Evaluation of the effect of handling, processing and storage practices on the quality bee products from Africa's most renewed bee village in Tanzania

ABSTRACT

Aim; *the main objective of this study was to effect of handling, processing and storage practices on the quality of selected bee products (honey, bee wax, propolis) from among the selected farms: a preliminary investigation from Africa's most renewed bee village in Tanzania.*

Material and methods*; A mixed methods approach was adopted for this study and collected data both primary and secondary data were collected focal group discussion, interviews, and questionnaires, purposive and random sampling techniques were used in this study to select a total of 106 participants who was taken as a sample from universal populations. Qualitative and quantitative data were analyzed using IBM Statistical Package for Social Sciences (SPSS) Computer Programme version 26, where the statistics aspect was determined from the results obtained from questionnaires.*

Results; This study identified significant factors that contribute to the successful production of quality bee and honey products from Kijiji cha Nyuki. Factors that were identified consist of handling, processing and storage procedures; it was specifically noted that, regulations compliance, application of current technology, ongoing workshop and training and the skilful management and farmworkers. The study found those involved in the beekeeping and policy implementers do employ several techniques to ascertain the quality of bee and honey products. Beekeepers regularly makes use of new equipment such as 20 plastics, knew knife cutting honey jelly, smoke machine for design for disposing bees and clothing design for beekeeping activities. These activities take place during the sun time, the harvested is transported to factory for processing and packaging. The products are packaged in plastic with the volume between 1 to 20 litres. Before selling, the products are stored in dehydrated place and it is not exposed to moisture. The findings reveal that beekeepers are aware of local and international market demands; therefore, this investigation concludes that bee and honey products produced in Kijiji cha Nyuki is clean and does meet international bee and honey product standards.

Contribution to policy implication; *This study recommends interventions among farmers and beekeepers on the safe use of good hygienic handling, and the storage practices. It has contributed to the understanding of how the quality bee product assured by adhering to technology, trainings and skilful management of bee product. 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.* This 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.

Key Words: *Quality Bee Products, Handling Procedures, Processing Procedures and Storage Procedures*

1. INTRODUCTION

Honey is one of the sweet, flavourful natural products produced by bees from nectars or honeydew. It is composed of carbohydrates (75% of fructose and glucose), 0.2-0.3% of proteins, free amino acids, vitamin, minerals, water, pollen and wax [1]; [2]; [3]; [4]. The composition of honey depends on the plant species visited by the honeybees and the environmental handling and storage conditions [5] Data on the quality of bee products (honey, beeswax, beebread, propolis) due to handling, processing and storage practices in Tanzania is so scanty. [6] described that quality of bee products can be affected by two common ways, 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. The quality of bee products relies of formulation of composition contents during collection process by honeybees when visited different plant and flower species, also the surrounding environment and handling process performed beekeepers and condition of storage facilities that are used [5]

The demand on honey in global is high which results to estimated 1.4 million tons of honey that produced worldwide as described by European Commission (2022), the Europe are considered one of the leading consumers of the honey products as well as one of leading areas with approximately 226 thousand tonnes produced yearly as indicated in 2019 but the production has been declined in 2020 to 218 thousand tones which is equal to 12% of the global honey produced [7]. In Europe, Hungary is leading producer of honey with 15 to 20% of all honey in European Union but experienced strong competition from developing countries that exporting high volume of honey to European Union [8]. The other leading producer of honey worldwide are China (22%), USA and Argentina (6%) and Turkey (5%) that led to global honey production approximately to 1,860,172 tonnes yearly, the leading producing countries of honey globally are China being responsible for 22%-29% of all production, followed by European Union (12%), Turkey (6%), and Argentina (4%) [9].

It has been noted that there is declined of honeybee colonies currently which become big concern of the global not only for the handling pollination activities which is vital for plant and food production, but also number of colonies are important to the volume of honey which have several significant benefits to human. The quality of bee colonies has been negatively affected by multiple factors such as poor nutrition, pests, diseases, and loss of natural bee habitat, the widespread uses of pesticides on agricultural activities was described as major socioeconomic activities that affect the health of bee colonies [10];[6].

The composition and properties of honey are dependent on handling processes, floral origins used by the bees and the climatic conditions of the area from which honey is harvested. According to [11], nowadays bee products are produced in an environment contaminated by different sources of chemicals. Heavy metals, organophosphates, pesticides, veterinary substances are considered to be among the important potential pollutants [12].

