a waxed card wad or a plastic ring which provides an excellent seal when the cap is screwed down tightly. Commonly available containers for different quantities and types are shown in Figure 1. Plastic jars with a press-on lid is also used for packing smaller quantities of honey.

During storage, temperature is an important factor since both physical and chemical changes take place in respect to color, aroma, and flavor. Storage at lower temperatures for longer duration or at higher temperature for shorter duration will have similar effects and the extent of change will probably be comparable. Sucrose and higher sugars tend to increase while fructose and glucose tend to decrease. Pasteurized honey does not ferment. Similarly, amino acids decrease if honey is stored at room temperature. Diastase level can be maintained by using cold storage. During this period, granulation can be prevented by heating the honey. Tupelo honey (16)

[16] Honeybeecentre.com, "About Honey - Honeybee Centre", 2013. [Online]. Available: http://www.honeybeecentre.com/learn-about-honey#about-honey-processing.

Liquid Pasteurized Honey	Extracted and cleaned using flash heating to a high temperature, super filtered through a 1 to 5 micron filter, and quickly cooled. Looses much of the goodness that nature provided, but will last over 9 months on the store shelf without granulating.

The rate of crystallization increases with:

- Lower water content
- Higher glucose content
- Presence of solid particles (ie. pollen grains & honey crystals)
- Temperature close to 14 C (Temperatures above 28 C and below 5 C result in very slow crystallization)
- Stirring

[17]E. Westly, "Why does honey crystallize? » Scienceline", *Scienceline.org*, 2007. [Online]. Available: http://scienceline.org/2007/04/ask-westly-crystallizedhoney/.

to become thick and cloudy. Crystallization, which can occur anywhere from a few weeks to a few months after honey has been bought, can be remedied by placing the honey container in a bowl of hot water for a few minutes. But be warned: While honey may naturally have a long shelf life, heating and cooling the spread too many times can cause it to lose its color and aroma, according to the Honey Hotline Fact Sheet. After multiple heating sessions, it's probably best to throw the honey away.

[18] Urban Toronto Beekeepers' Association[Online]
Available: https://www.facebook.com/groups/urbantorontobeekeepers/

Members (936) See All

DESCRIPTION

URBAN TORONTO BEEKEEPERS' ASSOCIATION
'Sustainable Beekeeping through Education and Mentorship"

The purpose of the Urban Toronto Beekeepers' Association is to assist its members, new beekeepers, and anyone interested in learning about bees and beekeeping.

This is a closed group for residents of Ontario.

We meet the first Tuesday of every month at 7:00 pm. Meetings are held at the Earth Sciences Building U of T.
33 Willcocks St. Room 4001

All are welcome to our monthly meeting, you do not have to be a member to attend.

GROUP TYPE

Club

[19]P. Chorabik, "About Us", *Toronto Bee Rescue*, 2016. [Online]. Available: http://www.torontobeerescue.ca/about-us.html

Toronto Bee Rescue is dedicated to the humane removal and relocation of established honeybee colonies within the Greater Toronto Area. We remove honeybee colonies from homes, sheds, decks, and other man-made structures. We will also collect swarms of honeybees that have clustered on tree branches, fences, etc. The collected honeybee colonies are then relocated to more suitable locations where they are able to thrive as beneficial pollinators to the local environment.

