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EVALUATION OF BEEKEEPERS' PERCEPTIONS OF QUALITY BEE HONEY PRODUCED IN SELECTED STATES IN SOUTHWESTERN NIGERIA

***[1]Falade L. O., [2]Ayodele I. A., [3]Omoloye A. A., [4]Thomas K. A. and [5]Idahor K. O.**

1Department of Forestry and Wildlife Management, Faculty of Agriculture, Nasarawa State University, Keffi
2Department of Wildlife and Ecotourism Management, Faculty of Renewable Natural Resources, University of Ibadan, Ibadan
3Department of Crop Protection, Faculty of Agriculture, University of Ibadan, Ibadan
4Department of Agricultural Economics and Extension, Faculty of Agriculture, University of Ibadan, Ibadan
5 Department of Animal Science, Nasarawa State University, Keffi, Shabu-Lafia Campus
*Correspondence: flo_orb@yahoo.com GSM: +2348033716312

ABSTRACT

This paper evaluated beekeepers' perceptions of the quality of bee honey produced in South-west, Nigeria. A multistage sampling technique was employed; Oyo, Osun, and Ogun states were purposively chosen due to their locations within desired agro-ecological zones. Three Local Government Areas were purposively selected to access beekeepers. Associated beekeepers (135) were administered a questionnaire using an opportunistic approach. Data obtained were subjected to descriptive statistical analysis. The mean value of perception on the quality of bee honey in Ogun state was the highest (4.7); followed by Oyo state 4.13; while Osun state had the lowest (4.02). Analysis of variance within beekeepers' perceptions of the quality of bee honey shows that there was a highly significant difference in the study ($p<0.05$). Correlation between socioeconomic factors confirmed that while some factors are significantly correlated, others are highly significantly correlated. Regression on beekeepers' perceptions in the selected states on the quality of bee honey (Table 5), shows adjusted R^2 (0.048) and (0.047), for educational background and religion respectively having only 4.8% and 4.7% influences on individual's quality of bee honey. Conclusively, beekeepers should be assisted financially to construct more hives and test for quality bee honey using more improved methods.

Keywords: *Beekeepers, Socio-economic factors, Perceptions, Bee honey, Quality*

INTRODUCTION

In Nigeria, the demand for honey is ever-increasing due to its nutritional and medicinal benefits. However, the quality of bee honey produced and sold to consumers leaves much to be desired. A routine assessment of the United States Food and Drug Administration on imported honey products found 14 samples (10%) out of 144 samples to be adulterated with added sweeteners, such as syrups from cane and corn. Such consignments were denied entry, to ensure that food is safe, wholesome and properly labelled; otherwise, consumers would be deceived (USFDA, 2022). The situation therefore necessitated that more research be conducted on the quality of honey produced in different agro-ecological zones in Nigeria. World Health Organization's Codex Alimentarius for Honey, stipulates that *"Honey is the natural sweet substance, produced by honey bees from the nectar of plants or from secretions of living parts of plants or excretions of plant-sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in honeycombs to ripen and mature." Also, "Honey consists essentially of different sugars predominantly glucose and fructose. The colour of honey varies from nearly colourless to dark brown. The consistency can be fluid, viscous or partly to entirely crystallized. The flavour and aroma vary, but usually derive from the plant's origin* (CAC, 2022)*."*

