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Determining Pesticide Residues in Bee produce and their Potential Risk to Consumers in Tanzania

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Abstract

Purpose: The purpose of this study was to examine pesticide contamination in bee products in Singida District Municipality of Tanzania, particularly at Kijiji cha Nyuki. The specific focus of the study was to assess the levels of pesticides residues in bee products harvested from the selected bee farms, identifying the common type of pesticides that contaminate honey and honey products on the quality of selected bee products.

Material and Methods: A mixed methods approach was adopted for this study and collected data both primary and secondary data was collected using physical observation and survey, interviews and questionnaires, the purposive and random sampling techniques was used in this study to select total of 104 participants who was taken as a sample from universal populations. Qualitative and quantitative data were analysed using IBM Statistical Package for Social Sciences (SPSS) Computer Programme version 25, where statistics aspect was determined from the results obtained from both questionnaires and laboratory experiment to the four (4) honey sample Bee pollen One Kg, propolis 500gm, and Bee wax One Kg.

Findings: The study found 252 pesticides residues ingredients in beeswax with a mean of 0.03 mg/kg. Lambda-cyhalothrin ingredient had 4.20 mg/kg of the total pesticide's ingredient found in beeswax against 251 which represent the rest of the pesticides ingredient that were concentrated in the beeswax. In regards with the effect of lambda-cyhalothrin identified in beeswax, bee pollen and honey, the results indicate current concentrations of pesticides in beeswax, bee pollen and honey does not pose risk to human health neither to environment, this is an indication that honey produced in the Kijiji cha Nyuki is safe for consumers as there is very low concentrations of lambda-cyhalothrin in each studies area.

Unique Contribution to the Theory, Practice and Policy: It was noted most of the pesticides that found in honey was agricultural pesticides therefore Theory of Planned Behaviour was relevancy in explain the relationship of individual to use pesticides to the agricultural. Therefore, study will contribute to the beekeeping programme guidelines for quality control of bee products to provide thoughtful mitigate to the amount of pesticide contamination in bee and honey products, the study could contribute to policy design and implementation to understanding of how the regulations outlining the use of insecticides is being implemented, and the current economic condition of studied farms.

Keywords: *Pesticides, Honey, Beeswax, Beekeepers, Contamination, Kjiji Cha Nyuki*

INTRODUCTION

The world population is estimated to reach 8.5 billion people by 2030 (Clark & Tilman, 2017). The growing population contribute to food demands in the process farmers have resorted to intense use of pesticides in order to increase their productivity and meet consumer demands yet extensive use of pesticides can lead to negative outcomes. By 2017 an estimated 6 million metric tons of pesticides were used (Bernhardt et al., 2017), with Europe being the largest pesticides consumer followed by China and the USA (Hossain et al., 2017).

The use of pesticides in developing countries is about 25% with exceptionally high application on vegetables (Zikankuba et al., 2019). Kasianchuk, et al. (2020) several researchers are of the view that pesticide residues have some negative effect to honey consumers. Hence the presence of pesticides in honey has been investigated in a number of countries including, Tanzania, Kenya, Ethiopia China, Egypt, Malaysia, Brazil, Italy, Poland, Spain, France, Argentina, the United States, Turkey, and India included (Kasianchuk, et al. 2020). Scripca˘ & Amariei, (2021) indicates that honey is a sweet substance naturally produced by *Apis mellifera* L. bees.

Bees collect and transform the nectar of plants or secretions of living parts of some trees, producing honey and storing it in honeycomb cells (Otero et al., 2020). Honey contains more than 180 substances, and the main compounds are sugars, water, and minerals (Nisbet at al., 2018; Waheed et al. 2018; Islam at al. 2020). According to Scripca˘ & Amariei, (2021) the water content of honey ranges from 10% to 20%. Scripca˘ & Amariei (2021) further opinionated that honey can be contaminated with pesticides from agricultural practices and beekeeping, these compounds can be transferred by nectar from the environment into honey. Acaricides drug used by beekeepers to control *Varroa destructor* mite infestation of bee colonies represent the direct source of pesticide contamination of honey (Mancuso at al., 2020). Honey is used in four main ways; (i) direct consumption, (ii) as an ingredient in various products, (iii) for industrial use, and (iv) as a raw material for meals and drinks made from honey (Kasianchuk et al. 2020). In general, residues of organophosphorus pesticides such as coumaphos and chlorpyrifos-methyl have been found in honey samples, along with organochlorine pesticide residues such as lindane, chlordane, endosulfan, aldrin, and endrin (Calatayud-Vernich, at al., 2016; Kumar at al., 2018).