The recent sudden decline of honeybee colonies is of global concern not only because of pollination services they provide in food production process, but also due to honey production among other benefits. While there are multiple variables, including poor nutrition, pests, diseases, and loss of natural bee habitat, negatively affecting bee health, it is becoming increasingly clear that the widespread use of pesticides on agricultural crops is a major factor [10];[6]. For example, millions of tons of pesticides are applied annually, but only a small fraction (<1%) effectively reaches the target organisms, and the remainder is deposited either in the soil, atmosphere or water, contaminating the environment and non-target organisms [13]. In Africa, honey is largely produced in Ethiopia, with approximately 45,300 tonnes annually, followed by Tanzania which produce about 30,393 tone of honey per annum and, 1,843 tons of beeswax. Other Eastern African countries that have been doing well include Kenya, Uganda and Rwanda producing about 4000 tonnes for domestic consumption and export to the UAE and Middle Eastern Countries [14]. Honey production in Africa increased from 78,873 tonnes in 1971 to 150,911 tonnes in 2020, with an approximate growth rate 1.65% annually [15].

Honey production in Tanzania, is the extended established economic activity, which contributes to the socio-economic development, environmental conservation. It is an essential activity for income generation for most communities living nearby forests and woodlands, the more than two million people, accounts for approximately 99% of the total honey produced in Tanzania, which continues to be below 1% National GDP, being too low compared to the existing potential. Among countries around the world with the highest potential for production of bee products, Tanzania is one of them, due to the availability of abundant plat species producing nectar and pollen. The country has around 33.5 million hectares of forests and woodlands distributed over the country, potential for boosting the beekeeping business. Unreserved forests and woodlands cover almost 20.5 million hectares, with 13 million hectares as forest reserves. Forest plantings that are also ideal for beekeeping cover more than 80,000 hectares of the gazette forest reserves. The 115,500-hectare mangrove forests of mainland Tanzania are also significant as bee feed. From the 30,993 tonnes of honey and 1,843 tonnes of beeswax produced in Tanzania approximately 7% of the produces are internally utilized in candle making and batiks whereas approximately 3% is [8]. Main buyers of the exported products include, Germany, United Kingdom, Belgium, USA, Japan and Netherlands [16]. Beekeeping has a potential of being conducted in agricultural area

since a lot of bee products may be harvested from agricultural crops including sunflower, green beans, coffee, coconut, and sisal [17].

Bees are termed to operate in either inside or outside clean, health and safe environments from which pollen, nectar and water is collected [18;19]. However, bee products are recently produced in a contaminated environment with bacterial, fungal spores, dusts and chemical residues, industrial pollutants, hydrocarbon emissions and naturally occurring toxins found in plants [16]. The handling, collecting and storing are major factor affecting the bee products, thus a need for preservation of bee as well as the products for best quality [8]. To preserve bee products health which is inextricably integrated with human health and to preserve the quality of bee by products especially honey, requires regular monitoring using rigorous analytical methods to confirm product quality [15].

Unfortunately, only a few researches have been conducted to display pesticide residues in other hive products such as bee pollen, bee venom, royal jelly, bee wax, bee bread and propolis, whereby, most of the researches concentrated on honey, since that is the readily available and mostly consumed bee product. These products are recently used as medical products hence a potential of bioaccumulation in human body [20]. Therefore, this research was designed to determine the pesticide contamination in bee products from selected honey producing areas (Singida) in Tanzania. Data on the contamination of bee products (honey, beeswax, beebread, propolis) due to pesticides in Tanzania is so scanty. Due to the frequent use of pesticides on cultivated and forest crops close to beehive farms, and the development, production and use of various pesticides with new design together with the associated harmful effects to human health, it is important to assess their levels in the bee products. Therefore, the study will focus on determining the effect of handling, processing and storage practices on the quality of selected bee products (honey, bee wax, propolis) from among the selected farms from honey-producing regions in Tanzania, Singida region chosen as a case study. Specifically, by assessing harvesting techniques, storage containers and additives.

2. LITERATURE REVIEW

2.1 Empirical Literature Review

[21] conducted the study to assess postharvest handling of honey and other bee products and detect opportunities ad effect on quality of honey production in Ethiopia, the study selected purposively two district officers dealing with bee products and four peasant association leaders was randomly selected. The outcome indicted that apiculture subsector was affected by the indigenous beekeepers' skills and knowledge on handling, storage facilities used such as earthen pot, gourd, and animal skins was playing significant on the quality of honey harvested. The study recommended conservation of natural resources, provision of high qualities resources and facilities would improve apicultural sector in Ethiopia.

[22] investigated the factors that have contributed on affecting quality of honey in Uganda, the study surveyed estimated 120 beekeeping households and sampled honey from several supermarket, stall market, and hawkers and assessed using Diastase Number (DN), Hydroxy methyl furfural (HMF), Moisture Content (MC), and Free Acidity (FA). The results found that most of household were harvesting honey using basket and grass hives which have positive contribution on lowering quality of honey from local household in Kampala, also it wa revealed that pressing, straining, and boiling were common processing practices of honey which compromise the quality of honey as well as harvesting immature honey, poor extraction procedure, lack of proper equipment, bad weather was also contributed on impacting quality of bees products in Uganda. The study recommended training on proper honey harvesting and extension on handling, processing, and storing bee products to preserve its quality should be emphasized.