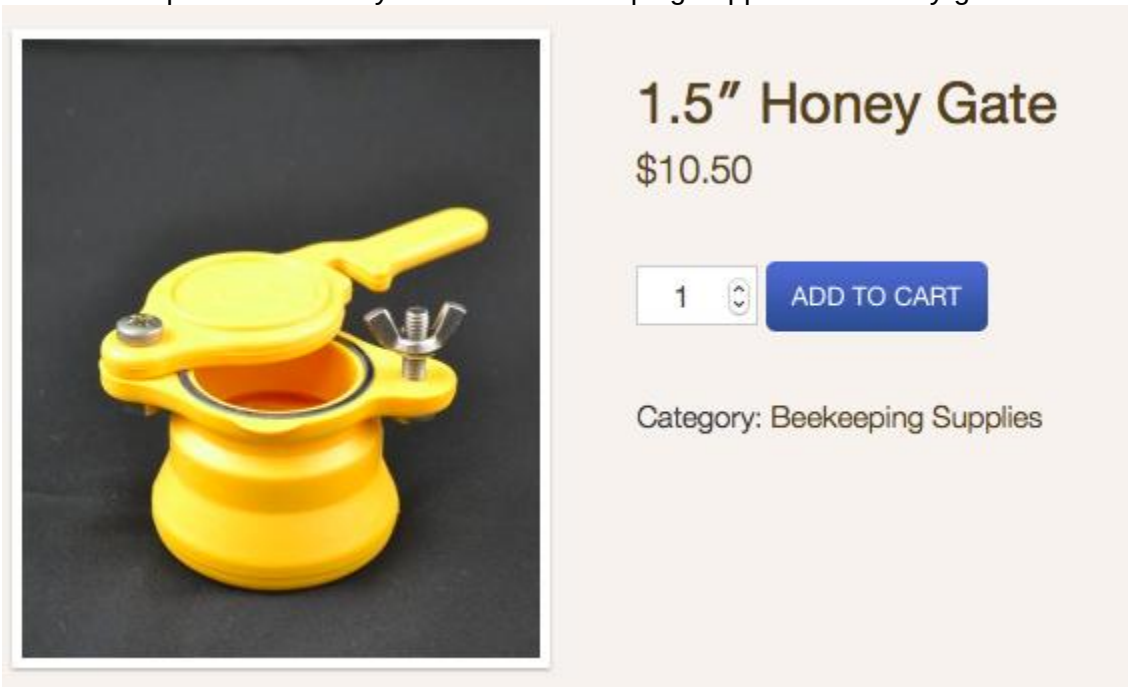
Our Goals Are:

1.To provide a humane manner in which to remove honeybee hives from structures
2.Relocate the rescued honeybee colonies to more suitable locations
3. Find great urban locations for honey bees
4. Provide the GTA with local honey

[20] Bottling Buckets, Miller Bee Supply.Image.
Available:http://millerbeesupply.com/catalog/bottling-bucket-p-55.php

[21] GothGourmet. “Honey Harvest” Image
Available: http://www.gothgourmet.com/2012/09/honey-harvest/

[22]CrocketHoney,Honey Gate. Image Available: http://crocketthoney.com/store/beekeeping-supplies/1-5-honey-gate/



[23]SnapGuide. “How to Extract Honey” Image
Available: https://snapguide.com/guides/extract-honey/

[24] BeeMaidBeeStore,Perfection Honey Gate.Image
Available: http://www.beemaidbeestore.com/product.php?txtCatID=66&txtProdID=117

Honey Gate - Perfection

Price: $47.50
SKU: H211
Shipping: Calculated at checkout
Quantity: 1 + Add to Cart

[25] Shop.carl-fritz.de, "Honey filling machines", 2016. [Online]. Available: http://shop.carl-fritz.de/index.php?cPath=16_21&language=en.

Filling station Dana api Matic 1000 mini

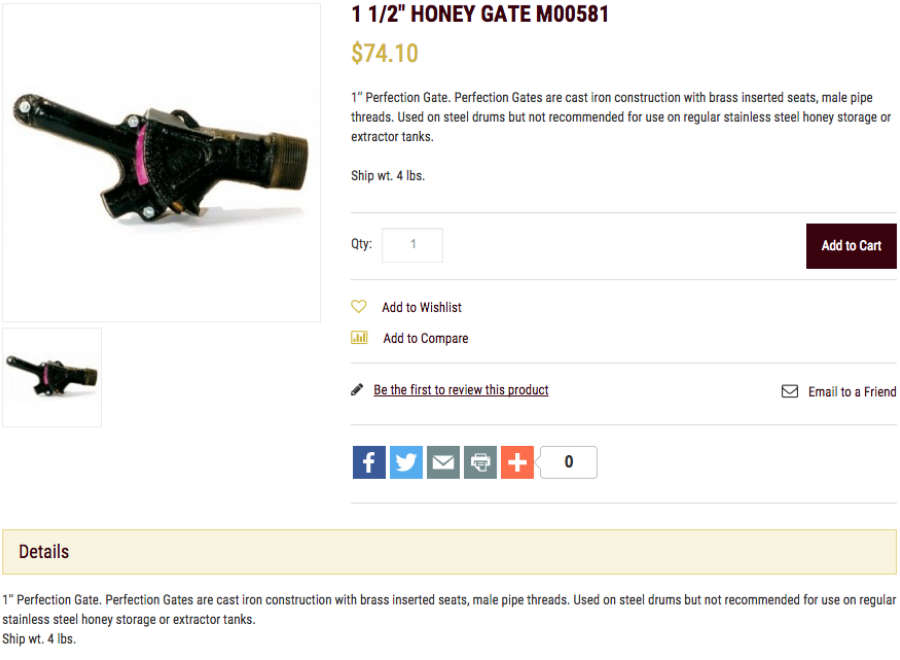
Consists of filling machine Dana api Matic 1000 and turn table Ø 70 cm on a mobile rack

from 4.199,00 EUR (incl. 19 % Tax excl. Shipping costs)