Bee Honey is a substance of wealth for many nations in the international market through the export and sales of all bee honey products (USDA, 2020). In 2020, India was the country leading in the construction of beehives, at around 12.2 million, next in line was China, then Turkey; while the United States only has about 2.7 million beehives. Though, at the time, China's production volume surpasses India's; producing a total of 458,000 metric tons of honey. Turkey, the next leading producer, by volume, produced only 114,500 metric tons of honey (Shahbandeh, 2023; Shahbandeh, 2022). Acceptance of bee honey at the point of entry into the international market requires that standard be attained. The United States has designated grades: A, B, and C, representing 90, 80 and 70 points for standardised requirements. Any rating below C (i.e. 70 points) is assessed as substandard (USDA, 2023). The specific composition, colour, aroma, and flavour of any batch of bee honey depend on the flowers foraged by honey bees, *Apis mellifera* Adansonii, which produced the honey (Michener, 2000). Nectar is a sugary fluid containing aromatic oils which give flowers their scent. Nectar foraged by bees, when mature or ripe, is thick, sticky and very sweet (Tracy, 2007). The composition and quality of honey vary, depending on the climatic region, whether wet or dry, the environmental temperature, the type of botanical plant used to produce it, the honey bees species, the sugar composition, the treatment of honey during extraction, processing and subsequent storage conditions (Amril and Ladjama, 2013; Alvarez-Suarez *et al*., 2010). Honey comes in a range of colours including white, amber, red, brown and almost black (Eleazu *et al*., 2012). Dafni, *et al*., (2012) reported that Honey is generally safe; though Eickwort (1975) had reported earlier that bee honey may have various potentially adverse effects or interactions upon excessive consumption, existing disease conditions, or use of prescription drugs. Chittka and Thomson (2001) reported that honey is composed of 17% water and 82% carbohydrates, honey has a low content of fat, dietary fibre, and protein. It is a mixture of sugars and other carbohydrates, honey is mainly fructose (about 38%) and glucose (about 32%) the remaining sugars include maltose, sucrose, and other complex carbohydrates. Its glycemic index ranges from 31 to 78, depending on the variety (Gullan and Cranston, 2014). This study therefore endeavour to evaluate beekeepers' perceptions on quality of bee honey in south-west Nigeria.

METHODOLOGY

The Study Area: The southwestern zone of Nigeria, composed of 6 states: Oyo, Ekiti, Osun, Ondo, Lagos and Ogun; was used to conduct the study. Oyo, Osun and Ogun states were purposively chosen as states that fall within the desired agroecological zones in southwest Nigeria. The weather conditions vary between the rainy season (March - October) and the dry season (November - February); with the dry season accompanied by Harmattan dust, cold dry wind from the northern desert blown into the southern regions around this time. Longitude 30^0 and 7^0E and Latitude 4^0 and 9^0N (Oni and Odekunle, 2016). Its rainfall is 2000-3000mm, and its temperature is over 17^0C (Uzoh, 2021).

Sampling Technique: A multistage sampling technique was used to purposively select states located within the agro-ecological zones (Ogun state in Rain Forest, Osun state in Southern Guinea savanna and Oyo state in Northern Guinea savanna) of interest in southwestern Nigeria. Three Local Government Areas were purposively selected, one from each Senatorial District in each State for even sampling of locations. A total of 135 questionnaires were administered. Opportunistic approach was used to choose 45 beekeepers from the beekeepers Association in each state, and 15 from each Local Government Area chosen, for consultation and administration of a questionnaire, which elicited information on socio-economic data and bee honey quality.

Data collection: Questionnaires were administered to 135 associated beekeepers. An opportunistic approach was used to administer the questionnaire. A total of 113 out of the 135 questionnaires were retrieved.

Data Analysis: Descriptive statistical analysis (frequencies, percentages, etc.) was used to analyse the data obtained (Table 1) and the Duncan Multiple Range Test was used to separate the means (Table 3).

RESULTS

Beekeepers' perceptions on the quality (viscosity, Bitter taste, testing for purity) of bee honey (Table 1), show that the perception of beekeepers on viscosity of bee honey harvested differ. The viscosity nature of bee honey was described as being generally slightly light by the majority 39, 24 and 20 (representing 95.1%, 70.6% and 55.6%) of the beekeepers from Osun, Ogun and Oyo states respectively. Although other beekeepers (2.4%) in Osun state claimed that they at times have light or slightly thick honey. Also, 2.8% of the beekeepers in Oyo state accepted that their honey was very thick. Generally, almost all 41, 36 and 33 (representing 100.0%, 97.1% and 94.7%) of the beekeepers said no, they do not pour bitter honey encountered in the process of harvesting honey away. Whereasfew beekeepers (2.9% and 5.3%) in Ogun and Oyo states respectively said yes they do pour bitter honey away. The majority of 35, 31 and 37 (i.e. 92.1%, 91.2% and 90.2%) of the beekeepers from Oyo, Ogun and Osun states respectively said no, they do not eat the bitter honey. It was revealed that in Oyo and Osun, most beekeepers, 24 (63.2%) and 21 (51.2%) respectively do not sell their bitter honey; while most of the beekeepers 19 (55.9%) in Ogun do sell off their bitter honey.

