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Research Article

Performance Evaluation of Local Honey Bee Races (*Apis mellifera bandansi*) at Wondo Genet, Sidama Regional State of Southern Ethiopia

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Abstract

The research was undertaken in Wondo genet agricultural a study conducted at a research facility between 2015 and 2017 focused on assessing the performance of *Apis mellifera bandansi* honey bee races. The objective was to identify and choose the most effective honey bee races based on various parameters such as defensive behavior, hygienic practices, absconding tendencies, foraging abilities, swarming patterns, and productivity in terms of hive product area. A total of thirty bee races were evaluated during the study period (30) colonies of *Apis mellifera bandansi*i honeybee were established on station. Basic management practices were made reasonably uniform for tested colonies. The investigation indicated the races exhibited aggressive behavior, resulting in stings on the examiner, with a maximum count of up to 158±15.3 and a minimum of 60 stings on the manipulator. The distance covered by the races extended long, reaching up to 255±74.1 meters away from the entrance. The absconding percentage from a total of thirty colonies ranged from a maximum of 50% in 2015 to a minimum of 26% in 2017. The early and late foraging behavior of the colony was also documented early morning 5:30 am time foraging, whereas late foraging time was at 7:15pm pm e back to their nest in the evening. The remaining hive products were quantified in a 5x5 cm2 comb area cell over the course of the production season, with measurements taken at 21-day intervals to assess the brood area. The values obtained, expressed as the mean ± standard deviation, indicated the range from maximum to minimum for the adult, brood, pollen, nectar, and honey area in cm^2. 79.5±13.4 107.1±24.6, 74.41±31.3, 48.2±9.0 for year (2015), 74.5±6.5, 107.1±24.6, 48.5±16.9, 81.8±31.6 for (year, 2016) and 114.8±20.5, 96.2±17.4, 50.0±19.4 and 90.7±40.2 for (year, 2017 respectively. The Apis mellifera, typically referred to in a general sense bandansi the race demonstrates positive attributes in terms of hygienic behavior and is also efficient in maximizing honey production when subjected to appropriate management strategies. It is recommended to conduct additional research on the specification of geographical location in relation to the distribution of different races and their identification for the purpose of breed determination and enhancement. This will aid in the selection of colonies that are more suitable in terms of production efficiency, temperament, resistance to pests, parasites, and diseases, as well as foraging and absconding tendencies.

Keywords

Aggressiveness, Apis Mellifer, Hygienic Behavior, Productivity % Swarming and Absconding

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1. Introduction

In Ethiopia, the production of honey is regarded as one of the longstanding agricultural practices [1] with advantageous natural resource endowment, unique agro-ecological conditions, and a plethora of over seven thousand flowering species, the region is well positioned to excel in the production of honey and wax [2]. The country is among the foremost honey producers in Africa and the world. There are over ten million bee colonies and one point eight million beekeepers exist in Ethiopia [1]. It ranks as the fourth most significant honey producer globally, following the Republic of India, China, and Turkey, with a total of 6,958,004 beehives [3] the quantities of honey and beeswax generated were 53782 tons and 5790 tons, respectively. [4].

Honeybee colonies differ in their performance, even within the same agro-ecological zone [5, 6]. The variations encompass both the favorable and unfavorable characteristics concerning production, productivity, and behavior [7]. Honeybee colonies exhibit differential performance even when subjected to identical environmental conditions and management protocols. Nevertheless, it is imperative for apiculture, like any other industry, to yield a positive financial outcome. Achieving this necessitates the establishment, propagation, and upkeep of high-quality bee stocks in apiaries [8]. Consequently, the assessment of honey bee colonies' performance across various races and ecotypes plays a crucial role in establishing a basis for the future enhancement and selection of the optimal race [9].

Objective

To assess the effectiveness of regional honeybee strains (A.m. *bandasii*) at the study area.

2. Materials and Methods

2.1. Explanation of the Research Site

The investigation was carried out at wondo genet a center for agricultural research situated at. sidama National region state. The central point was situated 270 kilometers to the South of Addis Ababa, 14 kilometers to the southeast of Shashemene, and 34 kilometers distant from Hawassa which is capital of the region to east direction. The geographical coordinates of the area is 38°37`13”– 38°`38’20”east and 7°5`23”-7°5`52” north at a certain elevation of 176-1920 meters above sea level respectively. The region experiences an average annual minimum rainfall of 709 mm and a maximum of 1128 mm [10]. The region displays an average high and low temperature of 26°C and 11°C correspondingly. In Wondo Genet, the precipitation pattern follows a bimodal distribution, characterized by brief rainfall episodes from March to May and prolonged rainy seasons from July to October.