In Africa, pesticides use represents less than 5% of the total amount of pesticides used worldwide but many developing countries have large stockpiles of obsolete pesticides, usually scattered over various sites (PAN UK, 2007, World Bank, 2013). These pesticides are in deplorable state and are hazardous to both human and environmental health (World Bank, 2013). Moreover, the rapid increase in human population in African countries requires more food supply putting a strain on agricultural land available for crop production (Naidoo, 2010; Williamson, 2008).

According to World Bank (2013), in Africa, pesticide use is usually lower when compared to other areas; this means bees are less exposed to pesticides per food visit. However, South Africa is the highest food producing country on the continent and is also the major consumer of pesticides in sub-Saharan Africa. The use of the pesticides poses serious issues to the country to develop satisfactory techniques, which can combine optimal agricultural productivity and environmental safety (Musa et al., 2011).

This causes more danger to consumers because humans accumulate 5 times more pesticides from food than any other sources such as air and water (Naggar et al. (2017). The use of honey contaminated with pesticides may lead to sudden death, if chemical is highly toxic, similarly the return of contaminated food to the hive exposes the whole colony. Therefore, monitoring of pesticide residues in honey is vital to ensure honey's quality and to safeguard consumer from any harmful effect (Scripcaˇ & Amariei, 2021). The production of bee products needs to pay attention to consumer health, international competition and better product quality. As a result, a continuous examination of honey bees and their products is critical for monitoring fluctuations in pesticide exposure and their levels in the environment. The presence of pesticides in the bee products poses potential health risk to consumers. Currently there is scants academic investigation that have revealed the level of contamination of bee products (honey, beeswax, beebread, propolis) due to pesticides usage in Tanzania. For example, Lahr et al. (2016) show the use of pesticides to poison wildlife is a growing concern throughout East Africa, where all classes of pesticides have been used, including organochlorines, organophosphates, carbamates, and pyrethroids. This is despite a study by Fawzy et al. (2014) suggesting tighter regulation in the production of pesticides, processing and distribution as well as implementation of integrated pest management methods.

Pesticides are applied during the production stage, storage, transportation, distribution and processing of food and feeds. Insecticides, herbicides, fungicides, nematicides and avicides are some of the examples (Botits et ak., 2017). Pesticides are classified into groups based on their chemical structure (organophosphates, pyrethroids, organochlorines, carbamates, neonicotinoids etc.), mode of action (systemic, contact), target (insecticides, acaricides, herbicides, fungicides, bactericides, nematicides) and synthesis (synthetic or natural) (Antonini & Argilés-Bosch, 2017; Botitsi et al., 2017). There are two types of pesticides, organic and inorganic pesticides. Organic pesticides are carbon-based pesticides from natural occurring materials or synthetically produced from organic chemicals (Zikankuba et al., 2019). Inorganic pesticides are derived from mineral compounds that occur as deposit in nature, mainly compounds of antimony, copper, boron, fluorine, mercury, selenium, thallium, zinc and elemental phosphorus and sulfur (Patinha et al., 2018).