The majority 23 and 24 (i.e. 62.2% and 58.5%) of the beekeepers in Oyo and Osun states respectively admitted that they use their bitter honey for medicinal purposes. Whereasin Ogun state, the majority 19 (55.9%) of the beekeepers do not know the usage of bitter honey as medicine. In general, all of the beekeepers sampled (100.0%) in each agroecological zone admitted that they do not use bitter honey encountered during harvest of honey as poison. The art of mixing bitter honey with other sweet honey is not common as the majority 41, 31 and 33 (i.e. 100.0%, 91.2% and 86.8%) of the beekeepers in Osun, Ogun and Oyo states respectively admitted that they do not mix their bitter honey with their sweet honey. The majority of the beekeepers (34, 23 and 22 representing 82.9%, 67.6% and 57.9%) in Osun, Ogun and Oyo states respectively disagreed with licking as an effective way to test for pure honey.

Also, the majority (23 and 22 representing 67.6% and 57.9%) of beekeepers in Ogun and Oyo states respectively inserted match in honey before striking to test the purity of honey; while the majority (24 representing 58.5%) of beekeepers in Osun state said they do not use the method. The majority 21 and 22 (representing 61.8% and 53.7%) of beekeepers in Ogun and Osun states respectively accepted that they do pour honey in water to test its authenticity locally. Whereasthe majority 20 (52.6%) of beekeepers in Oyo state claimed they do not practice this technique of testing the purity of honey. Generally, the majority 40, 26 and 26 (representing 97.6%, 76.5% and 68.4%) of the beekeepers in Osun, Ogun and Oyo states respectively have no knowledge of pouring drops of honey on surfaces to test for the genuineness of pure honey and do not use the method. However, some of the beekeepers 12, 8 and 1 (i.e. 31.6%, 23.5% and 2.4%) in Oyo, Ogun and Osun states respectively have the knowledge and uses the method to confirm purity of honey. The mean value of beekeepers' perception of the quality of bee honey in Oyo, Osun and Ogun States are revealed in Figure 1.

The mean value of perception of beekeepers on quality of bee honey in Ogun state located in the rain forest agro-ecological zone is 4.7; followed by Oyo state situated in the Northern Guinea savanna agro-ecological zone with a mean value of perception of 4.13; whereas that of Osun state found in Southern guinea savanna agro-ecological zone is 4.02. The level of variance within beekeepers' perceptions of the quality of bee honey was subjected to the ANOVA table (Table 2) which shows that there was a highly significant difference in the perception of beekeepers on the quality of bee honey in the study ($p<0.05$). Also, the Duncan test conducted ranked mean values of perceptions (Table 3). The correlation between socioeconomic factors confirmed that some factors are significantly correlated; while others are highly significantly correlated. For instance, gender and age with ethnic group and age are both significantly correlated; while marital status and age, religion and local government area, religion and age, occupation and gender with occupation and marital status are all highly significantly correlated (Table 4).

Regression equations on perceptions of beekeepers in Oyo, Osun and Ogun States on quality of bee honey (Table 5), show that the adjusted R^2 (0.048) between educational background and perceptions of beekeepers on the quality of bee honey shows that the educational background of beekeepers has only 4.8% influence on individual's quality of bee honey. Also, religion with adjusted R^2 (0.047), reveals that religion of beekeepers has only 4.7% influence on individual's quality of bee honey.

