

Research Article

# Investigation of the Physicochemical (Viscosity) Properties of Honey Produced in Southwestern Nigeria

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## Abstract

Honey is a natural sweetener with numerous nutritional qualities which provide substantial livelihood benefits. More clarification about the physical properties would help diversify the local applications critical for human livelihood. However, there is a scarcity of information on the physicochemical (viscosity) quality of honey produced in South-Western Nigeria (SWN). Therefore, this study evaluates the viscosity properties of honey produced in SWN. In a two-stage, sampling procedure, Osun, Ogun and Oyo states were purposively selected because of their prevalent apicultural activities. Three localities were chosen per state. In each of Aba Oka, Oke Onitii, Iyemogun, Iwoye, Federal University of Agriculture, Abeokuta (FUNAAB), Tai Solarin University of Education (TASUED), Oke Orogun, Forest Resource Management Department, University of Ibadan (FRMDUI) and Badeku, 15 beekeepers were randomly selected and a set of questionnaires was used to obtain information on the viscosity of their harvested honey. Also, an emergent sampling technique was used to obtain capped-comb honey from one beekeeper per locality. The honey collected was analysed for physicochemical [viscosity (Pa.s)] properties following standard protocols. The data obtained were analysed using descriptive statistics and ANOVA at  $\alpha_{0.05}$ . TASUED honey viscosity was the thickest,  $2000.00 \pm 0.00$  at 6 rounds per minute (RPM), whereas Oke Orogun was the lightest,  $9990.00 \pm 0.00$  at 6 RPM. Conclusively, TASUED honey was presumed to have the best quality, based on its thickest viscosity.

## Keywords

Apiculture, Bee, Honey, Quality, Viscosity

## 1. Introduction

Honey composition, colour, aroma, and flavour depend a lot on the influence of plants, climate and environmental conditions [23] and also on the skills of the beekeeper [4, 18, 29, 28]. The physicochemical properties of honey depend on

the nectar and pollen of the source plant [20]. There are differences among types of honey, especially between honey with blossom origin and honey from honeydew droplets [17, 6]. Scientifically, a refractometer can be used to check the

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Received: 16 January 2025; Accepted: 27 January 2025; Published: 17 February 2025



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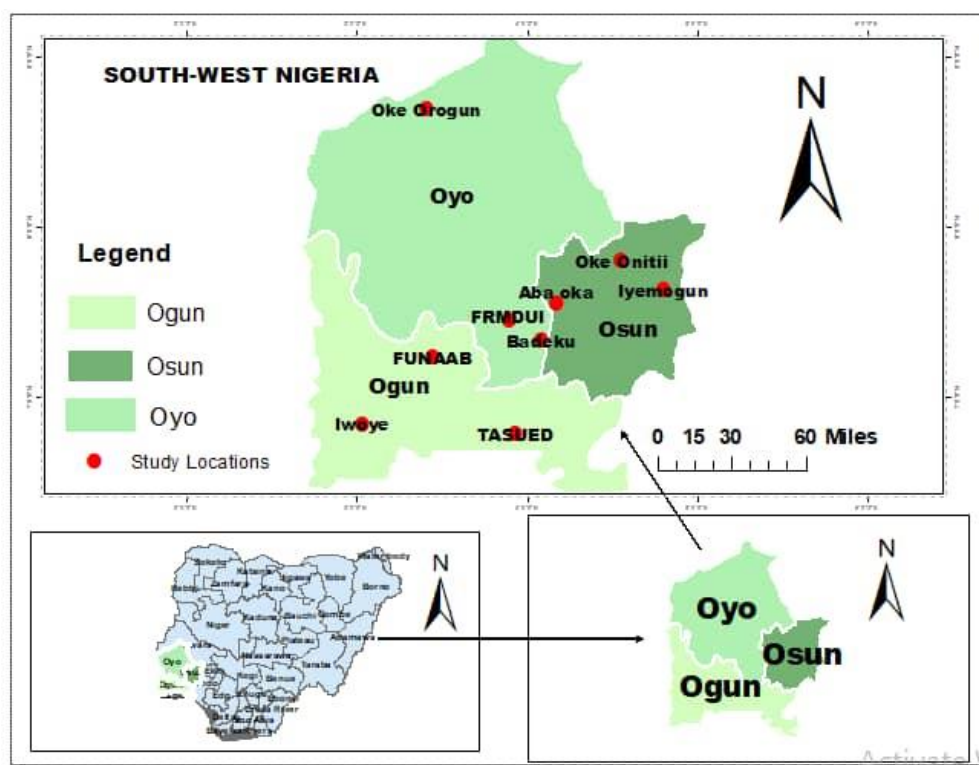
composition of fluids. It can be used to check the refractive index of bee honey [13]. Only a drop or two of bee honey is needed to do the test, using a refractometer. The test gives a reading of the amount of water in the bee honey. Having much water in bee honey is not acceptable, as it is a pointer that the bee honey is not pure and/or may soon go bad [31, 21].