Karazafiris et al. (2011) bee products may be indirectly contaminated through the transfer of pesticides from fields to beehive. To avoid residues pesticides should be used outside the bloom period or at least, not during the foraging time of bees. Beekeepers can also avoid residues by placing their hives more than 3 km from agricultural plants treated with pesticides (Kumar et al., 2020). As noted by Kumar et al. (2020) various parts of the world honey bees' experiences extreme infectious diseases such as European foulbrood disease (EFB) and American foulbrood disease (AFB). Nevertheless, habitual feeding of honey to the infants, old and ill people need to consider gazetted guidelines considering the chronic long-term exposures of these chemicals and their potential contribution to the epidemiology of antimicrobial resistance (Kumar et al., 2020). The chemical composition and quality of honey depend on many factors, such as the type of the melliferous plants the nectar was collected from, the beekeeping practices, and the conditions of honey storage (Kasianchuk, et al. 2020). Murashova et al. (2020) postulates that leaf vegetable absorbs much lead from the air, up to about 95 % with increased soil pollution by lead (about 50 mg/kg), herbaceous honey plants accumulate about a tenth of this amount. Bees are constantly affected by a variety of factors, especially when pollinating entomophilous plants and collecting nectar (Fatkullin, 2017). The most important condition is the proper placement of the apiary whilst paying attention to field pollution with pesticides, the sanitary condition of apiaries, the health of bee colonies and the use of various preventive and therapeutic means (Fatkullin, 2017; Murashova et al. 2020). For instance, honey products obtained along highways are prone to lead contamination in spite of the fact that the lead is not transported by plants but can get into honey products through direct contact with nectar and pollen (Murashova et al., 2020). Typically, pesticide residues in honey occurs when bees in search for food, visit crops that have been treated with various agrochemicals (Irungu et al. 2016; Tosi et al. 2018). Another investigation on the effect of pesticides on honey products was carried in Ethiopia and Kenya, from each county, 14 commercial honey samples were collected from local farmers (Irungu et al. 2016). Irungu et al. (2016) study found 17 pesticide residues were detected at levels 10-fold lower than their set MRL values except malathion which was detected at almost 2-fold higher than its set MRL.

Statement of the Problem

Tanzania is among the countries in the world with a high production of bee products especially honey and bee wax. This is mainly due to presence of a high population of bee colonies (estimated at 9.2 million), and presence of high number of vegetation that are preferred by bees in many areas of the country (Kihwele 2001).

Beekeeping in Tanzania, is mostly practiced on large- and small-scale basis as a source of both income and food in several cultivated and forest lands of Singida (Manyoni), Tabora, Mbinga and Mbeya regions. These areas are also used as crop (tobacco and tobacco) growing areas where application of various pesticides is inevitable. Consequently, there is a high likelihood for the bee products to become contaminated with pesticides due to the fact that the bees do not have boundaries during the collection of pollen. The availability of pesticides in the surrounding environments could lower the quality of bee products and kill the bees, which consequently pollute the environment, as well as pose potential risks to humans and other organisms. Presence of pesticides in the bee products also poses a potential health risk to the consumer of the products.

Data on the rank of the concentration of pesticide residues in honeybee is so scanty. Chemical pesticides have been reported to cooperation food quality and environment once exceeded the standard and thus causing threat to human health. But most previous researches were based on assessing only Nicotine in tobacco areas as well as tomato production areas. This created knowledge gape to researchers and beekeepers as well as consumers as they lack significant and vital information on the pesticide's contamination on bee products, the pesticide that are mostly used in the agriculture are area where honey bee went for collection of pollen substances. Therefore, this study focused on determining the pesticide contamination in bee products from honey-producing regions in Tanzania, Singida region chosen as a case study and fill the knowledge gap that existed related on the data of pesticides contamination.

Theoretical Review

Theory of Planned Behaviour (TPB)

The theory of planned behaviour introduced in 1980s to predict individual decision making toward presence of certain scenario (Shaw, 2016), the theory argued that human action and behavior are depends on individual intension and control ability that influence by sociocultural factors and external environment

In relation to this study, theory of planned behaviour has been utilized to explain the relationship of individual to use pesticides to the agricultural activities with intentional to increase food production without consider the impact to the environment, it has been noted that 20% of sickness in Australian has been contributed by the food handling behaviour (Mocinhato, et al., 2022).

The behaviour beliefs of farmers on uses of pesticides to boost fertility of land have causes environmental contamination which results to bees contamination since most of resources required by honey bee found on plants and crops, first through direct contamination that occurs due to handling and substances that used by beekeepers; and second is indirect contamination that occurs due to transportation of unwanted and toxic substances during the collection of pollen, nectar, water, and propolis and transferred to beehives; first through direct contamination that occurs due to handling and substances that used by beekeepers; and second is indirect contamination that occurs due to transportation of unwanted and toxic substances during the collection of pollen, nectar, water, and propolis and transferred to beehives (Muli, et al., 2018). Therefore, attitude and perceive behaviour of individual have direct contribution on intention of using pesticides that results to contamination of bee products

The theory of planned behavior has been criticized based on the argument that the theory ignored the lack of resources and opportunities for household to take decision of using pesticides can be influenced by more factors such as environment factors and economic factors than decision making of individual, also the theory fail to describe the timeframe of human intension and control action ability of individual. But with those limitation, the planned behavior theory (PBT) is more accurately have been utilized in determining pesticide contamination in bee products from honey producing areas.