[23] investigate improper use of pesticides causes accumulation of residues in foods, which decreases the safety and quality of food products and ultimately results in serious health problems. The results indicated that acute toxicity explains how poisonous a pesticide is to a human, animal, or plant after a single short-term exposure. The effects of acute toxicity appear quickly, or within 24h of exposure, acute toxicity can be measured as acute oral toxicity, dermal toxicity and inhalation toxicity.

[24] conducted the study on factors that have influence on quality of honey in Kenya, the study used descriptive research design for collection of data using questionnaire and interview from sample size of 90 respondent selected through simple random sampling techniques and analysed by qualitative means using table and percentages. The results found indicated that smokers and protective clothes was the common practices that used for harvesting honey which have diverse effect on both bees and quality of honey produce, the study

recommended for the government to design proper forums that would promote farmers awareness on better harvesting techniques with less effects on health of bees and quality of honey.

2.1.1 Bee Products Processing

This is the processing techniques and procedures that adopted to harvesting, extraction, purification, and separation of bee products from its raw nature with consideration of maintaining minimum effects on health of honeybees [25]. The procedure for each product is described in details in below paragraphs;

2.1.1.1 Honey processing

The honey processing is not a straightforward sequential chain of activities, despite the fact that the average consumer might think so at first glance. It should be emphasized that each processing stage, from the initial extraction to the packaging of the finished food product, is a solution to unique challenges relating to the physicochemical characteristics of various honeys [26].

Uncapping is the first stage in obtaining honey. The wax caps from the honeycomb cells must be removed. This is done by hand in small processors, while uncapping machines are used by large processors to scrape the wax caps off honeycomb cells one frame at a time in a fully automated operation [26]. Using an extractor, the honey is extracted from the cells. Typically, the frames are placed in a centrifuge, which rotates the frames and forces the honey out of the comb. The honey is spun to the extractor's sides before draining out the bottom into a collection receptacle. To extract the leftover honey, use a screw press to press the remaining wax.

Filtering raw honey can be difficult due to its viscous and sticky nature. Prior to filtering, honey is frequently cooked to 66°–77°C to reduce viscosity. Pasteurization of honey necessitates temperatures of 72°C or higher. The heating method also reduces moisture content, delays crystallization, and kills yeast cells, extending the shelf life of the product. Furthermore, heating the honey causes it to turn a darker brown colour. Heating can be done in tanks or above the product with an infrared heater or heat lamp.

Membrane filters are the most prevalent type of filter. Depending on the pore size and distribution of the membrane, certain substances flow through and others remain behind. Using metallic or nylon screens, macro-filtration is used for gross filtering (10–1,000 μm) to remove bubbles, dust, insect bits, and crystals. The honey is categorized as raw honey if this technique is utilized and no heat is applied. Yeast cells, coal dust, and certain microorganisms are also removed using microfiltration (0.1–10 μm). Ultrafiltration (0.001–0.1 μm) is a method that is occasionally used to produce a finished product that is no longer classed as honey in the United States. The process of ultrafiltration entails adding water and filtering it under high pressure.

Ultrasound can be used to nonthermally treat honey which involves temperatures around 35°C and times less than 30 seconds. Honey can be processed through controlled crystallization. Creamed honey contains a large number of small crystals, which prevent the formation of large crystals; it has a smooth, spreadable consistency. According to the study by [27] during the first sixth months of storage, glucose and fructose levels dropped significantly ($P < 0.05$). It has been noted that the sugar spectrum of ripened honey does not remain constant throughout time, but rather changes.

2.1.1.2 Propolis processing

Most industrializes of propolis are primarily based totally from number of liquid extracts. The uncooked cloth is hardly ever acceptable for direct inclusion in very last products. Similarly, for large public or small scale raw propolis is normally handled with a solvent and best the ensuing extract is used. The typically used is ethanol. The choice of the solvent relies upon the final use of the extract and technical feasibilities. Most active elements appear to be soluble in propylene glycol and ethanol, whereas fewer elements are soluble in water.

Some manufacturers boil a mixture of alcohol and propolis for 8 hours to dissolve all the resin. If propolis contains wax, most of it must be melted by heating. However, for high quality products, avoid heating. After 1-2 weeks, the liquid is filtered with a clean, very fine cloth or paper filter, which can be folded into several layers to enhance its effect. A second filtration may be beneficial and better results will be obtained if the extract can be cooled to less than 4^0 C for several hours or a day before filtration, but does not freeze. The filter must also be refrigerated before use. The rest of the initial filtration can be washed again or soaked in alcohol. The filtrate should be a clear liquid, particle-free, dark brown or slightly reddish in colour. It should be stored in a clean, dark and airtight bottle.

If dark coloured bottles are not available, they should be stored in a cool, dark place or wrapped in cloth, paper, or a straw to block light.

2.1.1.3 Bee wax processing

During honey extraction, wax is usually removed from the capping resulting to high-quality, light-coloured wax. Different qualities of wax can be produced by separating new white honeycombs from darker ones. Since whole combs are harvested and crushed or pressed, the proportion of wax per kilogram of honey (10–15%) will be much higher than with frame hive beekeeping, where the yield is only 1–2%.

