The Use of Plastic in Beehives

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Beekeeping is well entrenched into the plastic age, however the regulations set by our governing body, Food Standards Australia and New Zealand (FSANZ), and the New Zealand Government seem to be lagging behind developing apiculture practices regarding the use of plastic. This article will cover the impact of plastic on the apiculture industry and the mostly unexplored consequences of using plastic with little to no regulation. It is evident that given the importance of apiculture industry to New Zealand's export industry, that the lag in the regulations may at worst impact the brand name of honey from New Zealand which could be devastating to beekeepers across the country.

While the government has made numerous announcements to phase out and reduce the use of plastics, the opposite is happening in New Zealand's apiculture industry. Where wood was the primary component of beehives in the past, plastic has now replaced virtually all the components of a beehive. Everything from the hive floors, hive roofs, queen excluders, beehive frames and the hive bodies have been replaced with plastic components. Even queen bee rearing is carried out with plastic components. The ubiquity of plastic in beehives is so pervasive, that some beekeepers have no wooden components in their beehives.

However, getting rid of plastic in beehives would require more than a reversion back to wooden components. While wood is more natural; plastic is lighter, cheaper and more durable than wooden components. For these reasons alone, plastic has provided a benefit to labour-intensive beekeeping; beekeepers are no longer required to spend hours constructing and repairing beehive components. As such the use of the plastic alternatives reduce the material cost and wage cost significantly. Despite the growing apiculture industry in New Zealand, unlike the agricultural industries impact on the environment, the scale of plastic in beehives, has remained largely unnoticed by the consumer public and is overlooked by regulators. In this article, there are two focal points. The first is the safety of using plastics to store and harvest hive products, with a focus on honey. The second is on the disposal of diseased and degraded end-of-life plastic hive components.

The exposure to potentially hazardous chemicals migrating from food grade plastics is well established in research (For example, Massey University held a conference in June 2019 which focused on the health risks of plastics and food packaging chemicals https://www.unwrappedconference.org/) and while there is a focus on food packaging and

storage, there is little if any discussion about hive food products that are collected on plastics. Honey is a food product that is regulated by Food Standards Australia and New Zealand (FSANZ). Specifically, FSANZ, regulates the safety of any food packages and compliance with relevant legislation (Australia New Zealand Food Standards Code – Standard 1.4.1 Contaminants and natural toxicants). In other jurisdictions, such as the United States Code of Federal Regulations and the European Commission Directives (Framework Regulation (EC) No 1935/2004 and (EU) No 10/2011 and FDA legislation) the safety of all plastics is heavily regulated in food contact materials, including honey frames

New Zealand's apiculture industry exported 10.2 tonnes of honey (valued at $425m) in 2019/20 season (Ministry of Primary Industries, (2020). *2020 Apiculture monitoring programme)* and virtually all New Zealand's commercial beekeepers collect their honey on PET plastic frames (Polyethylene terephthalate plastic (PET)). PET plastic is widely used in food packaging and considered one of the more favourable food grade plastics in New Zealand. Despite this, some of New Zealand's beekeepers use plastic honey frames that are certified as *100% pure virgin food grade resin;* a variation of PET plastic (For example, Ecrotek Ltd issue a 'certificate of compliance' with the sale of their plastic frames (Framework Regulation (EC) No 1935/2004 and (EU) No 10/2011 and FDA legislation) - however not all hive suppliers do this). The certification makes their honey collection compliant with foreign regulations. However, it is unclear how many of New Zealand's beekeepers do this as it is an unregulated area. Presumably with a majority of beekeepers using PET plastics rather than electing to comply with foreign regulation, this should be a regulated area in New Zealand. Especially because more of New Zealand's export partners are now testing honey for toxicants (For example, Japan rejected a batch of honey after detecting traces of glyphosate in March 2020).

The guidance from Ministry of Primary Industries (MPI) is that any plastic packaging can affect food and identifies honey as a typical food where caution should be exercised (MPI, (2021). *Plastic packaging, microplastics and food safety.* Retrieved from https://www.mpi.govt.nz/food-safety-home/safe-levels-of-chemicals-in-food/plastic-packaging-microplastics/). However, MPI has set no specific guidelines regarding the type, quality or potential toxicity level of the plastic honey frames used to collect the honey. Furthermore, there is no commentary as to whether the plastic honey frames (The discussion here is limited to honey frames, however different plastic frames are used to collect propolis, another food product harvested from beehives) are considered to be food storage containers or part of the honey extraction process and therefore plastic conveyance products (Plastic conveyance products refer to items used in food processing such as plastic pipes for example). Regardless, the use of the honey frames would support them being classified as food storage containers rather than processing items, because unextracted honey can be stored in the plastic frames for months at a time.