In a laboratory setting, a spectrometer is used to test the quality of honey. The mass spectrometer allows for the detection, separation and analysis of various molecules in honey and the conclusion of whether the honey is of good quality. Sugars in honey are easy to analyse using this equipment. Some sugars that are added to honey, however, may go undetected [31]. The nutrient grade of honey is measured in Brix [21]. The higher the Brix measurement, the higher the quality of honey. However, honey's water content must be lower to have a high Brix measurement [21]. Unfortunately, this method of testing the purity and quality of honey is not readily available to beekeepers and honey consumers [31].

Honey has a minute quantity of different vitamins, minerals, amino acids and antioxidants. Though honey was not qualified as a rich source of traditional nutrients by the food ranking system, it was affirmed that honey emerged as a genuine source of sugar, vitamin B<sub>6</sub>, vitamin B<sub>2</sub>, manganese and iron [1, 35, 19]. It was added that the main nutritional constituents in honey are carbohydrates i.e. simple sugars: fructose and glucose. The vitamins found in honey may include (depending on floral variety) niacin, riboflavin and

pantothenic acid; minerals present include calcium, copper, iron, magnesium, manganese, phosphorus, potassium and zinc [8]. Amino acids present include enzymes, proline, alanine, leucine, glycine and glutamic acid [39]. Flavonoids and other polyphenols are phytochemicals recognised in honey that make it a potent ingredient and an antibacterial agent [16, 14, 27, 19]. All these components present in different proportions in honey add to its consistency. However, the solubility of the nectar, and how much solute it can dissolve in itself also contribute to the consistency of honey. A glycemic index of 32 to 91 had been recorded for honey based on botanical origin [5]. It has also been reported [38] that the sweetness and astringency indexes can be calculated using the ratio of soluble solids to acidity and vice versa.

Many arguments are for and against the quality of honey been determined by whether pure honey is light or thick. The situation therefore necessitated that, more research should be conducted on the honey quality being produced in Nigeria. Expected constituents in honey are regulated globally by the European Council Directive [7] and nationally by the National Agency for Food and Drug Administration and Control (NAFDAC) [22]. These regulations specified that the maximum water content of honey must be below 20% for it to be an authentic food product. Hence, this study will evaluate the quality of honey produced in the southwestern region of Nigeria based on its viscosity values.



Source. The study area map was digitised [3].

**Figure 1.** The map shows Nigeria, the 3 states selected in the South-west and the 9 study localities.

## 2. Methodology

### 2.1. The Study Area

The southwestern zone of Nigeria comprises 6 states: Oyo, Ekiti, Osun, Ondo, Lagos and Ogun. However, Oyo, Osun and Ogun states were chosen purposively based on their prevalent apicultural practices. The weather conditions change between the rainy season (March-October) and the dry season (November-February), and; the dry season is characterised by Harmattan dust and cold dry wind from the northern desert. [32]. The southwestern zone of Nigeria (Figure 1) is sighted between Latitude 4° and 9°N, and Longitude 30° and 7°E [12, 24]. Its rainfall ranges between 2000 to 3000mm, and its temperature is over 17°C [34].