To produce high-quality wax, melting honey combs is the preferred method. This can be achieved by boiling the combs in water in stainless steel containers before separating the pure yellow wax from the comb residue. Cooled and dried wax should be stored in containers made of glass, plastic, or stainless steel to avoid colour changes due to contamination by metals [26].

2.1.2 Quality Parameter of Honey Products

The composition and properties of bee products are dependent on handling processes, floral origins used by the bees and the climatic conditions of the area from which honey is harvested. According to [11], nowadays bee products are produced in an environment contaminated by different sources of chemicals. Heavy metals, organophosphates, pesticides, veterinary substances are considered to be among the important potential pollutants.

2.2 Theoretical Literature Review

2.2.1 Theory of Planned Behaviour (TPB)

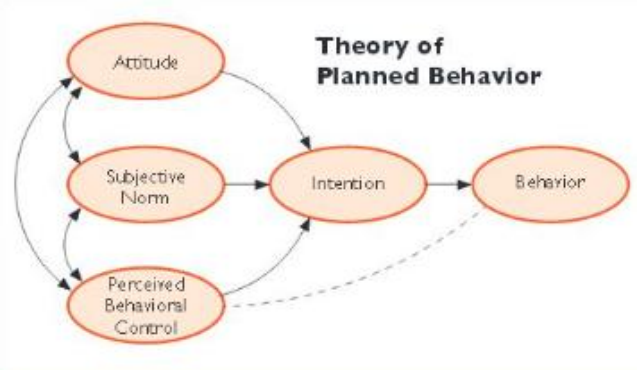

Figure 1; Theory of Planned Behavior

Sourced [29]

The theory of planned behaviour introduced in 1980s to predict individual decision making toward presence of certain scenario [28], The theory argued that human action and behavior are depends on individual

intension and control ability that influence by sociocultural factors and external environment. See figure 1

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 [30].

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 [7]. 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.

3. RESEARCH METHODOLOGY

This study implemented paradigm which concern use of quantitative and qualitative approach; the approaches was chosen since it provides an accuracy and valid reality on determining effect of handling, processing and storage practices on the quality of selected bee products (honey, bee wax, propolis) from bee products producing areas in Tanzania, Kijiji cha Nyuki Co. Ltd, located in Singida region. The areas of the study were selected based on the growing bees farming activities as major Agroecological zones in Tanzania in terms of bee production. Kijiji cha Nyuki is one of the major leading bee farming in Africa and a leader in the use of advanced technology and bee farming practices. The selected apiaries spread apart (<10m from each other).

3.1 Study Population

The study population comprised of Kijiji cha Nyuki bee farm workers, beekeepers, farmers, agricultural and forest officers and honey users who provided the relevant information on the quality of honey consumed. Kijiji cha Nyuki Co. Ltd contains 23.000 apiaries, whereby approximately 75% of the apiaries are located at Kijiji Cha Nyuki and the remaining being located at **Iginasoni** Ikungi District about 80 km from Singida Municipality.

3.2 Sample Size

Slovene's formula in Equation (i) was used to compute an appropriate sample of the human subject for the study, which is optimal. The Slovene's formula is given by:

$$\boldsymbol{n} = \frac{\mathbf{N}}{(\mathbf{1}+\boldsymbol{Ne^2})}$$ Equation----------Eq.1

Whereas:
n = number of samples
N = total population
e = Level of precision error, and
Confidence level of 95% for both consumers and farmers

The total was 104 (one hundred and four) respondents. Also, the issues of gender were highly regarded**.** The sample size composition is indicated in the Table 1.

Table 1; Sampling Composition

Participant	Male	Female	Total
Agriculture officers	1	1	2
Forest Officer	1	1	2
Farmers	27	25	52
Consumers (Users)	26	26	52
Bee keeper	1	-	1

Total	**55**	**54**	**109**

3.3 Data collection methods

In this study, multiple methods in data collection including physical observation and survey, interviews and questionnaires will be employed.

3.3.1 Physical Observations and Survey

This will help to identify the vulnerable areas of bee keeping, farming activities which are located nearby the selected cases. The survey and observation will assist in providing a clear picture that is on overview of the area and the possibility of the bee keeping infrastructure to be impacted by the agricultural pesticide. Preliminary survey will help to familiarize with the study area, establish contact with beekeepers and test the questionnaire and instruments to be used in the actual study which will be conducted at Itigi area.

3.3.2 Questionnaires

Questionnaires will be administered to obtain data and information related to beekeeping, farming activities and where bee products from Kijiji Cha Nyuki C. Ltd. The questionnaires will be prepared with both open ended and closed questions will be used in this study with a clear question sequence, formulation and wording, hence collection after being filled by the respondents for data analysis. The information to be collected will include; common type and number of pesticides used by farmers, distance from farms and apiaries as well as the handling, processing and storage practices by beekeepers (harvesting techniques, storage containers, additives used), A total number of 4 questionnaires will be administered to both district and regional agricultural and forest officers.