Buy now | Show details

[26] Dadant,10 Gallon Bottler. Image.
Available: http://www.dadant.com/catalog/honey-packing-bottling/m00624-10-gallon-bottler-wax-melter

[27] Datant,Honey Gate. Image.
Available: http://www.dadant.com/catalog/extracting/gates-valves/m00581-1-1-2-honey-gate-each



[28] *Processed Products Establishment Inspection Manual,* Canadian Food Inspection Agency, 2013-08-09, 6: Net Quantity. Available: http://www.inspection.gc.ca/DAM/DAM-food-aliments/STAGING/text-texte/processed_manual_chapter6_1386787455510_eng.pdf

Table 6-2: Tolerances for Net Quantities Declared in Metric Units of Weight or Volume (as per Schedule I, Part III, *CPLR*)

Column I Declared Net Quantity	Column II	
	Tolerance (%)	grams or millilitres
grams or millilitres		
> 0 and ≤ 50	9	-
> 50 and ≤ 100	-	4.5
> 100 and ≤ 200	4.5	-
> 200 and ≤ 300	-	9
> 300 and ≤ 500	3	-
> 500 and ≤ 1 kg or 1 L	-	15
kilograms or litres		
> 1 and ≤ 10	1.5	-
> 10 and ≤ 15	-	150
> 15	1	-

[29] *Consumer Packaging and Labelling Act*, (R.S.C. 1985, c. C-38), Government of Canada, 2016-01-25. Available: http://www.laws.justice.gc.ca/eng/acts/C-38/page-1.html#h-1

Where, within prescribed tolerances, net quantity not less than declared

(3) Where a declaration of net quantity shows the purported net quantity of the prepackaged product to which it is applied, that declaration shall be deemed not to be a false or misleading representation if the net quantity of the prepackaged product is, subject to the prescribed tolerance, not less than the declared net quantity of the prepackaged product and the declaration otherwise meets the requirements of this Act and the regulations.

[30] *Guide to Food Labelling and Advertising,* Canadian Food Inspection Agency, 2011-12, Chapter 12: Honey. Available: http://www.alimentheque.com/divers/GuideFoodLabellingAdvertising_CFIA_dec2011.pdf

12.2.1 Standard Container Sizes for Honey [29(2), *HR*]

The standard container sizes are applicable for honey which has been graded according to the *Honey Regulations* or that is marketed by a registered establishment - 150 g, 250 g, 375 g, 500 g, 750 g, 1 kg, 1.5 kg, 2 kg, 3 kg or 5 kg

[31] Producer Manual - Good Production Practices. Canadian Honey Council. Version 1.0. 16 July 2014.

GPP 2 – RECEIVING INPUTS

Producer/Owner.

2.3 FOOD SAFETY HAZARDS

2.3.1 Contamination by pathogenic bacteria (e.g. spores of *Clostridium* spp., *Bacillus* spp.) as a result of unsanitary transport carriers, equipment and/or mishandling in transit.

2.3.2 Contamination by residues of chemicals (e.g. petrochemical-based products) as a result of fouled transport carriers, equipment and/or mishandling in transit.

2.3.3 Contamination at source by residues of chemicals (e.g. petrochemical-based products, lead) in bulk and/or small containers as a result of incorrectly manufactured (e.g. non Food and Drug Act/Regulations-compliant) containers, coatings , plastic liners gaskets, lids, packaging, etc..

2.3.4 Contamination by extraneous material (e.g. metal, glass, rock/sand) as a result of fouled transport carriers, equipment and/or mishandling in transit.

2.3.5 Contamination by erroneous or unauthorized medications as a result of wrong product, incorrect identification, and/or incomplete documentation upon receipt.