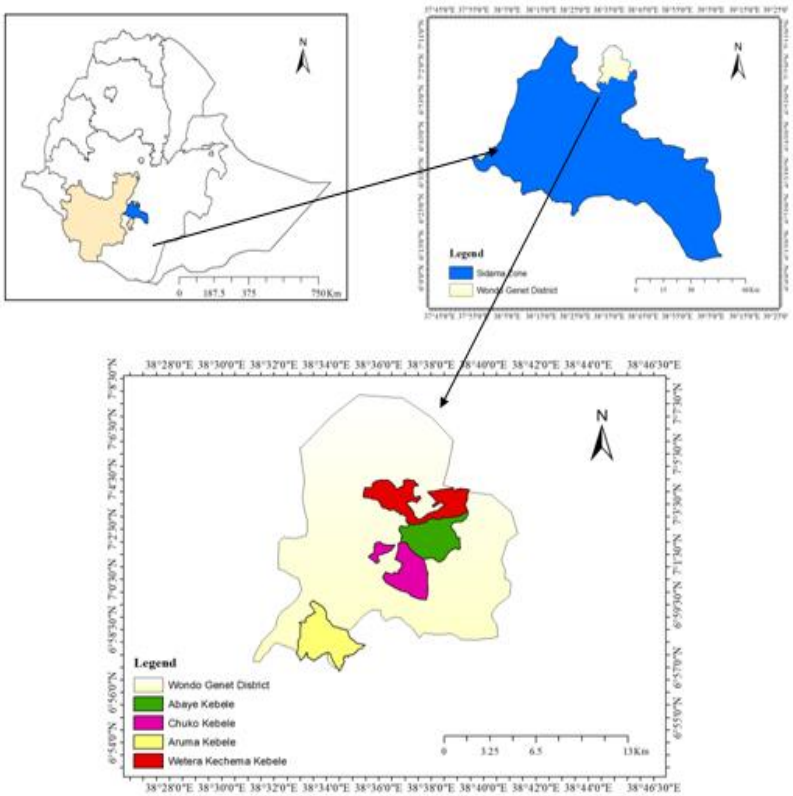

Figure 1. *Description of study area.*

2.2. Experimental Colonies and Their Management

A total of thirty (30) colonies of *Apis mellifera bandansii honeybee* were established on station. Basic management practices were made reasonably uniform for tested colonies. This experiment was done to evaluate defensive behavior, foraging behavior, honey yield, hygienic, brood area and absconding and swarming tendency.

2.3. Data Collection and Analysis

Defensive Behavior: Temperament measures the aggressiveness behavior of honey bee colonies. The colony's level of aggressiveness was assessed through suspension small the ball is struck against the entrance and lid repeatedly, typically two to three times glove. The essential data and parameters such as the timing of the initial sting on the glove, duration of aggression (mass attack), quantity of stings on the observer's gloves, and the distance covered by the defending bees were meticulously documented.

Assessment of Foraging Behavior: The evaluation of the foraging behavior of honeybees entailed quantifying the quantity of bees departing from the hives during a five-minute period at dusk. Additionally, the periods of early foraging and late foraging were documented.

Honey Yield: For honey yield evaluation a total of 8 bee colonies was established at WGARC. Frames containing sealed honey combs were removed from the colonies for further analysis. Each frame, bearing sealed honey, underwent a weighing process, followed by extraction of the honey using a centrifugal honey extractor. Subsequently, the empty frames post-extraction were also weighed to complete the data collection process. The final calculation of net honey yield involved subtracting the weight after extraction from the initial weight prior to the extraction process.

Hygienic Behavior: The hygienic behavior of the colonies was assessed through the intentional termination of 100 sealed brood cells. Subsequently, the hygienic behavior of the colony was examined after a 24-hour period by tallying the quantity of deceased brood cells that had already been cleared by the colony worker honey bees. The experiments were conducted thrice at various time points on identical conditions colonies. A greater quantity of eliminated deceased brood cells serves as an indication of enhanced hygienic conduct. Ultimately, the percentage of eliminated deceased brood was determined using the formula employed by [11].

$$R = \frac{K-E-C}{T-E} X100$$

Where:

R represents the percentage of deceased larvae eliminated within a 48-hour timeframe.

K denotes the quantity of expired brood removed within the same 48-hour period.

E indicates the count of unfilled cells located on either side of the insert prior to the commencement of the experiment.

C represents the number of sealed brood cells that remain intact after the passage of 48 hours.

T signifies the total quantity of brood cells present on both sides of an insert with a brood area measuring 5cm by 5cm.