DISCUSSION

For quality bee honey production, the general majority of respondents do not use heating method in the process of bee honey extraction. This is in tandem with the standard stipulated by CAC (2022) that honey shall not be heated to such an extent that its essential composition and quality are impaired. Also, the majority in general accepted the fact that they use a sieving method in the course of processing their bee honey. Although the majority in Ogun state declared that they do not use the sieving method. Sieving helps to remove beeswax and other unwanted particles in honey, as MacFawn (2018) upheld that sieve is used to remove beeswax and other unwanted particles during extraction; though the method still leaves debris settled at the bottom.

The general majority of beekeepers do not use the straining method, even though most of the beekeepers from Ogun state admitted that they use the straining method. Straining gives the clearest form of honey as narrated by Beekeeper (2021), who stated that to strain honey, the bee honey comb is mashed before straining, using a strainer, which has layers of wire mesh, cheesecloth and sieve in that order, placed on a pot. This way, impurities in the honey will be removed leaving the golden liquid form that is free from any debris. It was further observed that the general majority of respondents declined using filtration as a method to process their bee honey. This is contrary to the affirmation of Bryant (2017) who stated that many beekeepers want to remove large items of debris such as insect parts and pieces of wax from the honey they produce, for their products to appear clear in the jars of honey they sell. Though he suggested "no filtering" as the best method for honey samples analyses; to get an accurate understanding about the nectar types in the honey. A greater percentage of the beekeepers declared that their bee honey after extraction is always slightly light.

Some bee honey tastes bitter when extracted: the majority of the respondents in general, admitted that they do not pour away such bitter bee honey. This agrees with the affirmation of Walter (2011) that Acacia honey is extremely sweet, with no bitter aftertaste, whereas Chestnut honey (easily found in Italy) is dark and has a strong bitter taste. Bizzarri (2022) also added that no one knows exactly what gives the Sardinia Corbezzolo shrub (strawberry tree) honey its uniquely bitter taste,

though some believed that, it is due to the presence of glycoside arbutin (a molecule that binds with sugars in plants) in the nectar of the strawberry tree's flowers. The general majority agreed that they do not eat such bitter bee honey. Whereas, Delley and Brunner (2019) reported that bee honey is one of the essential breakfast foods in many countries around the world. Bizzarri (2022) stated further that though Corbezzolo honey is bitter, it is still edible; packed with nutrients, vitamin and minerals and with anti-inflammatory properties. The general majority accepted that they do not sell any bitter bee honey so harvested; though in Ogun state, the majority of their beekeepers agreed that they do sell such bitter bee honey.

It is general knowledge that anything that is original will most likely has its fake version. Original bee honey is not an exemption, as there are numerous adulterated bee honey being displayed for sale and consumption along the road sides and at supermarkets. There are various methods used by beekeepers locally to test and affirm the authenticity of original bee honey. Wolfe (2021) had reported that materials commonly used in fake honey include molasses, sugar syrup, flour and starch; and also that 75% of honey in the US tested by experts was found to be adulterated. This has continually generated concerns about the best way to affirm the originality of bee honey. The majority of the beekeepers declined that they do not or cannot use the licking method to confirm the originality of bee honey.

Generally, the majority of the respondents agreed that by insertion of a match in bee honey before striking it to generate fire is a sure method to confirm pure bee honey. This is consistent with the report of Honeyheaven (2023). However, the majority of the respondents in Osun state disagreed with this method of confirmation of pure bee honey: probably because it is not a common practice with them. The general majority agreed that pouring bee honey in water is used as a method to confirm bee honey's genuineness. This is like the report of Honeyheaven (2023). Whereas in Oyo state, majority of the beekeepers disagreed that pouring bee honey in water cannot be used to confirm pure bee honey. Generally, the greater percentage of the respondents disagreed that pouring a drop of bee honey on a surface of the table or ground cannot be used as a method to confirm bee honey's authenticity. However, Honeyheaven (2023), stated that rapid dissolution, unusual texture or clumping, sweetness level and blurred labelling are local ways of detecting fake bee honey.