3.4 Data Analysis

The collected qualitatively was analyzed using content analysis while quantitative data was inferentially tested. Thus, regression analysis was multiple linear regression model was used to test statistical significance estimates of the effects of handling, processing and storage procedures on bee product quality. The level of significance for interaction effect between dependent and independent variables tested using scientific procedures in ANOVA dialogue using F-test. Before multiple regression the diagnostics test for multicollinearity, normality, linearity and homoscedasticity of residuals assumptions were to shed. The following model was used;

$QBP = \beta_0 + \beta_1 HP + \beta_2 PP + \beta_3 SP + \ldots + €$--------*Eq.2*

QBP= Quality of Bee Products

HP=Handling Procedures

PP=Processing Procedures

SP=Storage procedures

B_{1---n}*= Slope Coefficients for specific independent variable*

B0= Constant

€= Error Term

4. DISCUSSION AND RESULTS

The section presents the findings that respond to the main research objective. The findings draw on data that was obtained from survey questionnaires, key informant interviews, and observation. The actual sample size of the study was 106 respondents. Singida is among the region that have many beekeeping farms, and many residents from the area have access to and are involved in honey production businesses. As such, this chapter presents data in regards with the effect of handling, processing and storage practices on the quality of selected bee products (honey, bee wax, propolis) from among the selected farms. Before proceeding with any analytical procedures, the study conducted validity and reliability test of the research instruments.

4.1 Validity and Reliability Statistics

4.1.1 Reliability Statistics

The internal consistence of the measuring instrument was done using Cronbach's Alfa test. According to [31] reliability refers to the consistence and accuracy of the research findings. He argued that, the reliability of a research instrument concerns the extent to which the instrument yields the same or consistent results on repeated trials. Cronbach's Alfa measures the precision, repeatability and trustworthiness of the study. It is expressed as alpha = Np/ [1+p (N-1)] Where N equals the number of items and p equals the mean interitem correlation. It is typically varying between 0 and 1, where 0 indicates no relationship among the items on a given scale, and 1 indicates absolute internal consistence [32].

Alpha values above 0.7 are generally considered acceptable and satisfactory, above 0.8 and are usually considered very-good, and above 0.9 are considered to reflect exceptional internal consistency [32]. In the social sciences, the acceptable range of alpha value is from 0.7 to 0.8 [31]. The Table 2 indicates that, the Crobanch's Alfa for this study tool is 0.94 based on standardized items, which is acceptable rate of consistence of the measuring instrument. Therefore, the study data was good for further procedures.

Table 2; Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.937	.941	18

Consequently, the study adopted Analysis of Variance (ANOVA) with Tukey's Test for non-additivity that detect existence of relationship of factors in the study and hoteling's T-squire Test to measure the significance of internal consistency in analysis of outcome from study. The Table 3 summarized the results, it indicates that ANOVA test had P-Values (0.000) of both between people within people and between items within item; which is very small less than 0.05 indicating significance internal consistency of the tool at 95 confidence intervals. Therefore, data collected was statistically significant for further analysis procedures and interpretation.

Table 3; ANOVA with Tukey's Test for Nonadditivity

			Sum of Squares	df	Mean Square	F	Sig
Between People			994.707	105	9.473		
Within People	Between Items		67.132	17	3.949	6.576	.000
	Residual	Nonadditivity	14.858[a]	1	14.858	25.074	.000
		Balance	1057.103	1784	.593		
		Total	1071.961	1785	.601		
	Total		1139.093	1802	.632		
Total			2133.800	1907	1.119		

Grand Mean = 3.8379

a. Tukey's estimate of power to which observations must be raised to achieve additivity = 3.501.

Another reliability measurement employed by the study were Intraclass Correlation Coefficient (ICC) that describe the reliability of information organized in group within the study [33]. The Table 4 show result of ICC in two-way effects have significant level that less than P-values of 0.05 Which is 0.000, this indicated that the ICC have statistically significant with 95% confident intervals.

Table 4; Intraclass Correlation Coefficient

Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0			
	Lower Bound	Upper Bound	Value	df1	df2	Sig

Single Measures	.451[a]	.382	.529	15.775	105	1785	.000
Average Measures	.937[c]	.918	.953	15.775	105	1785	.000

4.1.2 Validity Statistics

According to [34], validity is the accuracy of measurement of which the independent to dependent variable is to be of truthful for the results. If research was high in validity that means it was to produce results that correspond to real properties, characteristics, and variations in the physical or social world [35]

In order to ensure validity and reliability, sample adequacy was tested in explanatory factor analysis whereby the **Kaiser-Meyer-Olkin (KMO**) is used to examine sample adequacy.