2.3.6 Contamination at source by residues of chemicals (e.g. petrochemical-based products) as a result of incorrectly manufactured (e.g. non Food and Drug Act/Regulations-compliant) packaging accessories (e.g. packaging liners, lids, sealing wax, etc.) for small containers.

2.3.7 Contamination at source by extraneous material (e.g. metal, plastic, glass) as a result of incorrectly manufactured or reconditioned product (e.g. bulk metal, plastic drums/totes and/or small containers).

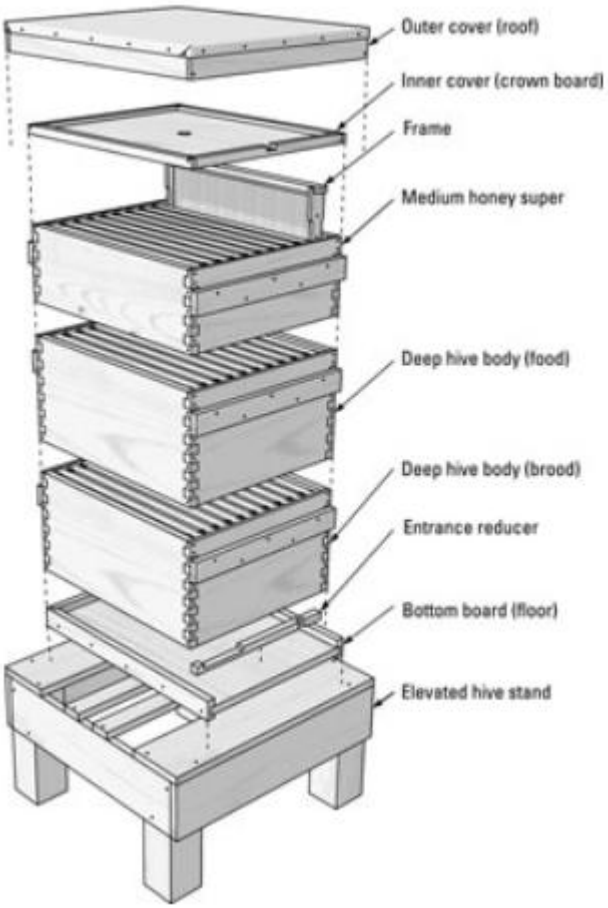
2.4 ACCEPTABLE LIMITS FOR CONTROL MUST DO

2.4.1 **Feed Supplements -** All feed supplement inputs that are damaged, punctured, or with indications of being cross-contaminated with chemicals (e.g. petrochemical-based products) as a result of fouled transport carriers, equipment and/or mishandling in transit are rejected for use upon delivery (not unloaded).

[32] Blackiston, Howland. *The Parts of a Beehive,* Building Beehives For Dummies. Available: http://www.dummies.com/how-to/content/the-parts-of-a-beehive.html.

Frames

Some hives use removable frames (for example, nuc, observation, British National, and Langstroth). The bees build their honeycomb onto the frames. Because the frames are removable from the hive, you can easily inspect, manipulate, and manage the colony.



Deep hive bodies

The deep hive bodies are essentially boxes that contain frames of comb. For a Langstroth hive, you typically build two deep hive bodies to stack on top of each other, like a two-story condo.

The bees use the *lower deep* as the nursery or *brood chamber,* to raise thousands of baby bees. They use the *upper deep* as the pantry or *food chamber,* where they store most of the honey and pollen for their use.

If you live in an area where frigid winters just don't happen (temperatures don't go below freezing), you may not need more than one deep hive body for your colony (one deep for both the brood and their food). In such situations, you want to monitor the colony's food stores and feed the bees if their supplies run low.

Honey super

Beekeepers use *honey supers* to collect surplus honey. That's *your* honey — the honey that you can harvest from your bees. The honey that's in the deep hive body must be left for the bees. Supers are identical in design to the deep hive bodies, and you build and assemble them in a similar manner. But the depth of the supers is more shallow.

Appendix B - Key Stakeholder Contact Information

Peter Chorabik
Toronto Bee Rescue
Cell: (416) 809-5669
info@torontobeerescue.ca

Urban Toronto Beekeepers' Association
https://www.facebook.com/groups/urbantorontobeekeepers/
urbantorontobeekeepers@gmail.com
Meetings are held the 1st Tuesday of every month @ 7:00 pm in the The Earth Sciences Building, University of Toronto, 33 Willcocks Street, Room 4001.