On the quality of bee honey, Ogun state beekeepers in the rain forest agro-ecological zones have the highest mean value of perception (Figure 1), it confirmed that they have a more divergent view about their quality of bee honey. Whereas, Osun state in the southern guinea savanna agro-ecological zone have the least mean value of perception, affirming that they have a more convergent view about their quality of bee honey. The mean value of perception of the respondents across Oyo, Osun and Ogun states was confirmed to be significant (Table 2); and a follow up test conducted ranked Osun and Oyo states' beekeepers as having closely similar and most convergent perceptions about their quality of bee honey (Table 3); while Ogun state beekeepers has the least convergence of perceptions about their quality of bee honey.

The correlation between socioeconomic factors confirmed that some factors are significantly correlated; while others are highly significantly correlated. For instance, gender and age with ethnic group and age are both significantly correlated; while marital status and age, religion and local government area, religion and age, occupation and gender with occupation and marital status are all highly significantly correlated (Table 4). The regression equations established the various level of influences that beekeepers' view has on the quality of bee honey in Oyo, Osun and Ogun states. The beekeepers' socioeconomic factors that are highly significant were age, marital status and religion: but educational background was returned highest having the most influence on beekeepers on the quality of bee honey (Table 5). Omoloye and Akinsola (2006), in south-west Nigeria,

however, reported a negative correlation between the intensity of visitation by honeybees and temperature, implying that moisture and temperature has influence on the quality of honey produced. Also, Bett (2017), reported that bee hive technology, harvesting and processing methods, intensified agricultural practices and pests and predators are the factors that influence the qualities of bee honey produced in Trans – the Nzoia East sub-county of Kenya. While Tadesse *et al.* (2021), reported that the major constraints that affect quality honey production include lack of modern technology, absconding, pests and predators, lack of credit access, poor extension service, lack of beekeeping equipment, and death of the colony.

CONCLUSION

Beekeepers' socioeconomic factors like age, marital status and religion were highly significant: but educational background was returned highest having the most influence on beekeepers on the quality of bee honey produced in south-west Nigeria. Therefore, education should be enhanced and awareness created on improved harmonised method practised by extant beekeepers as an easier way of confirming pure bee honey. Scientifically, proline test should be made readily available at affordable price, so that, testing purity of bee honey will no longer be a nightmare.

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Table 1: Beekeepers' perceptions on viscosity, Bitter taste and testing of bee honey on quality of bee honey in Oyo, Osun and Ogun States