For the **KMO** statistics Kaiser (1974) recommends a bare minimum of 0.5 and that values between 0.5 and 0.7 are mediocre, values between 0.7and 0.8 are good, values between 0.8 and 0.9 are great and values above 0.9 are superb. Table 5 Indicates that, the KMO measure of sampling adequacy was 0.79 which is good for further process of analysis.

Table 5; KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.			.786
Bartlett's Test of Sphericity		Approx. Chi-Square	150.782
		df	6
		Sig.	.000

4.2 Demographic Characteristics of the Respondents

This section presents respondents' characteristics such as their categories, gender, education qualifications, and age pattern of the school committee members as presented in Table 6

Table 6; Frequency and percentage distribution of respondents by category

	Respondents	**Frequency**	**%**
Gender	Female	52	49
	Male	54	51
Age	18-30	10	9
	31-50	67	66
	51-60	29	25
Education level	None	7	5
	Primary	67	65
	Secondary	26	25
	University	6	5

The variation of respondents by gender, whereby male participants were n=54 of the respondents, and n=52 of respondents were female. The age groups of respondents; the findings reveal n=67 of respondents was aged between 31-50 years of age. This suggests that, most of respondents were aged, followed by n=29 of the respondents who were between 51-60 years of age. Surprisingly, the study uncovered the youth living in the area

aren't that much involved in beekeeping activities as compared the adult community. For example, only n=10 of respondents was aged between 18-30 years old.

As shown in table 6. the majority of respondents n=67 only attended primary school, and n=26 of respondents attended both primary and high schools. In addition, n=6 participants including beekeeper, agriculture district officers and forest officers stated that they hold a university degree. This study also identified n=7 of respondent never been to school. This is an indication that the majority of individuals involved in beekeeping activities within Kijiji cha Nyuki and the surrounding can read and write which supposes that beekeepers can keep-up with regulation if they receive necessary training.

4.3 Evaluate the effect of handling, processing and storage practices on the quality of bee products

To investigate this objective the study made use of informants' interviews and questionnaires. Interviews participants consisted of beekeepers (1), district agriculture officers (1) and forest officers (2), while 106 respondents were distributed with questionnaires randomly. Regression analysis was done for quantitative data as well as content analysis for qualitative data

4.3.1 Diagnostic test

The objectives of the study discussed in the theoretical and empirical literature were entailed in the questionnaire and further multiple linear regression (MLR) was conducted by observing all its assumptions (OLS assumptions) such as normality, linearity, heteroskedasticity and multicollinearity.

4.3.1.1 Normality

Normal testing is assumption of the regression model that impact the validity of all tests (i.e. p-test, t-test and F-test). It shows whether the residuals is normally distributed. This implied that the assumption of normality was well founded.

The line representing the actual data distribution closely follow the diagonal in the normal Q-Q plot. Figure 2 the results of the normality test of the independent and independent variables indicated skewness; which suggests normal distribution [37]. [38], averred that in the Q-Q plot, or the normal probability plot, the observed value for each score is plotted against the expected value from the normal distribution, where a reasonable straight line indicates normal distribution.

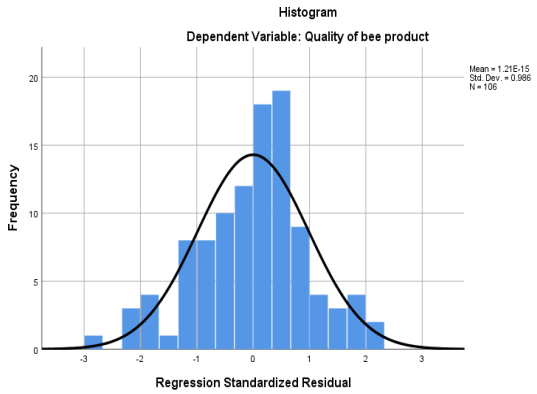

Figure 2; Normality Test

4.3.1.2 Linearity

Figure 3 indicates the tested linearity assumption of data collected through the inspection of bivariate scatter plots, it shows no serious violation of linearity and the scatter plots for the argued component plus residuals was linear in nature because all point variables linearly follow the diagonal regression line. [36], argued that the linearity of data is often assumed for variables in multivariate analysis and if left unattended, a non-linear data can seriously undermine any statistical inference.

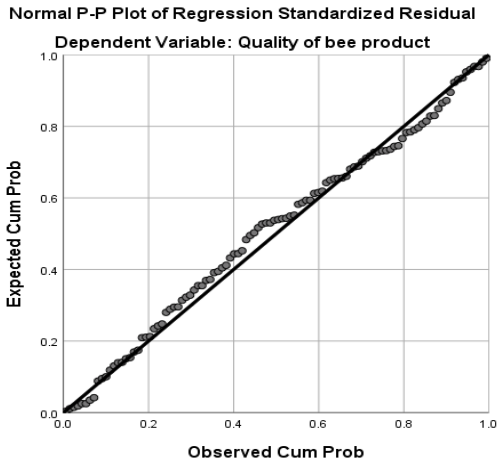

Figure 3; Linearity Test

4.3.1.3. Heteroskedasticity

This assumption states that the variances of error terms are similar across the values of the independent variables. A plot of standardized residuals (Scatter Plots) versus the predicted values has to show whether points are equally distributed rectangular across all variables influencing the quality of bee products. An important assumption in testing homoscedasticity is that the variance in the residuals has to be heteroskedasticity and homoscedastic or constant. The scatter plots (Figure 4, 5 and 6.) are distributed across the rectangle. Therefore, the overall, results suggest that homoscedasticity was not violated for both criterion variables [34].