Examination of Brood and Adult Habitat, Pollen, Nectar, and Honey Storage Patterns. The complete brood region was quantified every 21 days a wooden frame is utilized and positioned on either side of the brood combs. The entirety of the offspring populations were the measurement is derived from the overall space taken up by the offspring.

Absconding and Swarming tendency: Tendency towards absconding was evaluated by the counting of colonies evacuated the quantity of colonies utilized in the experiment may vary, as long as all colonies are subjected to consistent environmental conditions.

Swarming tendency was the assessment also includes an evaluation based on the quantity of swarms generated and the count of queen cells built throughout the process active the period of reproduction of honeybees.

3. Results and Discussion

3.1. Evaluation of Defensive Behavior

This study was show most of the colony responded to the examiner in a manner that was predominant moderately during the movement of the black ball at the entrance, it is essential to defend against the potential sting that may occur. This precaution should also be taken when opening the lid to ensure safety and smooth operation. The highest score achieved was 340, while the lowest score was not specified 60 stings recorded and mean +standard deviation (57.6±15, 9.3±32) on black ball and on glove was recorded respectively (table 1). This investigation was conducted to related with [12] which reported that 52.75±9.7 stings on balls from *A. M.* secutellata. But the resent study show A.M. bandasi show less defensive in study area than [13] which reported 540 and 80 maximum and minimum stings respectively.

This investigation focused on quantifying the frequency of stings and the distance traveled by the subjects. The methodology employed in this study included measuring the number of stings and the distance covered by the honeybee the relationship is directly proportional. The average quantity of stings observed in the colonies following a disturbance of *A.m. bandansi* was 158±15.3 on leather ball (Table 1). This result was lower than the number of sting reported by [13] which is 282 stings but the resent study was higher than [14,

8] which reports 80±5.08 and 21.5 sting on black ball for *A.M wayi Gambella* and *A.M moticolla* respectively. The variation the manifestation of aggressive behavior in honeybees is linked to various environmental factors, genetic characteristics, colony strength, and ample food reserves honey and pollen the quantity of alarm generated. There exists a significant amount of variation in defensive behavior, both among different groups and within individual groups of honey bee species [15] even within colonies led by queens with a genetic relationship, which are maintained in uniform environments within a single apiary [16, 17]. Factors leading to such variability in defensive behavioral phenotypes encompass social (non-linear) interactions [18, 19].

Mass attack of the colony happened within 19.2±2.5 seconds. The average distance traveled for defense and sting was 255±74.4 meters. This study was related with [13] which reported that 283 meters at jima Area. This suggests that the *Apis mellifera bandansi*i species exhibit high levels of defensiveness, posing a significant challenge when attempting to interact with them protective close and at day time.

Table 1. *The collective defensive behavior of the colony within the specified study region.*

Parameter	Mean+ sd
First sing (sec)	14.6±2.23
Time become aggressive (sec)	19.2±2.5
Number of sting on black ball	158±15.3
Number of sting on glove	9.3±2.5
Distance followed (m)	255±74.1

3.2. Foraging Behavior

Bees can also be classified as generalists or specialists depending on their foraging habits. The initiation of foraging behavior in honey bees is a well-documented phenomenon, typically commencing in the early hours of the morning and concluding by evening. Research indicates that in certain investigations, the foraging efforts of honey bee workers commenced precisely at 6.17 am. But in this study it was started early morning at 5:30 am and completed its foraging activity at 6:50- 7:15 pm let evening (Table 2). However, the foraging activities and time of first flight out and come back to the hive at the end weather conditions may have an impact on it, season and of the condition of the area in question is under scrutiny and examination. The current study reveals that *A.M badansi* start foraging earlier and back getting to the hive than the results of [13] which reported 6:25am, 6:40 pm for early morning and let getting back to the hive respectively at jimma area. But it is a line delineating the outcomes [8] which reports that 5:25am, 7:04 pm for early morning and let back getting to hive respectively for *A.M. moticolla* at northern part of Ethiopia.

The mean and standard deviation of bee within five (5) minutes during observation 4.1±1.3, 8.1±1.4 and 11.7±0.7 for early morning, 2015, 2016 and 2017respectivily. The mean and standard deviation of bee let back getting to hive were 7.2±1.5, 6.5±1.4 and 8.3±1.8 for 2015, 1016 and 2017 respectively.