LITERATURE REVIEW

Yamada, (2017) described Pesticide as any substance purposely released into the environment for preventing, destroying, expelling, attracting or controlling unwanted species of plant or animals, pesticides are applied during the production stage, storage, transportation, distribution and processing of food and feeds. According to Botits et al (2017) insecticides, herbicides, fungicides, nematicides and avicides are some of the examples of pesticides, pesticides are classified into groups based on their chemical structure (organophosphates, pyrethroids, organochlorines, carbamates, neonicotinoids), mode of action (systemic, contact), target (insecticides, acaricides, herbicides, fungicides, bactericides, nematicides) and synthesis (synthetic or natural) (Antonini & Argilés-Bosch, 2017; Botitsi et al., 2017). There are two types of pesticides, organic and inorganic pesticides. Organic pesticides are carbon-based pesticides from natural occurring materials or synthetically produced from organic chemicals (Zikankuba et al., 2019). Inorganic pesticides are derived from mineral compounds that occur as deposit in nature, mainly compounds of antimony, copper, boron, fluorine, mercury, selenium, thallium, zinc and elemental phosphorus and sulfur (Patinha et al., 2018).

Karazafiris et al. (2011) bee products may be indirectly contaminated through the transfer of pesticides from fields to beehive. To avoid residues pesticides should be used outside the bloom period or at least, not during the foraging time of bees. Beekeepers can also avoid residues by placing their hives more than 3 km from agricultural plants treated with pesticides (Kumar et al., 2020). As noted by Kumar et al. (2020) various parts of the world honey bees experiences extreme infectious diseases such as European foulbrood disease (EFB) and American foulbrood disease (AFB). Nevertheless, habitual feeding of honey to the infants, old and ill people need to consider gazetted guidelines considering the chronic long-term exposures of these chemicals and their potential contribution to the epidemiology of antimicrobial resistance (Kumar et al., 2020). The chemical composition and quality of honey depend on many factors, such as the type of the melliferous plants the nectar was collected from, the beekeeping practices, and the conditions of honey storage (Kasianchuk, et al. 2020). Murashova et al. (2020) postulates that leaf vegetable absorbs much lead from the air, up to about 95 % with increased soil pollution by lead (about 50 mg/kg), herbaceous honey plants accumulate about a tenth of this amount. Bees are constantly affected by a variety of factors, especially when pollinating entomophilous plants and collecting nectar (Fatkullin, 2017). The most important condition is the proper placement of the apiary whilst paying attention to field pollution with pesticides, the sanitary condition of apiaries, the health of bee colonies and the use of various preventive and therapeutic means (Fatkullin, 2017; Murashova et al. 2020). For instance, honey products obtained along highways are prone to lead contamination in spite of the fact that the lead is not transported by plants but can get into honey products through direct contact with nectar and pollen (Murashova et al., 2020). Typically, pesticide residues in honey occurs when bees in search for food, visit crops that have been treated with various agrochemicals (Irungu et al. 2016; Tosi et al. 2018). Another investigation on the effect of pesticides on honey products was carried in Ethiopia and Kenya, from each county, 14 commercial honey samples were collected from local farmers (Irungu et al. 2016). Irungu et al. (2016) study found 17 pesticide residues were detected at levels 10-fold lower than their set MRL values except malathion which was detected at almost 2-fold higher than its set MRL.

Zikankuba et al. (2019) is of the view that food distributors and stakeholder need to agree and comply with pesticides control regulation. The Codex Alimentarius Commission (Codex) and Joint Meeting of the Food and Agriculture Organization of the United Nations (FAO), and Environment and the World Health Organization (WHO) Core Assessment Group on Pesticide Residues (JMPR) should continue with readjusting and harmonise pesticide MRLs (Yamada, 2017). For example, developed countries have demonstrated tight regulations than developing countries due to poor education system, leadership will and scant resources (Handford, 2015). From the developed world perspective, in particular the USA, pesticides safety is shared by the Environmental Protection Agency (EPA) which enforces pesticides registration, regulations and establishes MRLs in food and feeds; the Occupational Safety and Health Administration ensures the safety of workers, working with pesticides (Ambrus & Hamilton, 2017). In Canada, the Pesticides Management Regulatory Agency has the mandate to protect people from pesticide risks and provide them with safe pesticide management tools (Islam et al.2017; Zikankuba et al. 2019).