### 2.2. Sampling Technique

In a two-stage, sampling procedure, Osun, Ogun and Oyo states were purposively selected because of their prevalent apicultural activities. Three localities were purposively chosen per state. In each of Aba Oka, Oke Onitii, Iyemogun, Iwoye, Federal University of Agriculture, Abeokuta (FUNAAB), Tai Solarin University of Education (TASUED), Oke Orogun, Forest Resource Management Department, University of Ibadan (FRMDUI) and Badeku, 15 beekeepers were randomly selected and administered a set of questionnaires to obtain information on honey viscosity. Also, an emergent sampling technique was used to obtain capped-comb honey from one beekeeper per locality. The honey collected was analysed for viscosity (Pa.s) properties following standard protocols.

### 2.3. Data Collection

A set of questionnaires was used to obtain information, from 15 beekeepers in each selected locality, on honey viscosity. Capped-comb honey samples were collected (Figures 2 and 3) by employing the services of a local beekeeper selected using an emergent sampling procedure in a locality within each Local Government Area chosen per district, per state. A total of nine honey samples were collected from various localities, labelled as Aba Oka in Ayedire, Osun State; Oke Onitii in Osogbo, Osun State; Iyemogun in Ilesa East, Osun State; Iwoye in Yewa South, Ogun State; FUNAAB in Abeokuta, Ogun State; TASUED in Ijagun, Ijebu Ode, Ogun State; Oke Orogun in Saki, Oyo State; FRMDUI in Ibadan North, Oyo State and Badeku in Ona Ara, Oyo State; during the honey flow period, from October to April. Three honey samples were sourced from each state. Each from a Senatorial District for fair representation. All the honey samples were stored at ambient temperature, in sample plastic bowls (Figure 4) and bottles (Figure 5) with tight-fitting lids, during the period of analytical investigation. The viscosity of each honey

sample was measured using standardised instrumental methods [2]. A viscometer was used to read the speed of different rotors (1, 2, 3, and 4) inserted into the honey samples to determine their rounds per minute [15].



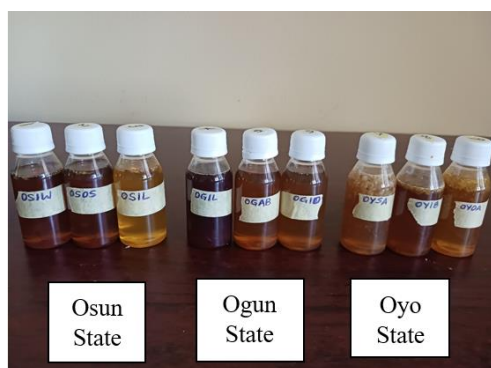
**Figure 2.** Falade L. O. and Osipitan A. A. at FUNAAB, Abeokuta, Ogun state, are ready to collect the capped-comb honey sample.



**Figure 3.** Falade L. O. and Olawumi A. T. at TASUED, Ijagun, Ijebu Ode, Ogun state, are ready to collect the capped-comb honey sample.



**Figure 4.** The 9 Capped-comb-honey samples were obtained from Aba Oka, Oke Onitii, and Iyemogun in Osun state; Iwoye, FUNAAB and TASUED in Ogun state; and Oke Orogun, FRMDUI, and Badeku in Oyo state.



**Figure 5.** The 9 Capped-comb-honey samples that were collected from Aba Oka, Oke Onitii, and Iyemogun in Osun state; Iwoye, FUNAAB and TASUED in Ogun state; and Oke Orogun, FRMDUI, and Badeku in Oyo state, were processed and sealed in sterilised plastic bottles for property analysis in the laboratory.

## 2.4. Data Analysis

Data were analysed using descriptive statistics, triplicate mean values and standard deviation were also determined for

the viscosity of honey samples and results were presented in tables. Software of statistical tools was used [33, 11] for inferential analysis, using SPSS to determine the level of significance with ANOVA at  $\alpha_{0.05}$  on data obtained from the analysis of honey samples in the laboratory.

## 3. Results

Table 1 establishes the coordinates and localities from where the honey samples were sourced. Table 2 displays the viscosity of honey as assessed by respondents in each of the localities. The majority (83 representing 100%) of the respondents affirmed that their harvested honey was slightly light. The viscosity nature of honey is described as generally slightly light by the majority of the beekeepers from Aba Oka and Iyemogun having 17% each. The result shows that honey produced in the study areas is slightly light as affirmed by the beekeepers,  $P < 0.05$ .