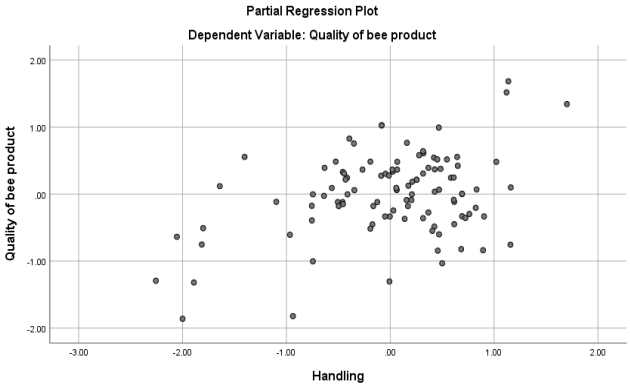

Figure 4; Heteroskedasticity for Handling Procedures

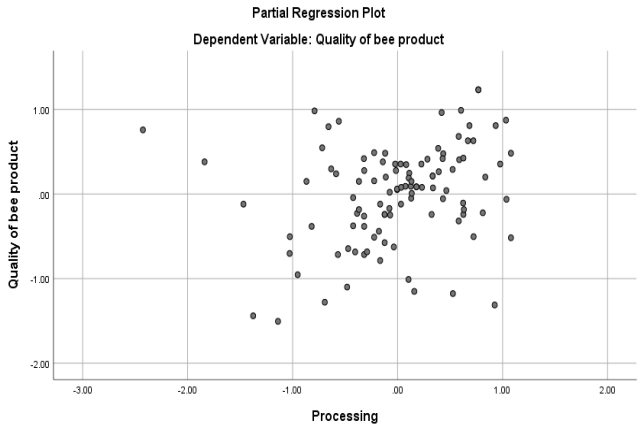

Figure 5; Heteroskedasticity for Processing Procedures

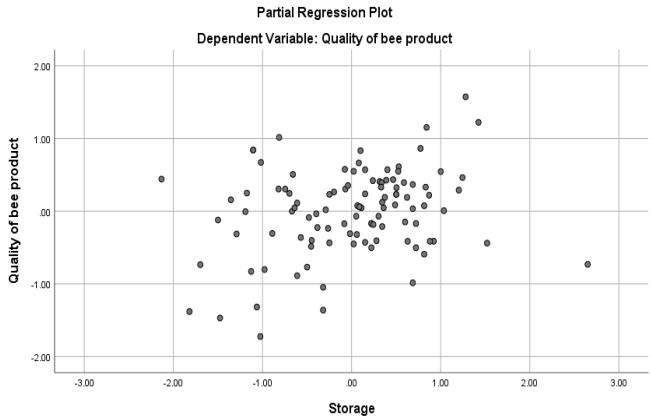

Figure 6; Heteroskedasticity for Storage Procedures

4.3.1.4 Multicollinearity

Multicollinearity results from the circumstances where two or several variables are so highly correlated in such a way, they both essentially represent the same underlying construct, that is; what appear to be separate variables actually measure similar constructs [37]. Table 7 indicates that the variance inflation factor (VIF) had values less than 5 and Tolerant values (1/VIF) are more than 0.2 indicating that there is no problem of multicollinearity among the independent variables. The authors posit that the VIF values greater than 5 and Tolerant values less than 0.2 indicates that there was no multicollinearity among the independent variable included in the model [39].

Table 7; Multicollinearity Test

Model		Collinearity Statistics	
		Tolerance	VIF
1	Handling	.712	1.405
	Processing	.552	1.811
	Storage	.620	1.613

a. Dependent Variable: Quality of bee product

4.4 Multiple Linear Regression Results

Basing on this study objectives, the quality of bee product was dependent variable while handling, processing and storage procedures were the independent variables. In order to answer the objectives of this study, three attributes were measured to determine how they influence quality of bee products. The study considers the

significant value less or equal to 0.05 as significant and above 0.05 as insignificant. Which means sig- value above 0.05 has low probability of explaining the relationship as compared to sig- value equal or below 0.05 which is equal to 95% confidence interval. Also, the R. square portrayed that it could explain the dependent variable by 49.1%. Below are table which shows the significant values and the beta coefficient.