Question	Response (%)	Oyo	Osun	Ogun	Total
Honey's Viscosity	Light	22.2 (8)	2.4 (1)	8.8 (3)	10.8 (12)
	Slightly light	55.6 (20)	95.1 (39)	70.6 (24)	74.8 (83)
	Slightly thick	19.4 (7)	2.4 (1)	20.6 (7)	13.5 (15)
	Very thick	2.8 (1)	0.0 (0)	0.0 (0)	0.9 (1)
	Total	**100.0 (**36)	**100.0 (**41)	**100.0 (**34)	**100.0 (**111)
What beekeepers do with bitter honey after harvest (Pour it away)	Yes	5.3 (2)	0.0 (0)	2.9 (1)	2.7 (3)
	No	94.7 (36)	100.0 (41)	97.1 (33)	97.3 (110)
	Total	**100.0 (**38)	**100.0 (**41)	**100.0 (**34)	**100.0 (**113)
What beekeepers do with bitter honey after harvest (Still ate it)	Yes	7.9 (3)	9.8 (4)	8.8 (3)	8.8 (10)
	No	92.1 (35)	90.2 (37)	91.2 (31)	91.2 (103)
	Total	**100.0 (**38)	**100.0 (**41)	**100.0 (**34)	**100.0 (**113)
What beekeepers do with bitter honey after harvest(Sold it)	Yes	36.8 (14)	48.8 (20)	55.9 (19)	46.9 (53)
	No	63.2 (24)	51.2 (21)	44.1 (15)	53.1 (60)
	Total	**100.0 (**38)	**100.0 (**41)	**100.0 (**34)	**100.0 (**113)
What beekeepers do with bitter honey after harvest(Use it as medicine)	Yes	62.2 (23)	58.5 (24)	44.1 (15)	55.4 (62)
	No	37.8 (14)	41.5 (17)	55.9 (19)	44.6 (50)
	Total	**100.0 (**37)	**100.0 (**41)	**100.0 (**34)	**100.0 (**112)
What beekeepers do with bitter honey after harvest(Use it as poison)	No	100.0 (38)	100.0 (41)	100.0 (34)	100.0 (113)
	Total	**100.0 (**38)	**100.0 (**41)	**100.0 (**34)	**100.0 (**113)
What beekeepers do with bitter honey after harvest(Mix with their sweet honey)	Yes	10.5 (4)	0.0 (0)	8.8 (3)	6.2 (7)
	No	86.8 (33)	100.0 (41)	91.2 (31)	92.9 (105)
	Undecided	2.7 (1)	0.0 (0)	0.0 (0)	0.9 (1)
	Total	**100.0 (**38)	**100.0 (**41)	**100.0 (**34)	**100.0 (**113)
Local means of testing pure honey(Licking)	Yes	42.1 (16)	17.1 (7)	32.4 (11)	30.1 (34)
	No	57.9 (22)	82.9 (34)	67.6 (23)	69.9 (79)
	Total	**100.0 (**38)	**100.0 (**41)	**100.0 (**34)	**100.0 (**113)
Local means of testing pure honey(Insertion of the match before the strike)	Yes	57.9 (22)	41.5 (17)	67.6 (23)	54.9 (62)
	No	42.1 (16)	58.5 (24)	32.4 (11)	45.1 (51)
	Total	**100.0 (**38)	**100.0 (**41)	**100.0 (**34)	**100.0 (**113)
Local means of testing pure honey(Pouring it in water)	Yes	47.4 (18)	53.7 (22)	61.8 (21)	54.0 (61)
	No	52.6 (20)	46.3 (19)	38.2 (13)	46.0 (52)
	Total	**100.0 (**38)	**100.0 (**41)	**100.0 (**34)	**100.0 (**113)
Local means of testing pure honey(Pouring a drop on surfaces)	Yes	31.6 (12)	2.4 (1)	23.5 (8)	18.6 (21)
	No	68.4 (26)	97.6 (40)	76.5 (26)	81.4 (92)
	Total	**100.0 (**38)	**100.0 (**41)	**100.0 (**34)	**100.0 (**113)

Source: Field survey, 2023

Table 2: ANOVA table on the perception of beekeepers on quality of bee honey

Variables	Sum of Squares	Degree of Freedom	Mean Square	F	Sig.
Between states	11.428	2	5.714	24.357	0.000**
Within states	25.805	110	0.235		
Total	37.233	112			

** Highly significant. * Significant

Source: Field survey, 2023

Table 3: Duncan test on the separation of the mean value of perceptions of beekeepers on quality of bee honey