**Table 1.** The localities of capped-comb honey collection.

Location	State	LGA	Town/Localities	GPS Coordinate [12]	Sample Collected
1	Osun	Ayedire	Aba Oka	4.17159E, 7.554715N	Capped-comb honey
2	Osun	Osogbo	Oke Onitii	4.555202E, 7.799927N	Capped-comb honey
3	Osun	Ilesa East	Iyemogun	4.798945E, 7.634453N	Capped-comb honey
4	Ogun	Yewa South	Iwoye	3.029313E, 6.845488N	Capped-comb honey
5	Ogun	Abeokuta	*FUNAAB	3.446188E, 7.237865N	Capped-comb honey
6	Ogun	Ijebu Ode	**TASUED	3.93024E, 6.790058N	Capped-comb honey
7	Oyo	Saki	Oke Orogun	3.406052E, 8.69561N	Capped-comb honey
8	Oyo	Ibadan North	***FRMDUI	3.897225E, 7.450028N	Capped-comb honey
9	Oyo	Ona Ara	Badeku	4.087692E, 7.337662N	Capped-comb honey

\*FUNAAB = Federal University of Agriculture, Abeokuta; \*\*TASUED = Tai Solarin University of Education; \*\*\*FRMDUI = Forest Resource Management Department, University of Ibadan.

**Table 2.** Viscosity of honey as assessed by respondents in each of the study areas.

Viscosity / Location	Light		Slightly light		Slightly thick		Very thick	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Aba Oka	1	8	14	17	-	-	-	-
Oke Onitii	-	-	10	12	1	7	-	-
Iyemogun	-	-	14	17	-	-	-	-
Iwoye	1	8	8	10	5	33	1	100



Viscosity / Location	Light		Slightly light		Slightly thick		Very thick	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
FUNAAB	1	8	3	4	-	-	-	-
TASUED	4	33	8	10	1	7	-	-
Oke Orogun	-	-	9	11	5	33	-	-
FRMDUI	4	33	9	11	2	13	-	-
Badeku	1	8	8	10	1	7	-	-
Total	12	100	83	100	15	100	1	100

The viscosity nature of honey is described as 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 [Table 3](#). However, other beekeepers (2.4%) in Osun state claimed that they at other times do have light or slightly thick honey. Also, 2.8% of the bee-

keepers in Oyo state accepted that their honey is thicker. The deduced index of viscosity of honey harvested by beekeepers on bee honey quality in Oyo, Osun and Ogun States ([Table 4](#)) shows the mean and standard deviation for honey viscosity and the overall mean as  $\text{of } 2.05 \pm 0.53$ .

**Table 3.** Beekeepers' layman assessment of the viscosity of honey harvested from various localities 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)

**Table 4.** Deduced index for viscosity of honey harvested by beekeepers on quality of bee honey in various localities in Oyo, Osun and Ogun States.

Parameter	*Mean	Standard Deviation	Mean $\pm$ Std. Dev.
Honey's Viscosity	2.05	0.53	2.05 $\pm$ 0.53

\*The Likert scale for the mean in the table is 1.0-2.4 (Negative), 2.5-3.4 (Neutral), 3.5-5.0 (Positive)

The results of a viscometer, ([Figures 6 and 7](#)) used to determine the viscosity of honey samples from various selected localities in Oyo, Osun and Ogun states, are presented in [Table 5](#). Results reveal that at 6 RPM (rounds per minute), the honey sample with the highest (9990.00 $\pm$ 0.00) mean speed, i.e. most light is from Oke Orogun in Saki, Oyo state. However, the honey sample with the lowest (2000.00 $\pm$ 0.00) mean speed, i.e. thickest, is from TASUED in Ijagun, Ijebu Ode, Ogun state. At 12 RPM, the honey sample with the highest (9990.17 $\pm$ 0.29) mean speed, the most light, is from Oke