Furthermore, the Analysis of Variance (ANOVA) using regression residuals indicating significance fit of the model because its P-Value was 0.000 very smaller than 0.05 significance level. Therefore, handling, processing and storage procedures significantly tells the quality of bee products; *See the Table 8*

The regression results reveal the relationship between independent variables were handling, processing and storage procedures as independent variables and dependent variable was quality of bee products; Each slop coefficient (***β)*** is partial regression coefficient and measures the change in estimated value for a unit change in value of a given independent variable, while other things remain constant.

QBP = 0.726 + 0.222PEU + 0.083QE + 0.352SI + …….. + € ----------Eq.2

Table 8; Multiple Linear Regression Results Showing Influence of HP, PP and SP on QBP

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1.177	.295		3.993	.000
	Handling Procedures (HP)	.312	.074	.352	4.198	.000
	Processing Procedures (PP)	.235	.088	.254	2.675	.009
	Storage Procedures (SP)	.191	.069	.247	2.750	.007
R		.701				
R-Square		.491	F-Change=.000			
ANOVA F-Test		F=32.784	P-Value=.000			

Therefore, basing on the Table 8 a unit change (say increase) in HP, PP, and SP will lead to a significant statistical change (increase) in quality of bee products (QBP) by 0.312, 0.235, and 0.191 respectively. It has been reported from the participants own perspectives and lived experienced of the investigated phenomena. For example, one of the beekeeper's states that:

> *We apply several techniques to ascertain we maintain the quality of bee. To ensure this is achieved we use new equipment such as 20 plastics, knew knife cutting honey jelly, smoke machine for design for disposing bees and clothing design for beekeeping activities. The activities take place during the day, the harvested is transported to factory for processing and packaging - (Respondent 3).*

Respondent (3) opinion was echoed in an interview with respondent (4) who spoke in length about the process involved in harvesting, storage and transporting of bee and honey products. Respondents (4) noted that:

> *The produce is then packaged in plastic with the volume between one litre to 20 litres. Honey which is ready for sale is stored in dry, cool and clean room, and it is not exposed to moisture in order to ensure that honey is not exposed to unwanted light and air which can affect it quality - (Respondent 4).*

The quotes discussed above demonstrates the steps that beekeepers and farmworkers take to account in order to ascertain bee and honey products produced in Kijiji cha Nyuki is clean and does meet international bee and honey product standards. Participants opinionated that they always apply all necessary steps stipulated in regulation guiding the use of pesticide in Tanzania as per Pesticide Control Regulations 1984 which regulate bee and honey production practices. All participants agreed that beekeepers from the investigated areas continue to comply with the practice of beekeeping as noted in National Environmental Management Act No. 20, Industrial and Consumer Chemicals (Management and Control) Act No. 3 and Occupational Health and Safety Act No. 5. Based on these findings, and the findings from quantitative analysis discussed in objective (3) and (4) reveal some level of correlation between the two methods implying that current level of insecticides used during the seed planting time, harvesting and processing period is within the recommended practices hence there is no any negative effect that was identified. The results show the application of workshops and trainings as noted by participant (3), and participant (5) and informative community meetings can be relied-upon, and maybe adopted

by other concerned authorities. The responses discussed above are further cemented by the participants from survey questionnaires discussed in table 4. and table 5 presented.

4 CONCLUSION

To evaluate the effect of handling, processing and storage practices on the quality of selected bee products (honey, bee wax, propolis) from among the selected farms, the study relied on, literature reviewed, focus group discussions, and face to face interviews. This study identified significant factors that contribute to the successful production of quality bee and honey products from Kijiji cha Nyuki. Factors that were identified consist of handling, processing and storage procedures; it was specifically noted that, regulations compliance, application of current technology, ongoing workshop and training and the skilful management and farmworkers. The study found those involved in the beekeeping and policy implementers do employ several techniques to ascertain the quality of bee and honey products. For handling and processing, Beekeepers regularly makes use of new equipment such as 20 plastics, knew knife cutting honey jelly, smoke machine for design for disposing bees and clothing design for beekeeping activities. These activities take place during the sun time, the harvested is transported to factory for processing and packaging. The products are packaged in plastic with the volume between 1 to 20 litres. Before selling, the products are stored in dehydrated place and it is not exposed to moisture. The findings reveal that beekeepers are aware of local and international market demands; therefore, this investigation concludes that bee and honey products produced in Kijiji cha Nyuki is clean and does meet international bee and honey product standards. This conclusion is built on the ground that beekeepers indicated that they regularly follow all necessary steps stipulated in regulation outlining the use of pesticide in Tanzania as per 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, NBP, 1998, Beekeeping Act No. 15/2002; Beekeeping Regulations, 2005; NBP 2001-2010 and GCBP 2007.

This 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. Finally, future study can investigate beekeeping facilities and handling process on a national level by assessing the quality of bee and honey products produced in various part of the country to determine the level of contamination, and to learn best practices. The findings spanning from a wide farming community could help policymakers, consumers, beekeepers and academics to learn the causality. The findings also can necessitate the formation of relevant pesticides policy that speak to the needs of all concerned actors.

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