In developing world, China adopted Codex MRLs as organized by the National Pesticide Residues Committee under the Ministry of Agriculture (MOA) (Han et al., 2018; Yang et al. 2018; Buijs et al, 2018). India pesticides are regulated under the Central Insecticides Board and Registration Committee, while the Food Safety and Standard Authority of India sets the MRLs of registered pesticides (Nambirajan et al., 2018; Zikankuba et al. 2019). In the case of Africa, some countries do not have pesticides registry just like some of the countries in the Southern Asia (Handford et al., 2015). Despite of the later, several African countries have adopted pesticide MRLs from the Codex limits (Islam et al., 2017). Nevertheless, due to lack of funding, enforcement remain a challenge. For example, in Tanzania the Tropical Pesticides Research Institute Act regulate pesticides usage in order to ensure public health safety. There several other Acts regulating the use of pesticides residue such as the Tanzania Food, Drugs and

Cosmetics Act No. 1 of 2003, Pesticide Control Regulations, 1984 for pesticides import, Plant Protection Act No. 13, National Environmental Management Act No. 20, Industrial and Consumer Chemicals (Management and Control) Act No. 3 and Occupational Health and Safety Act No. 5. Countries such as Kenya, Ghana, Egypt, South Africa have all introduced regulations and policies design to monitor the use of pesticides. For example, in South Africa, pesticides are managed under Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Ac (Onwona-Kwakye et al. 2018). Zikankuba et al. (2019) states that pesticide residues below MRLs in food are considered non-hazardous to human, although more research on chronic exposure are suggested because most of the pesticides are fat soluble and accumulate in body tissue over time (Zikankuba et al. 2019; Negatu, 2021). A standardized survey using a WHO case definition of severe forms of acute pesticide poisoning indicated a 16% overall prevalence of severe acute pesticide poisoning (Mulati et al., 2018). In order to balance the profits of increased agricultural production and the risks of intensified pesticide use on the environment and health, there is a need for increased pesticide regulation (Negatu, 2021). The status of pesticide residues on bee hive products is totally absent in sub-Saharan Africa yet such knowledge is important to safeguard human health and conserve pollinators (Mulati et al., 2018).

However, despite of several studies such of Irungu et al. (2016) on the food contamination; Murashova et al. (2020) with pesticide absorption on vegetables; Graham et al (2021), Hegaw, Habtegiorgis, and Edmew (2022) conducted the study on pesticides and their utilization level; Graham et al (2021) with study that was prepared to identifies concentration of sources of pesticides in pollen collection by bees. But none of them investigated on the pesticide contamination in bee products processed in Tanzania, therefore this study aimed to fill that gap by investigating pesticide residues in bee produce and their potential risk to consumers in Tanzania. The study guided by the following conceptual framework in filling the literature gap existed as indicated in Figure 1.