Orogun in Saki, Oyo state. Whereas, the honey sample with the lowest (1970.43 $\pm$ 0.51) mean speed, thickest, is also from TASUED in Ijagun, Ijebu Ode, Ogun state. At 30 RPM, the honey sample with the highest (3997.00 $\pm$ 1.00) mean speed, the most light, is from Aba Oka in Ayedire, Osun state. Whereas, the honey sample with the lowest (1884.00 $\pm$ 0.00) mean speed, most thick, is still from TASUED in Ijagun, Ijebu Ode, Ogun state. Lastly, at 60 RPM, the honey sample with the highest (1998.00 $\pm$ 0.00) mean speed, and lightest happened to be 7 samples (from Oke Orogun, FRMDUI, Badeku,

Aba Oka, Oke Onitii, Iyemogun and Iwoye) with the same value. The remaining 2 samples are of different values, of which the one with the least ( $1822.00 \pm 0.00$ ) mean speed, is from TASUED in Ijagun, Ijebu Ode, Ogun state.



**Figure 6.** Viscosity determination using a Viscometer.

The analysis of this study confirmed TASUED in Ijagun, Ijebu Ode honey as the thickest contrary to respondents' opinion of 0.0(0) for thickest honey viscosity. There was a high level of significant difference ( $p < 0.05$ ) in viscosity for the tested honey samples (Table 6). The DMRT follow-up test conducted (Table 7), ranked the means and affirmed that the consistency was similar for honey samples from Oke Orogun in Saki, Iyemogun in Ilesa East and Aba Oka in Ayedire; however, viscosity at 6RPM and 12RPM shows the highest

level of variation, as each location's viscosity was different from each other. Whereas, at 30RPM, the consistency of Oke Orogun in Saki, Iyemogun in Ilesa East and Aba Oka in Ayedire were similar and all other honey samples differed. Also at 60RPM, all honey samples had the same viscosity value except the honey sample from FUNAAB in Abeokuta and TASUED in Ijagun, Ijebu-Ode. Table 8 revealed the summary statistics, the viscosity mean value for each state, and the grand mean for viscosity in the whole localities as  $3705.504 \pm 0.292$ .



**Figure 7.** Shows a typical Viscometer reading at 12 RPM.

**Table 5.** Shows the viscometer readings for the viscosity of honey samples from 9 localities in Oyo, Osun and Ogun states.

S/N		1	2	3	4
PARAMETER		Viscosity at 250 C@ 6 RPM	Viscosity at 250 C@ 12 RPM	Viscosity at 250 C@ 30 RPM	Viscosity at 250 C@ 60 RPM
SOURCES OF HONEY SAMPLES	1**(Aba Oka in Ayedire) *Mean±SD	6760.67±1.15	6580.00±0.00	3997.00±1.00	1998.00±0.00
	2 (Oke Onitii in Osogbo) Mean±SD	3640.00±0.00	3620.67±1.15	3516.00±0.00	1998.00±0.00
	3 (Iyemogun in Ilesa East) Mean±SD	7260.00±0.00	7208.67±0.58	3996.67±1.15	1998.00±0.00
	4 (Iwoye in Yewa South) Mean±SD	4060.67±1.15	4050.00±0.00	3920.67±1.15	1998.00±0.00
	5 (FUNAAB in Abeokuta) Mean±SD	2040.00±0.00	2010.33±0.58	1908.04±0.07	1877.33±0.58
	6 (TASUED in Ijagun, Ijebu Ode) Mean±SD	2000.00±0.00	1970.43±0.51	1884.00±0.00	1822.00±0.00
	7 (Oke Orogun in Saki) Mean±SD	9990.00±0.00	9990.17±0.29	3996.00±0.00	1998.00±0.00
	8 (FRMDUI in Ibadan North) Mean±SD	4780.00±0.00	3360.00±0.00	3132.00±0.00	1998.00±0.00
	9 (Badeku in Ona Ara) Mean±SD	3259.33±0.58	4010±0.00	2772.33±0.58	1998.00±0.00

\*Data are mean values of triplicate determinations per sample  $\pm$  standard deviation (SD). \*\*{Osun state [Aba Oka in Ayedire], [Oke Onitii in Osogbo], [Iyemogun in Ilesa East]} {Ogun state [Iwoye in Yewa South], [FUNAAB in Abeokuta], [TASUED in Ijagun, Ijebu Ode]} {Oyo state [Oke Orogun in Saki], [FRMDUI in Ibadan North], [Badeku in Ona Ara]}