Table 2. *The mean standard deviation of foraging behavior.*

Year	Number of bee during observation	Mean±sd
2015	Early morning	4.1±1.3
	Let foraging morning	10.6±1.5
	Let foraging evening	7.2±1.5
2016	Early morning	8.1±1.4
	Let foraging morning	21.5±23
	Let foraging evening	6.5±1.4
2017	Early morning	11.7±0.7
	Let foraging morning	32.3±2.7
	Let foraging evening	8.3±1.8

NB. Early foraging from 5:30 ---6:10 am
Late foraging from 6:55-----7:15pm

3.3. Honey Yield

Honey production and productivity are contingent upon a multitude of factors and the prevailing conditions specific to the region. The types of honey bee races present, the agro-ecological setting, the prevailing weather conditions, the accessibility of food sources such as pollen, nectar, and resins, as well as the health status and strength of the colonies, all collectively contribute to influencing the yield of honey production. The mean the annual honey production per beehive is measured in kilograms is shown in Table 3. This study show that in study area honey was harvested 3(three) times per years. The harvesting time was November, February and may. The annual honey production per beehive is measured in kilograms was 10.903±2.46, 12.89±2.16 and11.28±1.93 (kg) for 2015, 2016and 2017 respectively. This study was comparable with [13] which reports 14±2, 9.67 ±1.53 and 12.33±4.5 (kg) in 2016, 2017 and 2018 years at Jimma respectively. Echter, *A.m.bandansii* colonies exhibited a notable decrease in honey production yield compared to the average national yield (19.8 kg) of colonies in frame hives which reported by [20]. The obtained result surpassed the honey production outcomes per harvesting period per colony of A. m. scutellata honeybees (9.64 and 11.54 in 2011 and 2012, respectively) documented by the researcher [21] in

Anna Sorra District. In the study area, the highest level was observed honey yield was obtained during the February than other two seasons, because of during Novembers the colony was recovered from long rainy season and strength themselves and during may there were long drought before attaining of production season.

Table 3. *Mean and standard deviation of honey yield in season and year.*

Year	Harvesting Time	Mean ±standard deviation
2015	November	9.7±1.8
	February	13.73±1.04
	May	9.3±0.62
	Mean	10.90±2.46
2016	November	11.73±1.7
	February	15.38±105
	May	11.38±1.40
	Mean	12.89±2.16
2017	November	11.38±1.40
	February	13.16±5.6
	May	9.3±0.55
	Mean	11.28±1.93

3.4. Hygienic Behavior

The detail of hygienic behavior of study area was shown in table 4.

Hygienic behavior was assessed through a pin-killed brood assay, whereby the duration was meticulously documented for colonies to identify and eliminate deceased brood from a segment of comb encompassing 100 cells (comprising around 100 capped pupae) on a singular side of the comb. It is trait for a trait for natural defense against diseases and parasites. The present result shows that colonies remove 94±2.80% from pin killed broods within 24hrs. This study similar with [12] which stated that 95.7% ±0.75% for *A. m. secutellata* at pawe. [22] reported that colonies deemed hygienic were those that removed more than 90% of deceased brood within a 24-hour timeframe. So this study showed that the A.M *Bandansi* in study area has an excellent hygienic behavior.

Table 4. *The hygienic conduct displayed by A.M. Bandensi.*

Round	Number of pin killed brood	Number of removed brood	%ge of removed
1	135.3	127.43	94.2
2	130.5	126.2	96.7
3	136.7	124.5	91.1
Mean±sd	134.15±3.23	126.04±1.5	94±2.80

Sd= standard deviation

3.5. Evaluation of the Brood and Adult Area, Pollen, Nectar, and Honey Storing Behavior

The adult, brood, pollen and nectar (honey) the measurement was conducted as part of the research time determinare their total the population was assessed by utilizing a gridded wooden frame measuring 5cm x 5cm, which was positioned over each side of the brood combs. The time of the highest brood rearing season was similar to that in a study by [12] during peak flowering time. The aggregate unit areas were derived based on the spatial extent covered by the adult, brood, pollen and nectar or honey occupied and presented in table 5 blow. The total unit was 79.5±13.4, 107.1±24.6, 74.41±31.3 and 48.2±9.0 for adult, brood, pollen and nectar (honey) respectively for 2015. 74.5±6.5, 95.7±48.51, 81.8±31.6 2016 and 77.07±7.6, 96.2±17.4, 50.0±19.4 and 90.7±40.2 for adult, brood, pollen and honey or nectar respectively for 2017. Honeybees are impacted by environmental factors due to their lack of hibernation or diapause. [23]. Temperature plays a crucial role in influencing colony activity and the strength of bees. Significant fluctuations in temperature have the potential to halt the process of brood rearing or lead to the mortality of bees [24, 25].

While variations exist in terms of race, geographic location, and numerical value, it is important to note that these factors are interconnected with the research findings [26, 12].