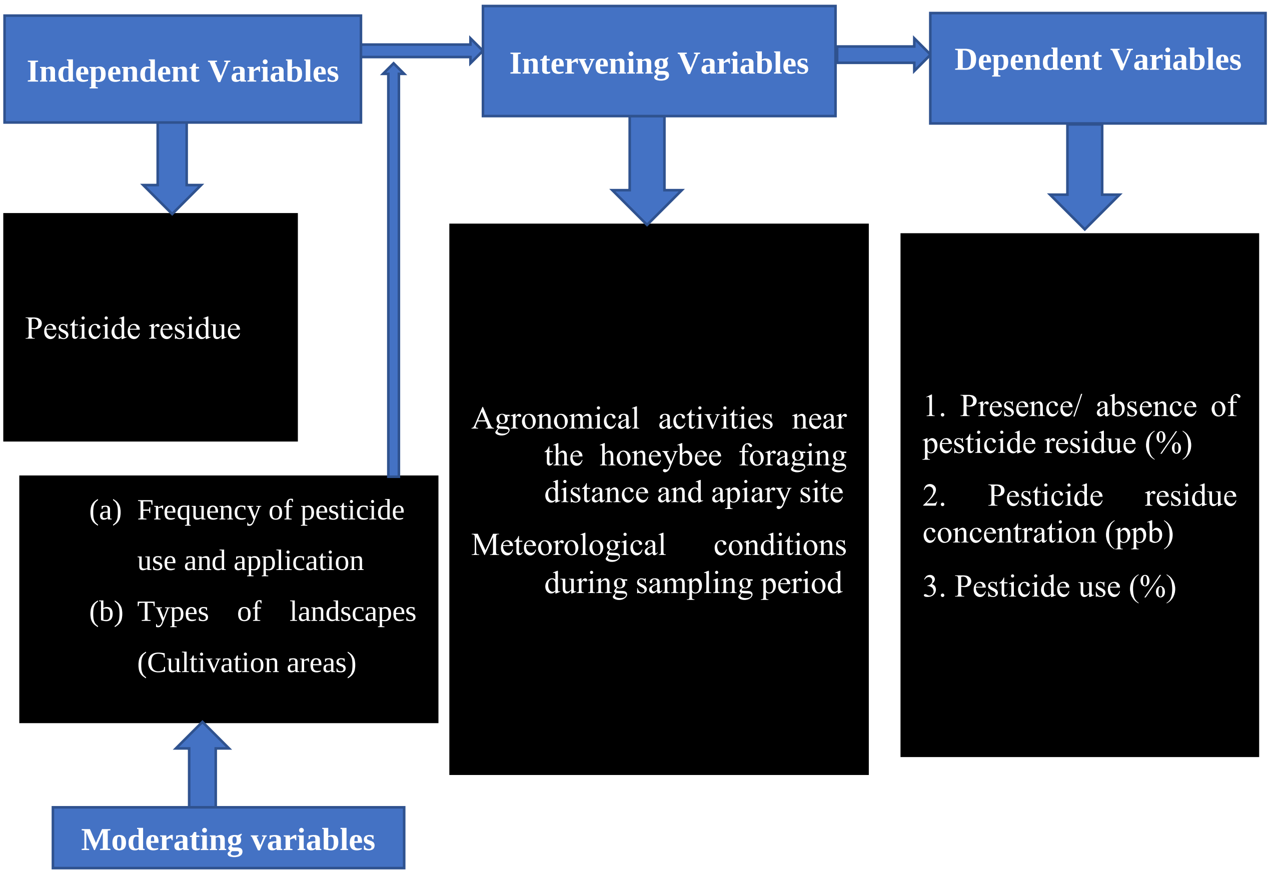


Figure 1: Conceptual Framework

Sources: Research Proposal Based on Literature Review, (2022)

METHODOLOGY

A mixed methods approach was adopted for this study and collected data both primary and secondary data was collected using physical observation and survey, interviews and questionnaires, the purposive and random sampling techniques was used in this study to select total of 104 participants who will be taken as a sample from universal populations. In each of these agro-ecological zones, eight apiaries spread apart (10m from each other) were randomly selected to pick four (4) honey sample Bee pollen One Kg, propolis 500gm, and Bee wax One Kg. Qualitative and quantitative data were analysed using IBM Statistical Package for Social Sciences (SPSS) Computer Programme version 25, where statistics aspect was determined from the results obtained from both questionnaires and laboratory experiment.

RESULTS

The outcome of the study was categorized based on focus of the study which were pesticides residues in beeswax, pesticides residues in bees' pollen, and pesticides residues in Honey.

Descriptive analysis was done to determine the relation between the levels of pesticides residues in bee products for all data obtained from laboratory experiment, and pesticides residues in honey. The findings that respond to this objective are presented in the Table 1

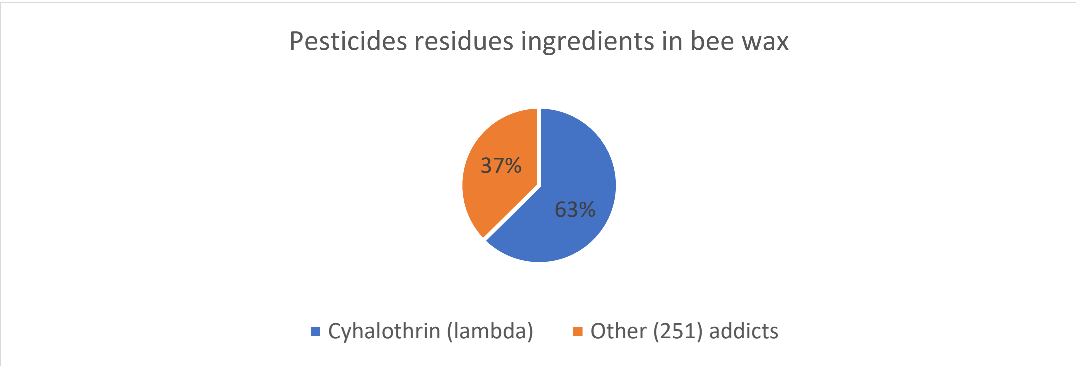
Table 1: Analysis of pesticides residues in bee products