State	N	Mean
Osun	41	4.0244[a]
Oyo	38	4.1382[a]
Ogun	34	4.7647[b]
Sig.		0.312

Source: Field survey, 2023

Table 4: Correlation analysis between the socio-economic factors

Socio-economic factor		LGA	Age	Gender	Marital Status	Educational Background	Years spent in the Community	Ethnic Group	Religion	Occupation	Total Monthly Income
LGA	Pearson Correlation	1									
Age	Pearson Correlation	.151	1								
	Sig. (2-tailed)	.126									
Gender	Pearson Correlation	.004	-.190*	1							
	Sig. (2-tailed)	.970	.043								
Marital Status	Pearson Correlation	-.102	.549**	-.006	1						
	Sig. (2-tailed)	.302	.000	.950							
Educational Background	Pearson Correlation	.025	-.069	.089	-.126	1					
	Sig. (2-tailed)	.804	.470	.350	.185						
Years spent in the Community	Pearson Correlation	-.126	.100	-.125	.137	.076	1				
	Sig. (2-tailed)	.204	.291	.188	.147	.426					
Ethnic Group	Pearson Correlation	.093	-.205*	.120	-.201*	.089	-.146	1			
	Sig. (2-tailed)	.350	.029	.207	.033	.350	.123				
Religion	Pearson Correlation	-.298**	-.299**	.115	-.004	.064	.159	.131	1		
	Sig. (2-tailed)	.002	.001	.223	.969	.501	.093	.166			
Occupation	Pearson Correlation	.117	-.142	.263**	-.315**	-.026	-.063	.074	.162	1	
	Sig. (2-tailed)	.238	.135	.005	.001	.783	.509	.439	.087		
Total Monthly Income	Pearson Correlation	-.046	-.070	-.167	-.047	.170	.170	-.081	-0.062	.038	1
	Sig. (2-tailed)	0.708	0.571	0.173	0.702	0.166	0.166	0.513	0.618	0.759	

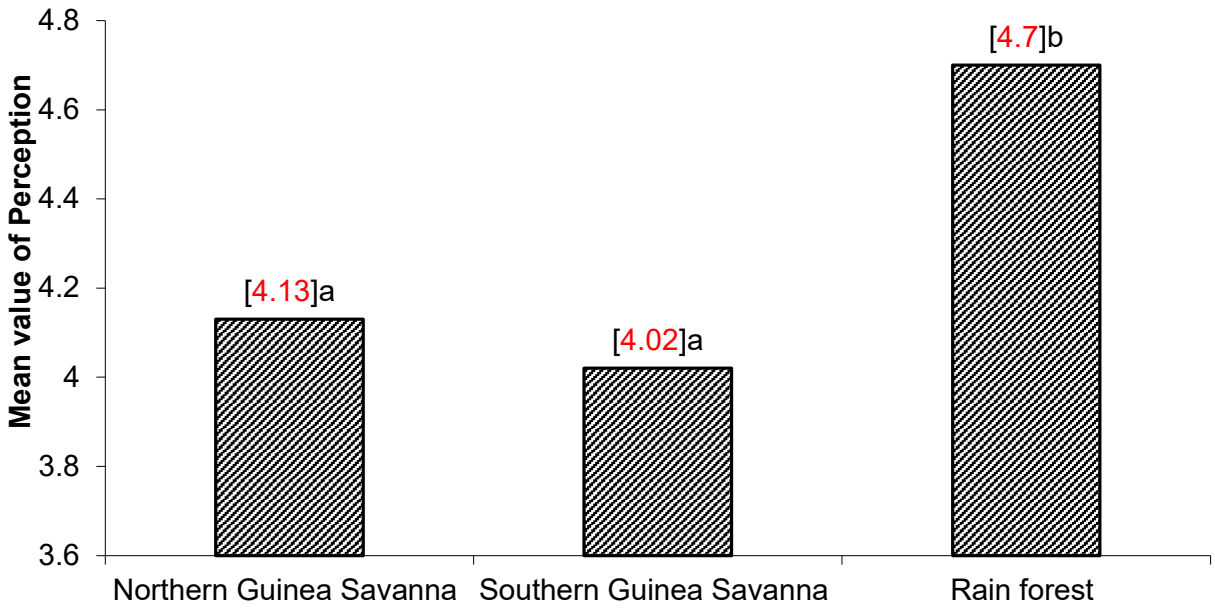
**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Source: Field survey, 2023

Table 5: Regression equation on the perception of beekeepers on the following indices

S/N	EQUATION	SIG	RMSE	R	R^2
Perception of beekeepers on the quality of bee products					
1	3.793+0.193(Educational Background)	0.012	0.5627	0.056	0.048
2	3.887+0.262(Religion)	0.012	0.5628	0.056	0.047

Source: Field survey, 2023



*Significant (p>0.05)

Figure 1: Mean value of perception of beekeepers on quality of bee honey

Source: Field survey, 2023