**Table 6.** Analysis of variance for the viscosity of honey samples.

Source	Viscosity	Type III Sum of Squares	Df	Mean Square	F	Sig.	R <sup>2</sup>
H	Viscosity at 250 C@ 6 RPM	169551048.296	8	21193881.037	63581643.111	0.000**	0.996
	Viscosity at 250 C@ 12 RPM	168989597.401	8	21123699.675	81014189.095	0.000**	0.994
	Viscosity at 250 C@ 30 RPM	18299062.727	8	2287382.841	5140442.861	0.000**	0.993
	Viscosity at 250 C@ 60 RPM	107272.296	8	13409.037	362044.000	0.000**	0.997
Error	Viscosity at 250 C@ 6 RPM	6.000	18	0.333			0.995
	Viscosity at 250 C@ 12 RPM	4.693	18	0.261			
	Viscosity at 250 C@ 30 RPM	8.010	18	0.445			
	Viscosity at 250 C@ 60 RPM	0.667	18	0.037			
Total	Viscosity at 250 C@ 6 RPM	169551054.296	26				
	Viscosity at 250 C@ 12 RPM	168989602.094	26				
	Viscosity at 250 C@ 30 RPM	18299070.737	26				
	Viscosity at 250 C@ 60 RPM	107272.963	26				

\*\* = highly significant

**Table 7.** Duncan Multiple Range Test ranked the viscosity of honey samples.

Sources of Honey Samples	Viscosity at 250 C@ 6 RPM	Viscosity at 250 C@ 12 RPM	Viscosity at 250 C@ 30 RPM	Viscosity at 250 C@ 60 RPM
Oke Orogun in Saki	9990 <sup>a</sup>	9990.17 <sup>a</sup>	3996 <sup>a</sup>	1998 <sup>a</sup>
Iyemogun in Ilesa East	7260 <sup>b</sup>	7208.67 <sup>b</sup>	3996.67 <sup>a</sup>	1998 <sup>a</sup>
Aba Oka in Ayedire	6760.67 <sup>c</sup>	6580 <sup>c</sup>	3997 <sup>a</sup>	1998 <sup>a</sup>
FRMDUI in Ibadan North	4780 <sup>d</sup>	3360 <sup>g</sup>	3132 <sup>d</sup>	1998 <sup>a</sup>
Iwoye in Yewa South	4060.67 <sup>e</sup>	4050 <sup>d</sup>	3920.67 <sup>b</sup>	1998 <sup>a</sup>
Oke Onitii in Osogbo	3640 <sup>f</sup>	3620.67 <sup>f</sup>	3516 <sup>c</sup>	1998 <sup>a</sup>
Badeku in Ona Ara	3259.33 <sup>g</sup>	4010 <sup>e</sup>	2772.33 <sup>c</sup>	1998 <sup>a</sup>
FUNAAB in Abeokuta	2040 <sup>h</sup>	2010.33 <sup>h</sup>	1908.04 <sup>f</sup>	1877.33 <sup>b</sup>
TASUED in Ijagun, Ijebu Ode	2000 <sup>i</sup>	1970.43 <sup>i</sup>	1884 <sup>g</sup>	1822 <sup>c</sup>

Mean values with the same superscript are not significantly different from each other.

\*{Osun state [Aba Oka in Ayedire], [Oke Onitii in Osogbo], [Iyemogun in Ilesa East]} {Ogun state [Iwoye in Yewa South], [FUNAAB in Abeokuta], [TASUED in Ijagun, Ijebu Ode]} {Oyo state [Oke Orogun in Saki], [FRMDUI in Ibadan North], [Badeku in Ona Ara]}

**Table 8.** State and grand mean summary statistics for honey's viscosity (a physicochemical property) were determined using a viscometer.