Analysis of pesticides residues in bee products					
	N	Minimum	Maximum	Mean	Std. Deviation
Bee wax	252	.01	4.20	.03	.26
Bee pollen	252	.01	.06	.01	.003
Honey	261	.00	.01	.01	.002

Source: (Field data, August 2021)

Pesticides residues in Beeswax

The study reveals the presence of lambda-cyhalothrin in the composition of ingredient found in the pesticide's residue in beeswax. The findings identified 252 pesticides residue ingredients in beeswax with a mean of 0.03mg/kg. Lambda-cyhalothrin ingredient had 4.20mg/kg (63%) of the total pesticide's ingredient found in beeswax against 37% of 251 which represent the rest of the pesticides ingredient that were concentrated in the beeswax. This means that the incorrect application of insecticides with Cyhalothrin (lambda) in agricultural activities may have direct effects to bee, and bee products. The report of WHO (2021:44) on lambda-cyhalothrin is a pyrethroid insecticide with rapid knock down effect and good photostability. The results of several laboratory test indicated in Chart 1 and Table 2



Data source: SGS Laboratory Analysis Report

Chart 1: Pesticides Residues Ingredients in Bee Wax

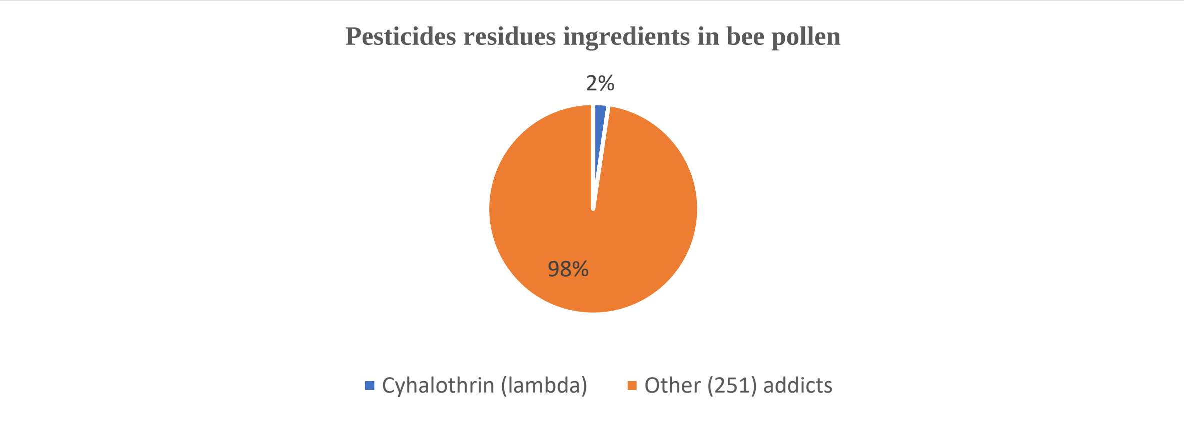
Table 2: Analysis Report TA21-00318.002 - Bee Wax

Test	Method	Result	Unit
Cyhalothrin (lambda) * 1	AOAC 2007.01 (GC-MS/MS)	4.20	mg/kg
Acephate * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Acetamiprid * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Acrinathrin * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Aldicarb * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Aldicarb-Sulfon * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS	0,01	mg/kg
Aldicarb-Sulfoxid * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Aldrin * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Atrazine * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Azinphos-ethyl * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Azinphos-methyl * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS	0,01	mg/kg
Azoxystrobin * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Benalaxyl * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bifenox * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bifenthrin * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Binapacryl * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bitertanol * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Boscalid * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bromophos (-metil) * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bromophos-ethyl * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bromopropylate * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bromuconazole * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bupirimate * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Buprofezin * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg

Data source: SGS Laboratory Analysis Report

Pesticides Residues in Bee Pollen

the study investigation reveals there are some kinds of similarities as the 2.57 mg/kg of the same 252 ingredients of pesticides residues that were found in beeswax was also present in bee pollen but with a mean of 0.01mg/kg. Whereby, lambda-cyhalothrin made 2% (0.06mg/kg) and other 251 pesticides residue ingredients made a 98% (2.51mg/kg). In terms of effect of pesticides found in bee pollen and its implication on human consumption, this result show that the current insecticides in bee pollen are not harmful to human consumption and surrounding environment. More detailed of the laboratory results summarized in Chart 2 and Table 3



Data source: SGS Laboratory Analysis Report

Chart 2: Pesticides Residues Ingredients in Bee Pollen

Table 3: Analysis Report TA21-00318.002 for Bee Pollen

Test	Method	Result	Unit
Cyhalothrin (lambda) * 1	AOAC 2007.01 (GC-MS/MS)	0.06	mg/kg
2,4-Dichlorophenol * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Acephate * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Acetamiprid * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Acrinathrin * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Aldicarb * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Aldicarb-Sulfon * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Aldicarb-Sulfoxid * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
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Azinphos-ethyl * 1	AOAC 2007.01. LC-MSMS/GC-MSMS)	0,01	mg/kg
Azinphos-methyl * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Azoxystrobin * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Benalaxyl * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bifenox * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bifenthrin * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Binapacryl * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bitertanol * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Boscalid * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bromophos(-metil) * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
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Bromopropylate * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bromuconazole * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bupirimate * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Buprofezin * 1	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg

Data source: SGS Laboratory Analysis Report

Pesticides Residues in Honey

The investigation found 261 pesticides residue ingredients in honey with a mean of 0.01mg/kg as per table (1). In which, all 251 addicts that were found in bee wax and pollen were also found in honey and 10 other addicts that were not found in bee wax and pollen were also identified in honey. This means honey found to have 4% more of pesticides residue ingredients than beeswax and pollen. Notwithstanding the number of pesticides found, current discussion omitted the chat because each residue found in honey had the same value of 0.01mg/kg. This would have been somewhat possible if the analysed raw data was presented in categorized format yet laboratory emphases was on lambda-cyhalothrin. The laboratory results presented in Table 4

Table 4: Analysis Report TA21-00317.001 for Honey

Test	Method	Result	Unit
Acetochlor *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Aclonifen *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Acrinathrin *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Alachlor *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Aldrin *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Allethrin *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Altraton *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Anilazine *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Anilofos *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Anthraquinone *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Atrazine *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Azinphos	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Azinphos-methyl *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Azobenzine *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Benalaxyl *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bifenox *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bifenthrin *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Binapacryl *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bitertanol *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Boscalid *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg
Bromophos(-metil) *	AOAC 2007.01. (LC-MSMS/GC-MSMS)	0,01	mg/kg

CONCLUSION AND RECOMMENDATIONS

Based on the data reported in Table 1, 2, 3, and 4 respectively, the results show there is no significant differences in the amount of insecticides found in beeswax, bee pollen and honey. The study concludes that, there are 252 pesticides residue ingredients in beeswax with a mean of 0.03mg/kg. Lambda-cyhalothrin ingredient had 4.20mg/kg of the total pesticide's ingredient found in beeswax against 251 which represent the rest of the pesticides ingredient that were concentrated in the beeswax. In relations to the amount of lambda-cyhalothrin found in the bee and honey products, it was concluded that level of the insecticides found in bee and bee's products such as beeswax, bee pollen and honey does not pose risk to human health neither to environment.

The study shows the need to incorporate into pesticides regulations praxis, modalities that address the roots of beekeeping challenges. This calls on policymakers to rethink ways of engaging the beekeepers, and to have an ongoing discussion with beekeepers and concerned stakeholders about a model that could be used to enhance pesticides regulation in Tanzania. The study suggests improving engagement strategies to necessitate fair participation of all concerned actors with interest in bee and honey products, also government policy regulating

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bee practices should put emphasis on starting and running government owned farm as there's growing demands for bee and honey products for medical reasons.

Furthermore, study calls for further research that would focus on findings ways for sustaining quality. Technically, farms hardly comply with government regulations, and government lack the know how in terms of influencing beekeepers to stay away from the application of non-approved insecticides which has long term implications for sustainability. It also recommends further study that will examine the perceptions of decisionmakers, consumers, beekeepers and academicians in relation to extended use of pesticides in Tanzania, bearing in mind the health implication of unauthorized use of pesticide.

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