Table 5. *The quantity of mature bees, brood space, pollen reserves, and honey storage within a colony 5*5cm^2.*

Year	Months	Adult	brood	pollen	Nectar
2015	November	70.04±16.7	124.5±25.8	95.52±21.3	39.2±17.7
	December	88.9±13.5	89.9±22.02	51.3±16.5	57.2±23.2
	Mean±sd	79.5±13.4	107.1±24.6	74.41±31.3	48.2±9.0

Year	Months	Adult	brood	pollen	Nectar
2016	January	74.1±19.8	84.6±11.5	25.3±4.3	112.3±27.5
	May	68.2±12.4	78.7±14.4	16.04±3.6	94.6±33.7
	November	81.2±14.4	123.9±36.8	104.3±16.9	45.9±16.3
	mean±st	74.5±6.5	107.1±24.6	48.5±16.9	81.8±31.6
2017	January	93.5±2.0	26.5±3.5	81.9±2.0	124.3±28.1
	May	80.3±17.0	14.2±3.5	68.3±24.6	101.1±21.2
	November	114.8±20.5	106.4±19.4	80.8±21.6	46.4±20.7
	mean±sd	77.0±7.6	96.2±17.4	50.0±19.4	90.7±40.2

Sd= standard deviation.

3.6. Evaluation of the Absconding and Swarming Behavior of *Apis mellifera. Bandancsi*

The percentage of absconded colony during study was presented in table 6 blow.

The act of absconding was necessitated by various external factors such as diseases, pests, environmental conditions, and other forms of disturbances [27]. The present study has revealed that absconding of the absconding tendency of *A. m bandansi* at study area was related to [13] which shows, the act of absconding was deemed severe within the colonies under observation, primarily attributed to persistent disruptions, infestations by pests, and the inadequacy of bee forage during the rainy season. This phenomenon could potentially be linked to a scarcity of resources or the application of pesticides for agricultural purposes in the vicinity. [28]. These study show that *A.M. Bandansi* in study area highest absconding percentage was recorded at establishment years (2015) which account 50 % and decreasing year by year.

The propensity of colonies to swarm was assessed through the enumeration of queen cells built by all colonies within the study, as well as the count of swarms generated during the typical reproductive season of honeybees. In comparison to European honey bees, Africanized honey bees exhibit a considerably higher rate of swarming, yielding between six to twelve swarms annually [29]. The current study was showed that the maximum quantity of queen cells was observed counted started from the beginning of November to the mid of January. Because during this time was the highest floral flowing in the study area. These studies was similar with [13] which says that The outcome demonstrated a heightened inclination towards swarming, which was noted to be more prominent in the months of October and November compared to all other seasons within the duration of the research.

Table 6. *Percentage absconded of A.M. bandansi in the study area.*

Year	Number of colony established	Number of colony absconded	% of absconded
2015	30	15	50
2016	30	10	33.3
2017	30	8	26.7

4. Conclusion and Recommendation

A. m. bandasi races are situated in the central western to south eastern highlands part of Ethiopia. In the geographical region under examination this race had mostly similar behavior and productive performances with other ecotypes of the country

Ecotypes from the same region display comparable behavior and demonstrate productive performances akin to their counterparts in other areas of the country, but there was little variation in some behavior. It also showed that from moderately to the behavior observed in the African honey bee species is characterized by a strong emphasis on defense and hygiene in the country. The mean number of the sting for the colonies undergo changes following a disruption in the morning A. M *bandansi* was158±15.3 and the average distance travelled for defensive

and sting 255±74 meters away from the hive. This race was highly hygienic above 998% pin-killed dead brood within 24hours in most colonies. This best the significance of hygienic performance may play a crucial role in the resistance against diseases, such as varroa mites, pests, wax moths, and bee beetles. Under optimum management *AM bandesi* showed less absconding tendency. In general, the *Apis mellifera bandansi* race demonstrates favorable hygienic characteristics and exhibits efficient honey production when subjected to appropriate management strategies.

This study suggests conducting additional research on the specification of geographical locations in relation to the distribution of different races and their identification for the purpose of breed determination and enhancement. These studies aid in the selection of colonies that are more favorable in terms of production efficiency, temperament, and resilience to pests, parasites, and diseases, foraging and absconding tendency.

Abbreviations

KG	Kilo Gram
KM	Kilo Meter
ILRI	International Livestock Research Institute
MOA	Ministry of Agriculture

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Author Contributions

Edao Shanku: Conceptualization, Formal Analysis, Software, Writing – original draft

Firomsa Ijara: Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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