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Short communication

Safety Assessment of the Frame Used for Honeybee Breeding and Beekeeping Product Production

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Abstract In this study, we assessed the safety of honeybee-breeding frames. Hazardous substances (arsenic, lead, sulfur dioxide, o-phenyl phenol, thiabendazole, biphenyl and imazalil) were monitored in the commercial frame. The frames were collected from two different regions in Korea. According to the Korean Food Contact Materials Code, arsenic, lead, sulfur dioxide, o-phenyl phenol, thiabendazole, biphenyl, and imazalil contents were below the standard values for wood (0.1, 1.0, 12.8, 7.3, 1.8, 0.9, and 0.6 mg/L, respectively). Our results indicate the safety of the frames and promote a frame database establishment, and thus, contribute to the development of apiary pre-harvest hazard analysis critical control point.

Keywords Beekeeping, Frame, Beekeeping product, Safety

INTRODUCTION

Honeybees are considered livestock, similar to cattle, horses, and sheep, and beekeeping products obtained from honeybees are defined as livestock products (MAFRA, 2022). Currently, domestic livestock farms have a hazard analysis critical control point (HACCP) in the production stage of the Livestock Products Sanitary Control Act, but honeybees are excluded (MFDS, 2021a). Production stage HACCP in livestock farms analyzes risk factors (veterinary drug residues like *Salmonella*) that may occur during the livestock growth stage and establishes standards for priority management and prevent contamination. However, in the case of domestic livestock products, after applying HACCP to slaughterhouses and processing plants in 1998, HACCP was introduced to all processes from farms to sales, and the scope of food safety management has been expanded to the production stage (livestock growth stage). Livestock product safety control measures were also established.

Australia and Canada have implemented quality and safety management systems in the overseas beekeeping industry, and the common point is that practices in both countries are based on HACCP. Australia follows the B-QUAL certification developed by the Australian Honey Bee Industry Council, which is intended for beekeepers and honey packers, a quality assurance program for the honeybee industry based on the Food Standards Code and the HACCP principles of the Food Standards Agency for Australia and New Zealand (B-QUAL accreditation rules, 2019). Canada developed the Canadian Bee Industry Safety Quality Traceability (CBISQT) program in 2014 as a result of developing an internationally recognized HACCP system as part of the farm-level food safety program established by the Canadian Honey Council (Canadian Honey Council, 2014).

In the current state of domestic honeybee breeding over the last five years, the number has increased to 22,609 colonies in 2016, 24,629 colonies in 2017, 26,487 colonies in 2018, 29,026 colonies in 2019, and 27,532 colonies in 2020 (MAFRA, 2021). In the future, we will need more quality control practices in addition to production.

Therefore, in this study, we analyzed the safety of

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frame food contact material (wood) in the market, constructed a quality database, and attempted to use it as basic data for future HACCP research in the production stage for beekeeping farmers.

MATERIALS AND METHODS

1. Sample preparation

The frame used in the experiment was used for analysis after purchasing the comb foundation frame from the market in 2022 (Jeonnam Gwangju, Chungnam Geumsan) and separating the relevant parts.

2. Analysis of frame safety

1) Arsenic (As_2O_3)

The safety analysis of the frame was performed according to the Food Contact Materials Code (MFDS, 2021b). Briefly, the test and standard solutions were tested using the inductively coupled plasma emission intensity measurement method (wavelength: 193.7 nm).

2) Lead (Pb)

The standard and test solutions were prepared following the Food Contact Materials Code and the measurement method was based on inductively coupled plasma emission (wavelength: 220.4 nm).

3) Sulfur dioxide

To establish the sulfur dioxide content, we followed the aeration distilled alkali analysis method of the Food Contact Materials Code. The calculation formula was as follows (however, less than 2 μg/mL was not detected):

$$\text{Sulfur dioxide (μg/mL)} = \frac{(a-b)\times f \times 32}{c}$$

a: 0.001 M NaOH consumption of test solution (mL)
b: 0.001 M NaOH consumption of blank solution (mL)
c: Volume of test solution used for distillation (mL)
f: Factor of 0.001 M NaOH

4) o-phenyl phenol, thiabendazole, biphenyl and imazalil

o-phenyl phenol, thiabendazole, biphenyl, and imazalil contents were measured using high-performance liquid chromatography (HPLC; Agilent, Santa Clara, USA). A C_{18} column was used (4.6 mm I.D. × 250 mm, 5 μm) and two mobile phases consisting of water (0.25% phosphoric acid) and acetonitrile (0.25% phosphoric acid), respectively, were applied at a flow rate of 1.0 mL/min and a temperature of 40°C. The injection volume was 20 μL and detection was performed at 230 nm (Table 1).

Table 1. HPLC conditions to detect o-phenyl phenol, thiabendazole, biphenyl and imazalil contents

Parameters	Conditions
Injection volume	20 μL
Detector	DAD
Wavelength	230 nm
Column temperature	40°C
Flow rate	1.0 mL/min
Mobile phase	A: 0.25% phosphoric acid in water, B: 0.25% phosphoric acid in acetonitrile

3. Statistical analysis

Data presented as mean ± standard deviation (SD).

RESULTS AND DISCUSSION

The comb foundation frame, an essential material for beekeeping, serves as a habitat for bees and as a storehouse for beekeeping products. In particular, beekeeping products, including honey, are used for community preservation and are the main source of income for beekeeping farmers. Prior research on these beekeeping products includes nutritional content, functionality, and toxic substance analysis (Kim *et al*., 2019a; Kim *et al*., 2019b; Kim *et al*., 2020). However, research on the safety of comb foundation frames, which directly or indirectly affect the production of beekeeping products, is incomplete. Therefore, in this study, we attempted to evaluate the safety of a honeybee-breeding frame based on the Food Contact Material Code (wood). The contents of all tested chemicals were found to be below the standard value or not detectable (Table 2). In contrast, honeybees are known to use propolis collected from plants to fill gaps in honeycombs and maintain the honey-

Table 2. Analysis of hazardous substances in the commercial frame

Hazardous substances (mg/L)	Samples	
	F1[1)]	F2
As (As_2O_3)	ND[2)]	0.0
Pb	0	0
Sulfur dioxide	ND	ND
o-phenyl phenol	ND	ND
Thiabendazole	ND	ND
Biphenyl	ND	ND
Imazalil	ND	ND

[1)]F1: Jeonnam Gwangju, F2: Chungnam Geumsan (collected location).
[2)]ND: Not detected.

comb in a sterile state, and food-poisoning bacterial and fungal toxins were not detected in drone pupae collected from honeycombs as reported previously (Ghisalberti, 1979; Kim *et al*., 2018). It is correct to investigate all the frame distributed in the Korean market, but there were limitation in terms of temporal and physical. In the future, we will plan to investigate the safety of other frame. Therefore, although the safety of the honeycomb, frame, and beekeeping products was confirmed through previous studies, further research is necessary on the correlation between them.

CONCLUSION

In this study, before the introduction of HACCP in the production stage, we investigated the safety of the frame as it is in direct contact with the honeycomb, which is essential for honeybee breeding and the production of beekeeping products. After purchasing a commercially available comb foundation frame, only the frame was separated, and as a result of the analysis (mg/L), arsenic content was below the standard value or not detected, lead content was below the standard value, and sulfur dioxide, o-phenyl phenol, thiabendazole, biphenyl, and imazalil contents were not detected. Therefore, the results of this study confirm the safety of frames, and further suggest that they can be used for HACCP research in the production stage of beekeeping farms.

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