With this is mind, there is increasing research which has established that non-intentionally added substances This are products not listed in the regulations that present as break-down products (Bach, C., Dauchy, X., Chagnon, M. & Etienne., S. *Chemical migration in drinking water stored in polyethylene terephthalate (PET))* not listed in the regulations, i.e., plastic

chemicals/particles, are migrating from all 'safe' plastic food containers[1] into the food. The urgency of this matter has been taken up by World Health Organisation, which is calling for more research into the current standards and the efficacy of the different [cleaning] treatment processes of food-grade plastics (WHO, (22 August, 2019). *WHO calls for more research into microplastics and a crackdown on plastic pollution.* Retrieved from https://www.who.int/news/item/22-08-2019-who-calls-for-more-research-into-microplastics-and-a-crackdown-on-plastic-pollution) . From the apiculture perspective, the critical gaps in the research relate to the impact on human health from honey held on PET honey frames and the environment for the bees (Research has already established there is microplastics found in honey. See Liebezeit G, Liebezeit E. *Non-pollen particulates in honey and sugar*. Food Addit Contam Part A Chem Anal Control Expo Risk Assess. 2013;30(12):2136-40. doi: 10.1080/19440049.2013.843025. Epub 2013 Oct 28. PMID: 24160778).

The presumption from FSANZ implies the plastic honey frames are food safe (FSANZ 2.8.2(1)). However, there is little or no discussion about the life cycle of a honey frame. It is when the plastic frame is exposed to extreme heat, and repeated reuse, plastic honey frames may ultimately become unsafe regardless of the food standards.

Honey frames are exposed to heat in two fundamental ways. Firstly, the temperatures within a hive remain between 35-37 degrees Celsius on average regardless of the outside weather. The nature of the beehive means bees cluster over their brood frames (bee larvae are held in the brood frames), generating the heat to keep the bee brood warm. In the summer months, the internal temperature of the hive can reach up to 40^{o} degrees Celsius. Secondly, when honey frames are harvested from the beehives, they are stored in heated rooms (range 27-30^{o} Celsius) for several days prior to extraction: the heating process reduces the moisture content (FSANZ Standard Code – 2.8.2 – Honey), viscosity of the honey, prevents crystallisation and eases the extraction process from the frames(Singh, I., & Singh, S. (2018). Honey moisture reduction and its quality. *Journal of food science and technology*, *55*(10), 3861–3871. https://doi.org/10.1007/s13197-018-3341-5). Consequently, plastic honey frames are exposed to sustained heat throughout the duration of their use. Even if the honey frames are considered a stable thermoplastic – sustained heating goes against MPI's policy and guidance for the use of food-grade plastics (MPI, (2021). *Plastic packaging, microplastics and food safety.* Retrieved from https://www.mpi.govt.nz/food-safety-home/safe-levels-of-chemicals-in-food/plastic-packaging-microplastics/) because sustained heat can increase the release of chemicals from PET plastics regardless of its thermoplastic stability.

Moreover, the durability of the plastic honey frames means that beekeepers will reuse the honey frames over many years; high powered washing (this is carried out with high pressure water blasting – the water can be hot, warm or cold) the plastic frames with chemical detergents/bleaches is a standard practice. Eventually, the older the honey frames degrade to a point where they can no longer be used. Yet there is no guidance (from either MPI or the apiculture industry itself) at which point honey frames should be no longer used and discarded. New Zealand has to have more than 17 million honey frames circulating in

beehives(854,477 hives x 20 plastic frames (2 super boxes) per hive – 17, 089, 549 plastic frames) in any one season, thus, this is an important issue that has yet to be addressed by regulators.