Viscometer readings	Osun state Mean±SD	Ogun State Mean±SD	Oyo State Mean±SD	Overall Mean±SD
Viscosity at 250 C@ 6 RPM	5886.89±0.383	2700.22±0.383	6009.67±0.193	4865.59±0.32
Viscosity at 250 C@ 12 RPM	5803.11±0.577	2676.92±0.363	5786.67±0.097	4755.57±0.35

Viscometer readings	Osun state Mean±SD	Ogun State Mean±SD	Oyo State Mean±SD	Overall Mean±SD
Viscosity at 250 C@ 30 RPM	3836.56±0.717	2570.90±0.407	3300±0.193	3235.82±0.439
Viscosity at 250 C@ 60 RPM	1998±0.00	1899.11±0.193	1998±0.00	1965.037±0.06
Overall Viscosity's Mean±SD	4381.14±0.4192	2461.79±0.337	4273.58±0.121	3705.504±0.292

{Osun state [Aba Oka in Ayedire], [Oke Onitii in Osogbo], [Iyemogun in Ilesa East]}

{Ogun state [Iwoye in Yewa South], [FUNAAB in Abeokuta], [TASUED in Ijagun, Ijebu Ode]}

{Oyo state [Oke Orogun in Saki], [FRMDUI in Ibadan North], [Badeku in Ona Ara]}

## 4. Discussion

Bee honey production is practiced in Oyo, Osun and Ogun states where this study was carried out and one of the hive products is honey processed by bees from the nectar of flowering plants. The physicochemical composition of bee honey from various chosen localities within these states has established that the mean and standard deviation for their viscosities ranged from 2000.00±0.00 to 9990.00±0.00 at 6 RPM and 1822.00±0.00 to 1998.00±0.00 at 60 RPM. Generally, concerning the viscosity of honey, the honey sample from TASUED in Ijagun, Ijebu-Ode, Ogun state was ascertained to be the thickest, richest, and best by scientific laboratory analysis using a viscometer. Whereas, the lightest honey was confirmed to be those majorly from Oke Orogun in Saki, Oyo state, Iyemogun in Ilesa East and Aba Oka in Ayedire, both in Osun state in that order.

Several other investigative processes have been reported to ascertain honey physicochemical properties together with colour using the Pfund scale, moisture, sugars, pH, free acidity, viscosity, electrical conductivity, hydroxymethylfurfural (HMF) content, insoluble solids and formol index [25, 10, 30, 26, 9, 36, 37] nonetheless because of the number of obtainable honey varieties, additional precise techniques are needed to determine honey's physicochemical properties. The findings of this study aligns with the limit stated in the CODEX International Standard Regulations [7] and Nigeria Honey Regulations [22]. Hence, the bee honey samples produced in southwestern Nigeria were presumed to be good quality and safe for human consumption and health, locally and globally.

## 5. Conclusion

The honey from southwestern Nigeria is presumed to be of good quality based on its consistency. The honey sample from TASUED in Ijagun, Ijebu Ode, Ogun state was affirmed the best, having the thickest consistency when compared across all the selected localities and states. The government should therefore subsidise and make available to all extant beekeepers, affordable scientific *refractometers* needed to check the composition, especially the amount of water and refractive

index of bee honey; *viscometers* to determine the actual thickness of bee honey for proper grading and *spectrometers* for easy detection, separation and analysis of various molecules in bee honey in laboratories across the nation to test the quality of bee honey with ease at affordable price.

## Abbreviations

FRMDUI	Forest Resource Management Department, University of Ibadan
FUNAAB	Federal University of Agriculture, Abeokuta
NAFDAC	National Agency for Food and Drug Administration and Control
SWN	South Western Nigeria
TASUED	Tai Solarin University of Education

## Acknowledgments

The researchers are grateful to all the beekeepers who harvested capped-comb honey used for the research, and to Mr. D. A. Adegboyega and Mrs O. O. Balogun, the laboratory technicians, for their meticulous efforts in the analysis.

## Author Contributions

**Falade Luke Olawole:** Conceptualization, Funding acquisition, Investigation, Methodology, Writing – original draft, Writing – review & editing

**Osipitan Adebola Adedoyin:** Investigation, Resources, Validation

**Olawumi Akinyode Timothy:** Investigation, Resources, Validation

**Kolapo Samson Rotimi:** Resources, Software, Validation

## Conflicts of Interest

This study shed light on the relationship between the degree of honey viscosity and its constituent quality. There are no financial, commercial or other affiliations which may be perceived as potential conflicts of interest by the academic community. The authors declare no conflicts of interest.



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