Biosecurity (National American Foul Brood Management Plan) Order 1998. Since the introduction of beehives into New Zealand in 1839, the industry has worked hard to restrain introduced bee diseases; specifically American Foul Brood (AFB). The first Apiaries Act (1906) had oversight of disease prevention, but AFB was poorly understood, so the inspectors would try to treat the disease and if unsuccessful, ultimately burn the hive. The newer informed Biosecurity (National American Foulbrood Pest Management Plan) Order (1998) (Biosecurity Plan) aims to eradicate AFB from New Zealand beehives so that all the components of a diseased AFB hive including any honey must be destroyed by burning (Biosecurity (National American Foulbrood Pest Management Plan) Order 1998, s28 deals with the hive components and s31 deals with the destruction of the honey). The hives are usually burnt at the apiary [after the bees have been euthanised]. In keeping with this tenet, the AFB Pest Management Plan Agency (AFB PMP) recommends any used or obsolete hive products should also be burned and the use of landfills avoided. However, neither the government nor the AFB PMP could have anticipated the pervasive use of plastics in the modern beehive; other hard plastics are used in other hive components apart from PET honey frames. As a result, beekeepers across New Zealand are burning large quantities of plastic in open pits whenever they burn a diseased hive or end of life hive components. Every time a hive or hive components are burnt, the open fire pits are releasing dangerous chemicals into the air, including particulates; something that could not have been anticipated by the Biosecurity (National AFB Management Plan) Order 1998.

Most **regional councils** prohibit the burning of plastics because of the long-term health implications for people and animals. However, in certain instances, a resource consent can be obtained, for when a contaminant is discharged into the air from any industrial or trade premises (s15 Resource Management Act). However, there are several challenges with this approach for beekeepers. Firstly, the burning of AFB infected hives is mandated by the Biosecurity Plan and the AFB Management Agency spends a significant part of its budget ensuring compliance (Countries like the USA for example allow AFB infected plastic to be radiated however that is not the case in New Zealand). Noncompliance can result in penalties for the beekeeper (Biosecurity (National AFB Pest Management Plan) Order 1998). Moreover, the application and timeframe for the issue of a resource consent permit could potentially exceed the 7-day requirement to burn a diseased hive (Biosecurity (National AFB Pest Management Plan) Order 1998). Nevertheless, a diseased hive found in an apiary must be burnt on site; there are very few exceptions to this regulation(An application for an exemption has to be made to the AFP PMP Agency). With that in mind, apiaries are found across New Zealand, from urban to rural locations. However, whether any apiary location could be defined as an industrial or trade premises for the purposes of s15 of the Resource Management Act is yet to be decided in court.

Furthermore, beehives burn vigorously with flames reaching 2 -3 times the height of the stack; generating significant heat, odour and smoke. The vigour of beehive fires is connected not

only to the plastic components in the hives, but any wooden components could have potentially been paraffin dipped (The wooden hive components are dipped in paraffin wax, an alkane hydrocarbon material otherwise known as petroleum wax). Paraffin dipping is a common practice among commercial beekeepers because it extends the life of the wooden components of the hive (A vat of paraffin wax (130 kilos usually) is heated to 160 degrees and the wooden components are dipped for 10 mins). Again, the AFB agency provides guidance on how to use a paraffin dipper but does not specify if a resource consent is needed – paraffin wax has a flash point of 182 degrees). However, the burning of petroleum products is usually strictly prohibited by district councils because of the smoke and dioxin pollutants (For an example see Waikato Regional Council at https://www.waikatoregion.govt.nz/environment/air/outdoor-burning/).

Nonetheless, beekeepers are not only burning plastic, but they are also burning petroleum products as well. Whether plastic and/or paraffin dipped hive components, once alight, the speed of burning increases dramatically so whether a beekeeper can minimise the smoke or fumes nuisance that arises from burning beehives and hive components safely is moot. In ordinary circumstances, the person causing the nuisance would be required by the council to extinguish the fire however that would not apply in these instances.

There are 854,477 hives in New Zealand (2021) and New Zealand has an AFB rate of approximately 3% - which means every year at least 25,634 hives are burnt (854,477 (number of hives) x 3% = 25,634 hives to be destroyed every year). Yet the burning of hives flies in the face of New Zealand's Climate Change Response (Zero Carbon) Amendment Act (2019); a framework for gas emissions reduction targets. This includes the prevention of the burning of plastics because carbon dioxide emissions increase when plastic is burnt (Verm, R., Vinoda, K.S., Papireddy, M., and Gowda, A.N.S. (2016). Toxic pollutants from plastic waste- A review. Procedia Environmental Sciences, Vol 35, pp. 701-708).

In conclusion, the issues raised in this article will be familiar to anyone who has been involved in New Zealand's beekeeping over the past decade or so. The food safety and environmental impact that the hive plastic has is real; finding solutions will be complicated given the pervasive use of plastic in New Zealand's beehives. However, there is no doubts about the importance of the apiculture industry to New Zealand's export industry , therefore New Zealand's regulators need to take steps to address these concerns.